APPENDIX 7: COMMERCIAL FISHERIES IMPACT ASSESSMENT

BASIC ASSESSMENT FOR A SPECULATIVE 3D SEISMIC SURVEY OFF THE EASTERN CAPE, SOUTH AFRICA

COMMERCIAL FISHERIES SPECIALIST STUDY

September 2022

Prepared for the Environmental Assessment Practitioner:

SLR Consulting (South Africa) (Pty) Ltd

On behalf of the client:

Capricorn Marine Environmental

CapMarine
Capricorn Marine Environmental

PO Box 50035 Waterfront
Cape Town South Africa 8002
Unit 15 Foregate Square
FW de Klerk Boulevard
Cape Town South Africa 8001

Telephone +27 21 425 2161
Fax +27 21 425 1994

www.capfish.co.za

EXPERTISE AND DECLARATION OF INDEPENDENCE

03 April 2023

This report was prepared by Sarah Wilkinson of Capricorn Marine Environmental (Pty) Ltd (CapMarine). Ms Wilkinson has a BSc (Hons) degree in Botany from UCT and is a professional natural scientist registered with the SA Council for Natural Scientific Professions (SACNASP).

As one of the directors of the company since 2008, Sarah has considerable experience in undertaking specialist environmental impact assessments and baseline studies relating to marine hydrocarbon and minerals exploration. She specialises in spatial and temporal analysis (GIS) of fisheries exploitation in the southern African region.

This specialist report was compiled for SLR Consulting (South Africa) (Pty) Ltd (SLR) for their use in compiling an Environmental Management Plan for a 3D seismic survey proposed by CGG, offshore of the Eastern Cape Coast, South Africa. I hereby declare that CapMarine is financially and otherwise independent of the Applicant and of SLR.

Sarah Wilkinson

EXECUTIVE SUMMARY

CGG Services SAS (CGG) is applying for a Reconnaissance Permit to undertake a speculative three-dimensional (3D) seismic survey over a number of licence blocks in the Algoa/Outeniqua Basin off the Southeast Coast of South Africa. The Reconnaissance Permit Area is situated in water depths of between 200 m and 4 500 m, roughly between the Robberg Peninsula in the Western Cape and Cape Recife in the Eastern Cape and extends from approximately 50 km offshore at its nearest point off Cape Recife to 180 km. The application area covers an area of approximately 12 750 km^2. The proposed survey acquisition area would, however, only cover an area of approximately 9 000 km^2 within the application area. As part of a previous reconnaissance permit application process, CGG had liaised with the commercial fishing sector and has taken concerns regarding the potential overlap with key fishing grounds into consideration in planning for its data requirements.

The survey would be undertaken by a dedicated vessel towing a short array of airguns (sound source) and an array of up to 8 streamer cables (sound receivers) with a maximum length of 6 000 m. The streamer array would be towed at a depth of 12 m below the sea surface. The duration of the survey would be up to 120 days with an anticipated commencement date of January/February 2024, subject to permit award.

SLR Consulting (South Africa) (Pty) Ltd has been appointed as the Independent Environmental Assessment Practitioner (EAP) to undertake a Basic Assessment process for the proposed exploration activities. Capricorn Marine Environmental (Pty) Ltd has been contracted to provide a specialist assessment of the potential 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 south and south-east coast of South Africa. These impacts have been identified as those arising during planned operations namely noise emitted by the seismic survey operation and temporary exclusion from fishing grounds, and accidental events such as hydrocarbon spill and loss of survey equipment to sea.

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 acquisition area. The impact on catch rates due to sound elevation levels was assessed using the results of a Sound Transmissions Modelling Loss (STML) study and sensitivity / vulnerability differences amongst each fishing sector. 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 survey is expected to be ~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 240 m from the source. Fish species without swim bladders have higher injury impact thresholds, and therefore a smaller zone of potential injury within 120 m from the array source. The zones of potential recoverable injury (TTS effect) for fish species with and without swim bladders are predicted to be up to 2 km from the survey lines for the cumulative 24-hour operation scenario considered. 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) is considered to be relatively high to moderate behavioural risks are expected at near to intermediate distances (tens to hundreds of meters) from the source location and relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location extending to a distance of ~4 km from the sound source. With the location of the proposed survey area ensuring minimal overlap with key fishing areas, January/February commencement and the implementation of the project controls and mitigation measures, the residual impact due to noise impacts is considered to be of **LOW significance for the demersal trawl, midwater trawl, demersal longline, large pelagic longline and south coast rock lobster sectors (and DFFE research surveys)**. There is **no impact expected on the small pelagic purse-seine, linefish, squid jig, netfish and small-scale fisheries sectors** as these fishing grounds are situated beyond the expected range for disturbance by underwater noise.

During the seismic survey, fishing vessels could be required to maintain a safe operational distance of up to 6 nautical miles from the survey vessel. The impact of potential exclusion was assessed for each commercial sector based on the affected area of fishing ground and the relative quantities of catch reported within the proposed Reconnaissance Permit Application area (which includes a buffer around the survey acquisition area to accommodate vessel turning circles). With the location of the proposed survey area ensuring minimal overlap with key fishing areas, January/February commencement and the implementation of the project controls and mitigation measures, the residual impact due to fisheries exclusion is considered to be of **LOW significance for demersal longline, large pelagic longline, south coast rock lobster, demersal trawl and midwater trawl sectors**. There is **no impact expected on the small pelagic purse-seine, linefish, squid jig, netfish and small-scale sectors**.

Stock biomass estimate surveys by DFFE would be expected within the seismic survey area over the period April/May (demersal trawl) and November (acoustic survey for small pelagic species). Seismic survey operations that coincide with scheduled **fisheries research surveys could result in an impact of overall LOW significance**.

Fishery Sector	Percentage (%) Overlap with Reconnaissance Permit Application Area		Residual Impact Significance			
	Catch	Effort	Exclusion Zone	Underwater Noise	Accidental Spill	Loss of Equipment at Sea
Demersal Trawl	6.4	6.8	Low	Low	Very Low	Very Low
Midwater Trawl	16.2	18.2	Low	Low	Very Low	Very Low
Demersal Longline (hake-directed)	6.7	6.2	Low	Low	Very Low	Very Low
Demersal Longline (shark-directed)	0	0	No Impact	No Impact	Very Low	Very Low
Small Pelagic Purse-Seine	0	0	No Impact	No Impact	Low	Very Low
Large Pelagic Longline	3.3	3.4	Low	Low	Very Low	Very Low
Traditional Linefish	0	0	No Impact	No Impact	Low	No impact
South Coast Rock Lobster	1.9	1.7	Low	Low	Very Low	No impact
Squid Jig	0	0	No Impact	No Impact	Low	No impact
Small-Scale Fisheries	0	0	No Impact	No Impact	Low	No impact
Netfish	0	0	No impact	No impact	Low	No impact
Fisheries Research	Present April/May & Oct/Nov	Present, April/May & Oct/Nov	Low	Low	Very Low	Very Low

Fishing intensity within the reconnaissance permit area increases inshore of the 900 m depth contour, with only the large pelagic longline sector operating in deeper waters. Based on a seasonal increase in fishing effort of several fishing sectors over the period December to March, taking cognisance of survey duration, it is recommended the survey be initiated in January/February. This could reduce the disruption to the demersal trawl, demersal longline and south coast rock lobster sectors, but would, however, not affect the overall significance ratings of the impact on these sectors. Although the increase in underwater noise is not expected to impact the squid resource, which is targeted from November to March inshore of the survey area, as a precautionary approach it is recommended that shallow-water acquisition be undertaken during April and/or May, during which time the squid fishery is closed. It is, however, acknowledged that this might not be technically feasible due to the Agulhas current and related survey lines orientation.

Prior to the commencement of survey activities, affected fisheries 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 the SA Tuna Association, SA Tuna Longline Association, Fresh Tuna Exporters Association, South African Deepsea Trawling Industry Association (SADSTIA), South African Hake Longline Association (SAHLLA), South Coast Inshore Trawl Fishing Industry Association (SECIFA), South Coast Rock Lobster Association, South African Squid Management Industrial Association (SASMIA) and the South African Midwater Trawling 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 reconnaissance permit area.

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ACRONYMS, ABBREVIATIONS AND UNITS

ALARP	As Low As Reasonably Practicable
CapMarine	Capricorn Marine Environmental (Pty) Ltd
CPUE	Catch Per Unit Effort
dB	Decibel
DFFE	Department of Forestry, Fisheries and Environment
DMRE	Department of Mineral Resources and Energy
EAP	Environmental Assessment Practitioner
EMPr	Environmental Management Programme
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
NEMA	National Environmental Management Act 107 of 1998, as amended
m	Metres
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (No. 28 of 2002)
SADSTIA	South African Deep-Sea Trawling Industry Association
SAHALLA	South African Hake Longline Association
SANHO	South African Navy Hydrographic Office
SAPFIA	South African Pelagic Fishing Industry Association
SASMIA	South African Squid Management Industrial Association
SATLA	South African Tuna Longline Association
SEL	Sound Exposure Level
SLR	SLR (Consulting) South Africa (Pty) Ltd
SPL	Sound Pressure Level
t	Tonnes
TAC	Total Allowable Catch
TAE	Total Allowable Effort

ToR	Terms of Reference
VMS	Vessel Monitoring System
μPa	Micropascal

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

CGG Services SAS (CGG) is applying for a reconnaissance permit to undertake a speculative three-dimensional (3D) seismic survey to investigate for oil and gas reserves in a number of petroleum licence blocks in the Algoa/Outeniqua Basin off the Southeast Coast of South Africa. The Reconnaissance Permit Area is situated roughly between the Robberg Peninsula in the Western Cape and Cape Recife in the Eastern Cape and extends from approximately 50 km offshore at its nearest point off Cape Recife to 180 km. It covers an area of approximately 12 750 km^2. Data acquisition within the reconnaissance permit application area would, however, only cover a specific target area of ~9 000 km^2 and would exclude marine protected areas (MPAs) as well as a 2 km buffer around the Port Elizabeth Corals MPA. As part of a previous reconnaissance permit application process, CGG had liaised with the commercial fishing sector and has taken concerns regarding the potential overlap with key fishing grounds into consideration in planning for its data requirements. The location of the Reconnaissance Permit application area is shown in Figure 1.1.

SLR Consulting (South Africa) (Pty) Ltd (SLR) has been appointed by CGG to undertake a Basic Assessment process in terms of the National Environmental Management Act, 1998 (No. 107 of 1998) as part of applying for an Environmental Authorisation for the proposed seismic survey. SLR in turn has approached Capricorn Marine Environmental (Pty) Ltd to provide a specialist report on potential impacts of the proposed operations on commercial and small-scale fisheries in the area.

The duration of the survey could cover up to 120 days during a summer survey window period. Subject to obtaining authorisation, CGG is proposing to undertake the survey commencing in January/February 2024 assuming permit award.

The survey would be conducted by a dedicated vessel towing a short source array (airguns) and receiver (hydrophone) of up to 8 streamers spaced 200 m apart and extending 6 km astern of the survey vessel. The streamer/s would be towed at a depth of approximately 12 m and would not be visible, except for the tail-buoy at the far end of the cable. As the survey vessel would be restricted in manoeuvrability, other vessels should remain clear of it. A supply/chase vessel usually assists in the operation of keeping other vessels at a safe distance.

The sound source or airgun array would be situated some 80 m to 150 m behind the vessel at a depth of approximately 7 m below the surface.

The survey vessel would steam a series of predefined transects describing the survey grid, the headings of which would be fixed and reciprocal. During surveying the seismic vessel would travel at a speed of between four and six knots and the sound sources would be discharged by the airgun array.

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).

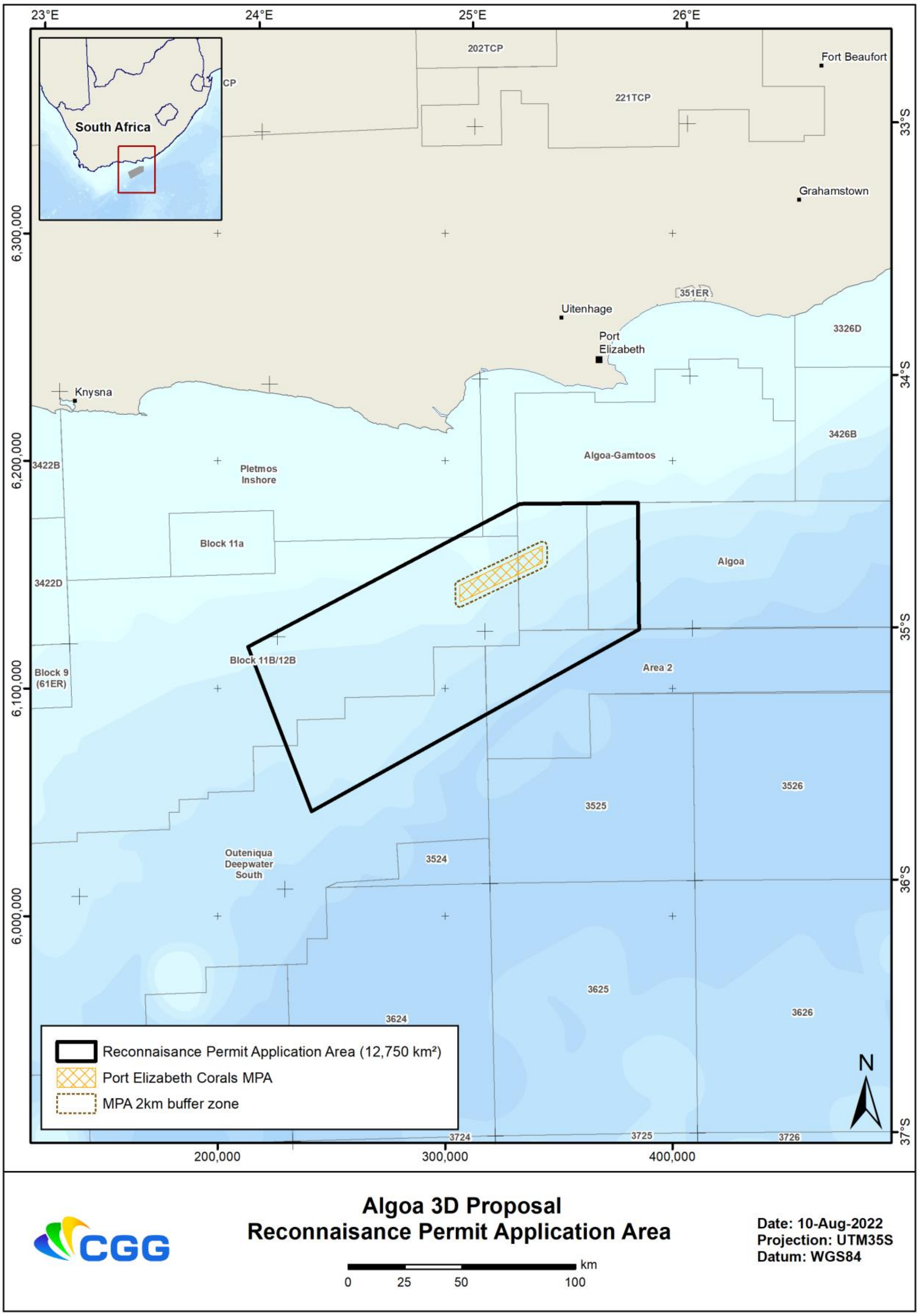


Figure 1.1: Locality map of CGG's Reconnaissance Permit Application area situated off the Southeast Coast of South Africa.

1.2 TERMS OF REFERENCE

The Scope of Work for the commercial fisheries assessment are as follows:

- Present a 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 and methods used are presented.
- A literature review of the specific identified sensitivities of commercial fishing sectors related to the impacts arising as a result of the proposed activities;
- A description of the fisheries sectors operating in the South African Exclusive Economic Zone, including a spatial and temporal assessment of recent and historical fishing catch and effort;
- Detailed maps delineating fishing grounds relative to the reconnaissance application area and proposed survey area;
- Identify and assess the potential impacts on commercial catches in terms of disruption to normal fishing activity and potential loss of catch;
- Identify any practicable mitigation measures to reduce negative impacts on the fishing industry; and;
- Describe any assumptions made and any uncertainties or gaps in knowledge.

1.3 APPROACH AND METHODOLOGY

1.3.1 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 2017 to 2020 (where available). All data were referenced to a latitude and longitude position and were redisplayed on a 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).*

The information for the identification of potential impacts was primarily drawn from the marine fauna specialist report for this project (Pisces Environmental) as well as a number of scientific publications and primarily literature reviews by Carroll *et al.* (2017).

1.3.2 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 reconnaissance permit area / area of interest. 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 20% 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, calculations of potential loss of catch were based on the assumption that fisheries would be excluded from the entire Reconnaissance Permit area for the entire duration of the survey. In practice, the exclusion area would be a moving footprint of approximately 165 km^2 extending around the vessel (based on the required safety clearances shown in Figure 3.1). Thus this approach is likely to be an overestimate of the potential impact on fishing operations.
- The acoustic impact has been considered to affect the entire Reconnaissance Permit Application area. The transitory nature of the acoustic impact has not been factored into the assessment i.e. that the sound source moves in space and time as the survey progresses within the target area. Thus the calculations of potential reduction of catch are therefore likely to be overestimates.
- The effects of seismic sound on the Catch Per Unit Effort (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 also likely 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.

1.3.3 IMPACT ASSESSMENT METHODOLOGY

The proposed Project's potential significant impacts on commercial 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; 2) effects on catch rates due to noise disturbance in the wider vicinity of the survey area and 3) accidental events e.g. hydrocarbon spills and loss of survey equipment to sea.

The spatial distribution of catch was mapped at an appropriate resolution for each fishing sector (based on the fishing method and resulting area covered by fishing gear). The Reconnaissance Permit Application area was provided by the client and includes the proposed seismic acquisition area as well as the vessel manoeuvring area[1]. The potential zone of acoustic disturbance to fisheries catch rates was assumed to be within 5 km of the acquisition area thus the area affected by underwater sound was assumed to be limited to within the Reconnaissance Permit Application. The average annual catch and effort reported by each sector within the impacted area was expressed as a percentage of overall total landings and effort expenditure.

The convention used to evaluate the significance of the impact was provided by SLR and is presented in Appendix 1. The sensitivity of the receptor was derived from the baseline information and relates to the 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 impact magnitude (or consequence) was determined based on a combination of the

[1] The vessel manoeuvring area includes turns between survey lines and run-ins to the start of the survey line.

"intensity", "duration" and "extent" of the impact. Magnitude 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 DESCRIPTION OF RECEIVING ENVIRONMENT: FISHERIES BASELINE

2.1 OVERVIEW OF FISHERIES SECTORS

South Africa has a coastline that spans two ecosystems over a distance of 3 623 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 14 different commercial fisheries sectors currently operate within South African waters. Table 2.1 lists these along with ports and regions of operation, catch landings and 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 2.1. 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*). 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 Gqeberha 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 canning of sardine. Smaller fishing harbours on the West / South-West Coast include Port Nolloth, Hondeklipbaai, Doringbaai and 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 commonly use boats but occur mainly close to the shore. 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.

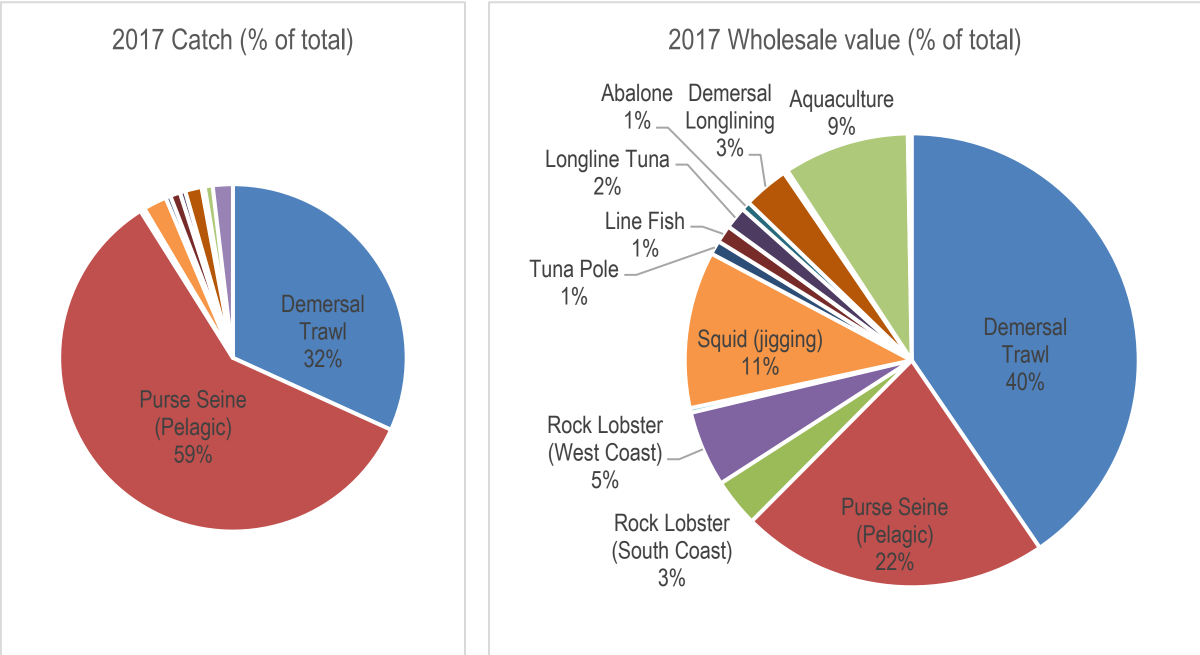


Figure 2.1: Pie chart showing percentage of landings by weight (left) and wholesale value (right) of each commercial fishery sector as a contribution to the total landings and value for all commercial fisheries sectors combined (2017). Source: DEFF, 2019.

Table 2.1: 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
Mid-water trawl	34 (6)	19555			
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

Sector	No. of Rights Holders (Vessels)	Catch (tons)	Landed Catch /sales (tons)	Wholesale Value of Production in 2017 (R'000)	% of Total Value
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 2.2: 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 in Priority	Target Species
Small pelagic purse-seine	West, South Coast	St Helena Bay, Saldanha, Hout Bay, Gansbaai, Mossel Bay	Anchovy (*Engraulis encrasicolus*), sardine (*Sardinops sagax*), Redeye (*Etrumeus whiteheadi*)
Demersal trawl (offshore)	West, South Coast	Cape Town, Saldanha, Mossel Bay, Gqeberha	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 (mackerel (*Trachurus capensis*)
Mid-water trawl	West, South Coast	Cape Town, Gqeberha	Adult horse mackerel (*Trachurus capensis*)
Demersal long-line	West, South Coast	Cape Town, Saldanha, Mossel Bay, Gqeberha, Gansbaai	Shallow-water hake (*Merluccius capensis*)
Large pelagic long-line	West, South, East Coast	Cape Town, Durban, Richards Bay, Gqeberha	Yellowfin tuna (*T. albacares*), big eye tuna (*T. obesus*), Swordfish (*Xiphius gladius),* southern bluefin tuna (*T. maccoyii*)
Tuna pole	West, South Coast	Cape Town, Saldanha	Albacore tuna (*T. alalunga*)
Linefish	West, South, 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, Gqeberha	*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	Gqeberha, Port St Francis	Squid/chokka (*Loligo vulgaris reynaudii)*
Gillnet	West Coast	False Bay to Port Nolloth	Mullet / harders (*Liza richardsonii*)
Beach seine	West, South, East Coast	Coastal	Mullet / harders (*Liza richardsonii*)
Oysters	South, East Coast	Coastal	Cape rock oyster (*Striostrea margaritaceae*)

Sector	Areas of Operation	Main Ports in Priority	Target Species
Seaweeds	West, South, East	Coastal	Beach-cast seaweeds (kelp, *Gelidium* spp and *Gracilaria* spp
Abalone	West Coast	Coastal	*Haliotis midae*

2.2 SPAWNING AND RECRUITMENT OF FISH STOCKS

The South African coastline is dominated by seasonally variable and sometimes strong currents, and most species have evolved highly 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 coast 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.

The principal commercial fish species undergo a critical migration pattern in the Agulhas and Benguela ecosystems (see Figure 2.2). Adults spawn on the central Agulhas Bank in spring (September to November) and spawn move southwards with the Agulhas current before drifting northwards in the Benguela current across the shelf. As 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 – this takes place from October through to March. Juveniles shoal and then begin a southward migration – it is at this stage that anchovy and sardine are targeted by the small pelagic purse seine fishery. Demersal species such as hake migrate offshore into deeper water.

Squid (*Loligo vulgaris reynaudyi*) spawn inshore (largely between Cape St Francis and Algoa Bay) where they aggregate at specific locations and at preferred depths, substrate type and temperatures (Augustyn *et al.* 1992).

Off the KwaZulu-Natal coastline, the Natal Bight is an important nursery area for successful recruitment of linefish species to the shelf region. Both the Tugela, as well as the many estuaries along the KZN coastline, serve as important nursery areas for many of these species.

Figure 2.3 shows the reconnaissance permit area and proposed area of interest for 3D seismic acquisition in relation to important pelagic and demersal fish, and squid spawning areas. The inshore portions of the project area overlaps with major fish spawning and migration routes, and ichthyoplankton abundance in inshore waters over the continental shelf (<200 m) is likely to be seasonally high. Larval concentrations vary between 0.005 and 4.576 larvae/m^3 decreasing rapidly with distance offshore (Beckley & Van Ballegooyen 1992). In the offshore portion of the project area, ichthyoplankton abundance is, however, expected to be low (Pulfrich, 2022).

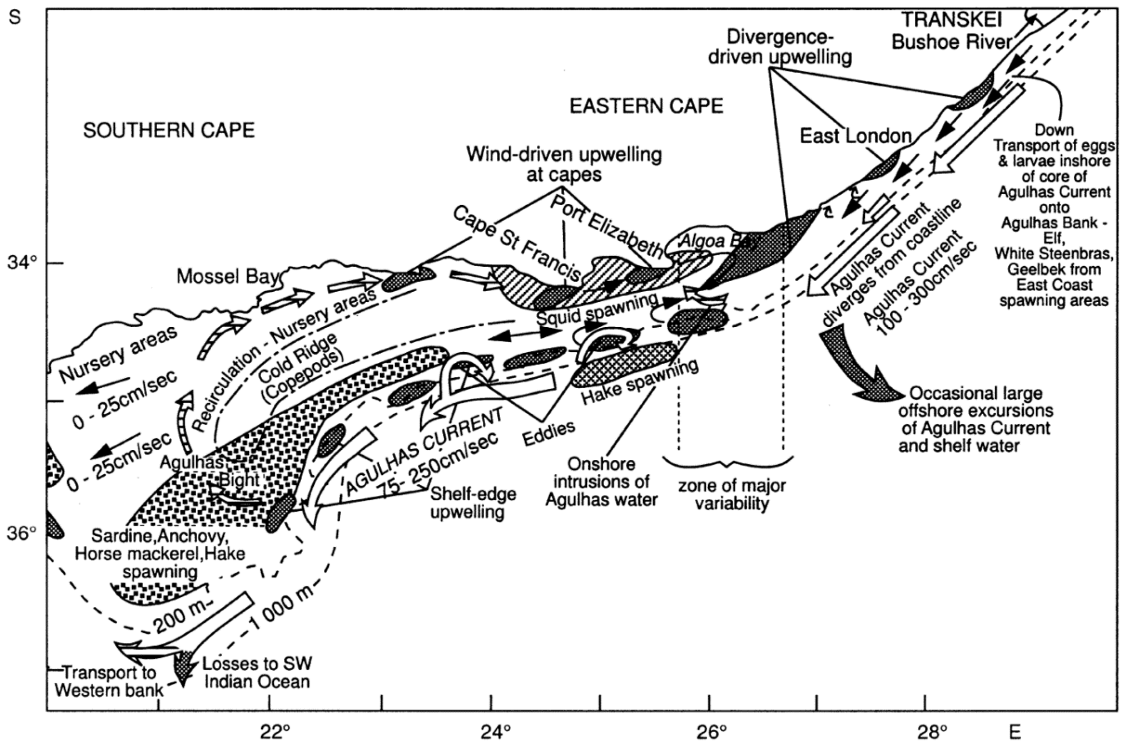


Figure 2.2: Generalised figure showing the central-eastern Agulhas Bank nursery and spawning grounds for primary commercial species (after Hutchings *et al.*, 2002).

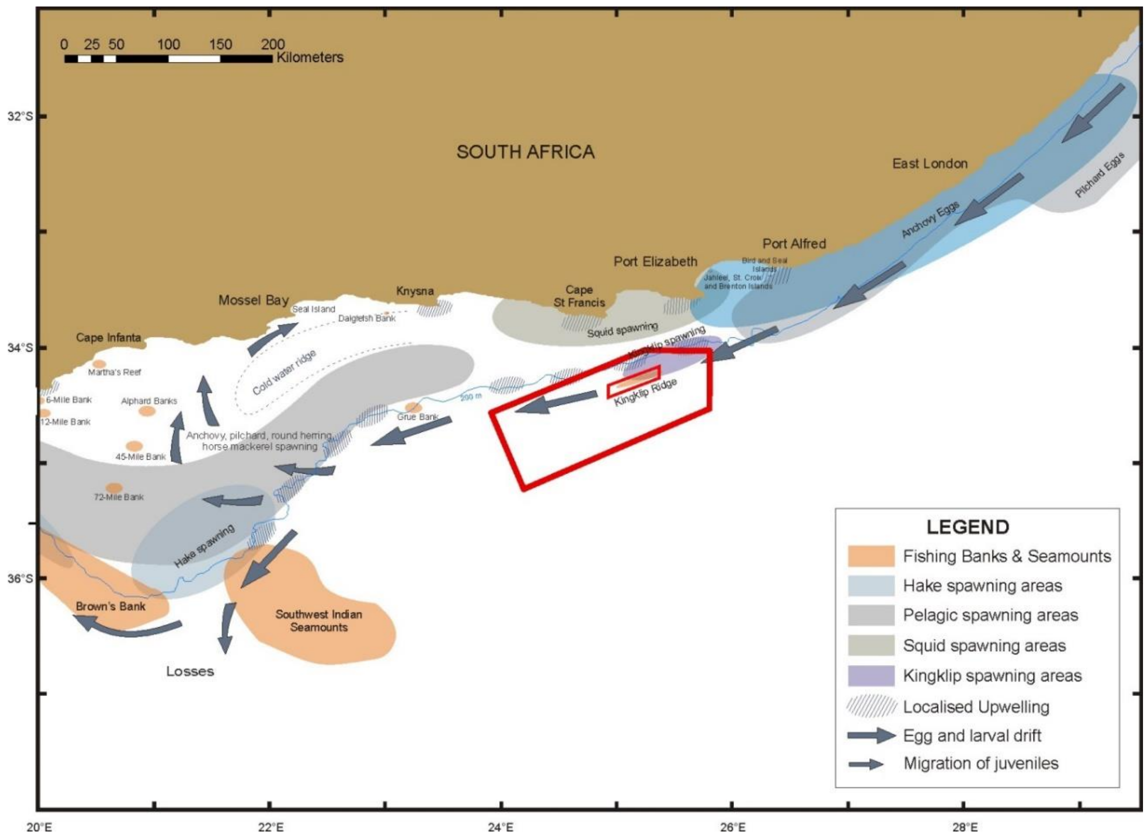


Figure 2.3: The Reconnaissance Permit Area (red polygon) in relation to important pelagic and demersal fish, and squid spawning areas. The 200 m depth contour is also shown. (Source Pulfrich, 2022 after Anders 1975; Crawford *et al.* 1987; Hutchings 1994).

2.3 COMMERCIAL FISHING SECTORS

As noted previously, CGG has considered the key fishing grounds in making a decision on the extent of the area of interest in order to reduce the potential impact on fisheries. The text below reflects the percentages of overlap with fishing grounds.

2.3.1 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. Vessels operating in the inshore sector usually trawl throughout the traditional "inshore" area i.e. in waters shallower than the 110 m isobaths, but are not restricted from operating in deeper water. By contrast, vessels operating in the deep-sea trawl fishery may not operate in water depths of less than 110 m or within 20 nautical miles of the coast, whichever is the greater distance from the coast.

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 latest value estimates show a steady increase to R550 million and R6 billion for the inshore and offshore trawl fishery, respectively. The 2022 TAC for Cape hake was set at 8 131 and 110 448 tonnes for the inshore and offshore trawl fisheries, respectively . (The remaining 10% is allocated to the hake demersal longline sector – refer to section 2.3.3). A time-series of total hake catch as well as hake catch by sector is shown in Figure 2.4. The annual TAC limits and landings of hake (both species) by the trawl and longline sectors is listed in Table 2.3.

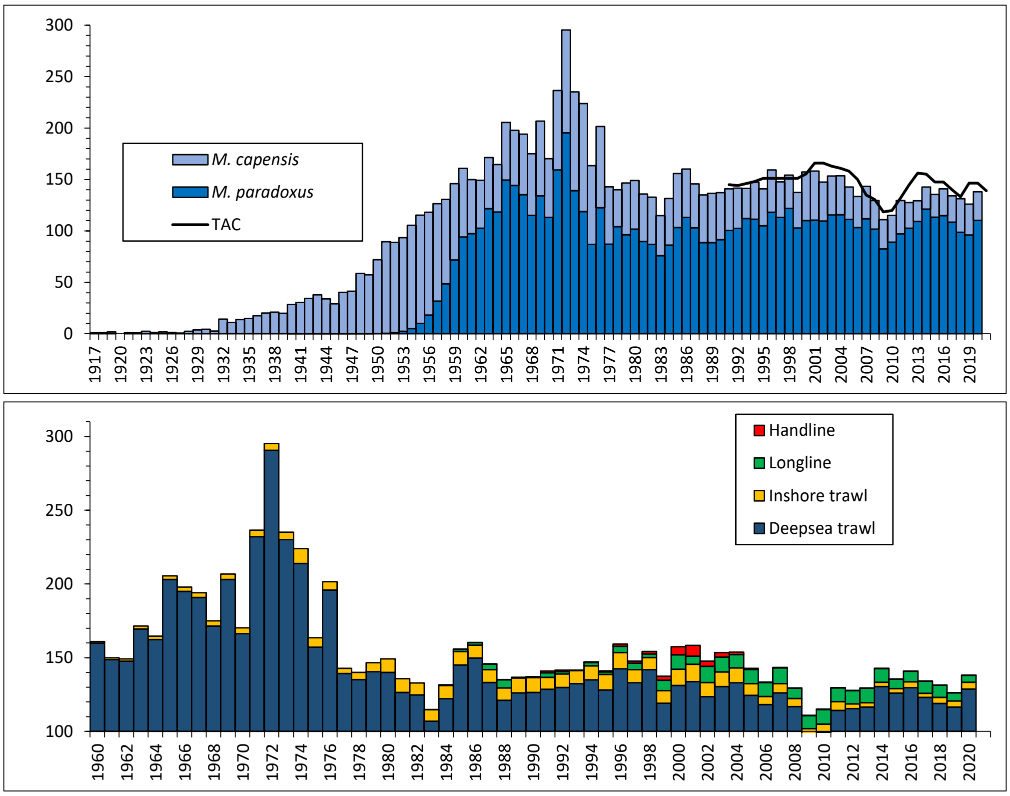


Figure 2.4: (Top panel) Total catches (‘000 tonnes) of Cape hakes split by species over the period 1917–2020 and the TAC set each year since the 1991. (Bottom panel) Catches of Cape hakes per fishing sector for the period 1960–2020. Prior to 1960, all catches are attributed to the deep-sea trawl sector. Note that the vertical axis commences at 100 000 tonnes to better clarify the contributions by each sector. (Source DFFE, 2022)

Table 2.3: 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 DFFE, 2022[2]).

		M. paradoxus					*M. capensis*						TOTAL
Year	TAC	Deep-sea		Longline		TOTAL	Deep-sea		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	5217	90	98777	12689	12863	3983	2615	481	32668	131370
2019	146431	70608	22201	5328	34	98171	14193	9454	4149	3623	299	31718	129898
2020	146400	97093	10061	5847	47	113048	18115	3500	4536	2348	321	28820	141872
2021	139109	102865	15597	5892	18	124372	15585	2937	4517	2932	194	26165	150537

[2] 2 FISHERIES/2022/OCT/SWG-DEM/35rev: Ross-Gillespie (2022). Update to the hake Reference Case Operating Model with corrected longline data, and 2021 commercial and 2022 survey data. Marine Resource Assessment and Management Group, University of Cape Town, Rondebosch, 7701

Figure 2.5: Photograph of MV *Boronia*, a freezer vessel in the South African offshore demersal trawl sector (operated by I&J)

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 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.

The inshore fishery consists of 31 vessels, which operate on the South and East Coasts mainly from the harbours of Mossel Bay and Gqeberha. 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 2.6). 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.

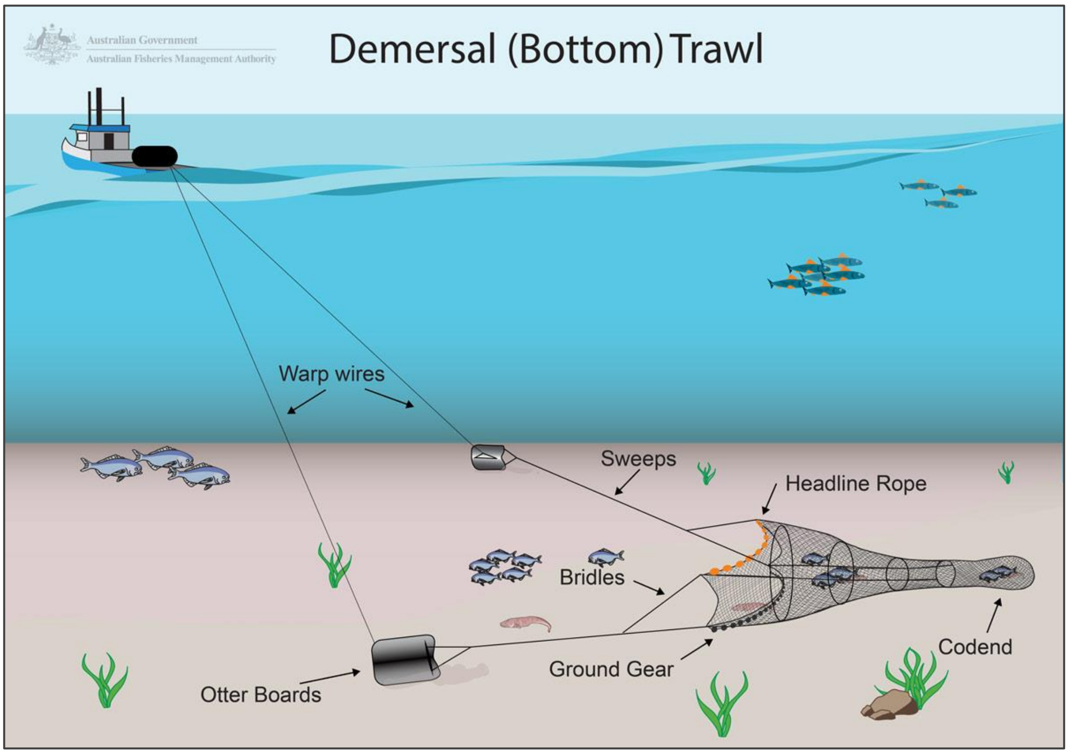


Figure 2.6: Typical gear configuration used by offshore demersal trawlers targeting hake (Source: www.afma.gov.au/fisheries-management/methods-and-gear/trawling).

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 km² and 17 000 km² for the offshore and inshore fleets, respectively. Trawl depths range from approximately 20 m to 980 m, though very few trawls are recorded deeper than 800 m (Currie *et al*, 2021).

Figure 2.7 shows trawl effort expended in relation to the reconnaissance permit area. The area coincides with the easterly extent[3] of trawling grounds between Storm's River and Cape Padrone and overlaps with an offshore fishing ground referred to as the "Chalkline". The "Chalkline" is an important offshore ground and includes sandy, gravel and hard ground seafloor substrate along the outer shelf and shelf edge (Sink *et al*., 2012). Inshore of the reconnaissance permit area, are south and south-east coast grounds fished by the inshore trawl fleet.

The reconnaissance permit area covers ~2653 km² (4.6%) of offshore trawl fishing ground. There is no overlap of the area with ground fished by the inshore trawl fleet which are situated ~30 km inshore of the area.

[3] Trawling has not extended past Port Alfred for at least the last 50 years and permit conditions prohibit trawling eastward of 27°E.

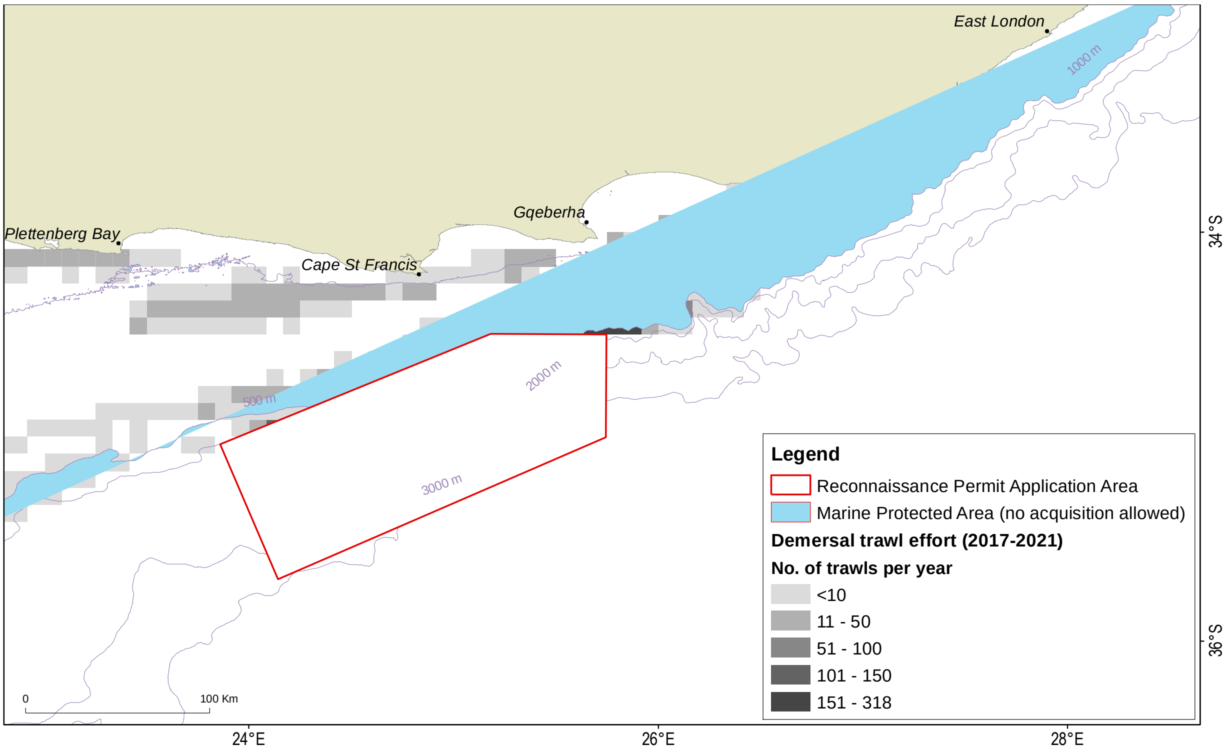


Figure 2.7: Overview of the spatial distribution of fishing effort expended by the inshore and offshore demersal trawl sectors in relation to the reconnaissance permit area.

Over the period 2017 to 2021 an annual average of 2631 trawls within the reconnaissance permit area yielded 4125 tons of hake which is equivalent to 6.8% and 6.4% of total effort and catch, respectively. Fishing activity can be expected within the area inshore of the 900 m depth contour. Although the fishery operates continuously throughout the year, fishing effort in the vicinity of the reconnaissance permit area is highest during the period October to March (see Figure 2.8).

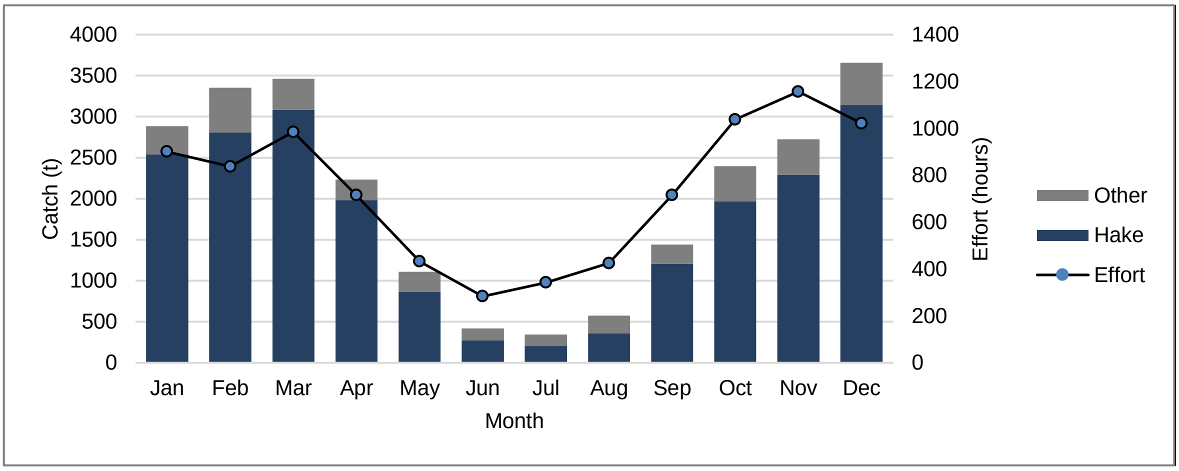


Figure 2.8: Demersal trawl catch and effort by month in the vicinity of the reconnaissance permit area (average values over the period 2008 to 2019).

2.3.2 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 2.9 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 FV *Desert Diamond* – refer to Figure 2.10).

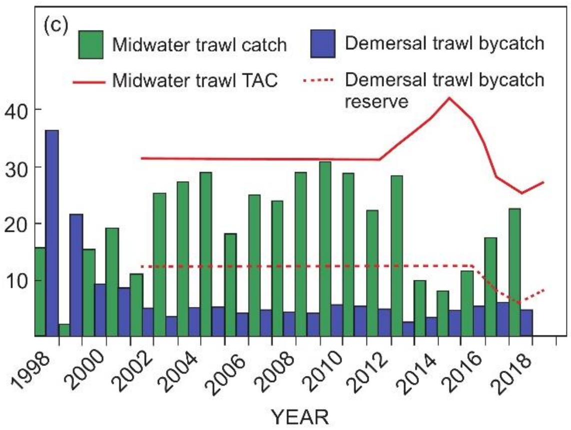


Figure 2.9: Trawl catches (tons, 1998 – 2018) split into the demersal and midwater trawl components. The midwater trawl TAC (solid line) and demersal trawl bycatch reserve (dashed line) are also shown (Source: DEFF, 2020).

Figure 2.10: Photograph of FMV *Desert Diamond* (midwater trawler).

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.

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 sea bed 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 2.11 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.

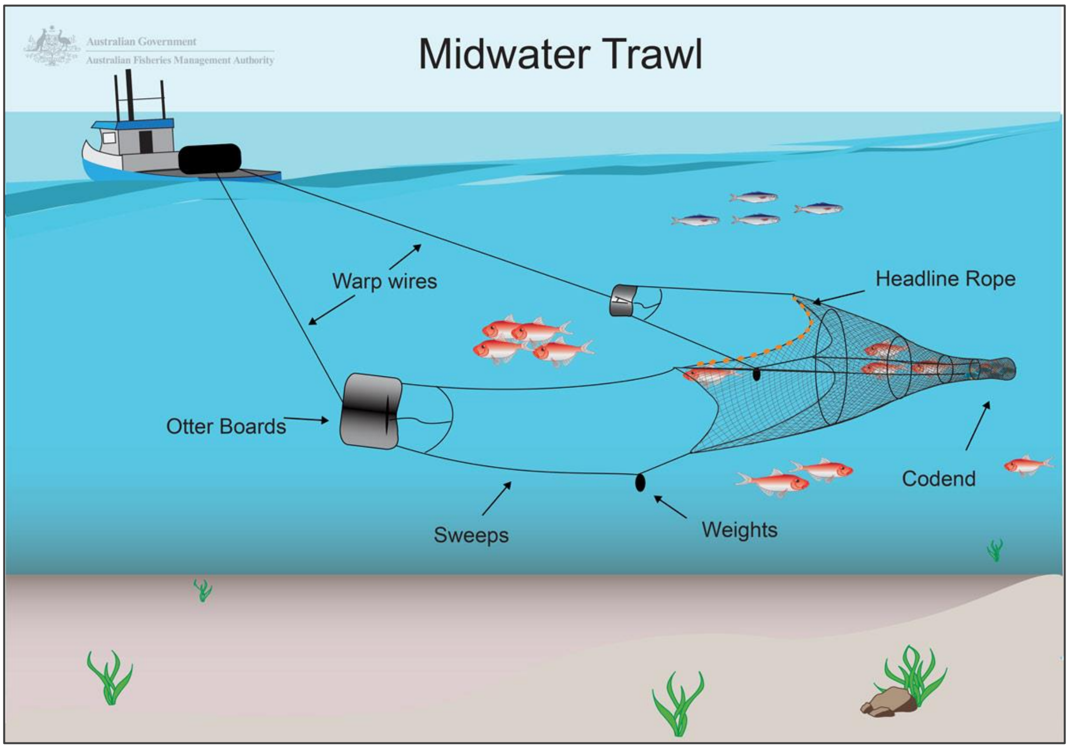


Figure 2.11: Schematic diagram showing the typical gear configuration of a midwater trawler (Source: www.afma.gov.au/fisheries-management/methods-and-gear/trawling).

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. From 2017, DFFE has permitted experimental fishing to take place westward of 20°E. Figure 2.12 shows an overview of the spatial extent of fishing effort expended by the midwater trawl sector in relation to the reconnaissance permit area.

Midwater trawling takes place inshore of the Port Elizabeth Corals MPA between Cape St Francis and Cape Recife. Over the period 2017 to 2021, an average of 92 trawls per year took place within the reconnaissance permit area yielding 2884 tons of horse mackerel. This is equivalent to 18.2% and 16.2% of the overall effort and catch recorded annually by the sector. Fishing could be expected within the area between the 100 m and 500 m bathymetric contours.

The fishery operates continuously throughout the year. In the reconnaissance permit area, effort occurs year-round however catches are lowest during June and July (see Figure 2.13).

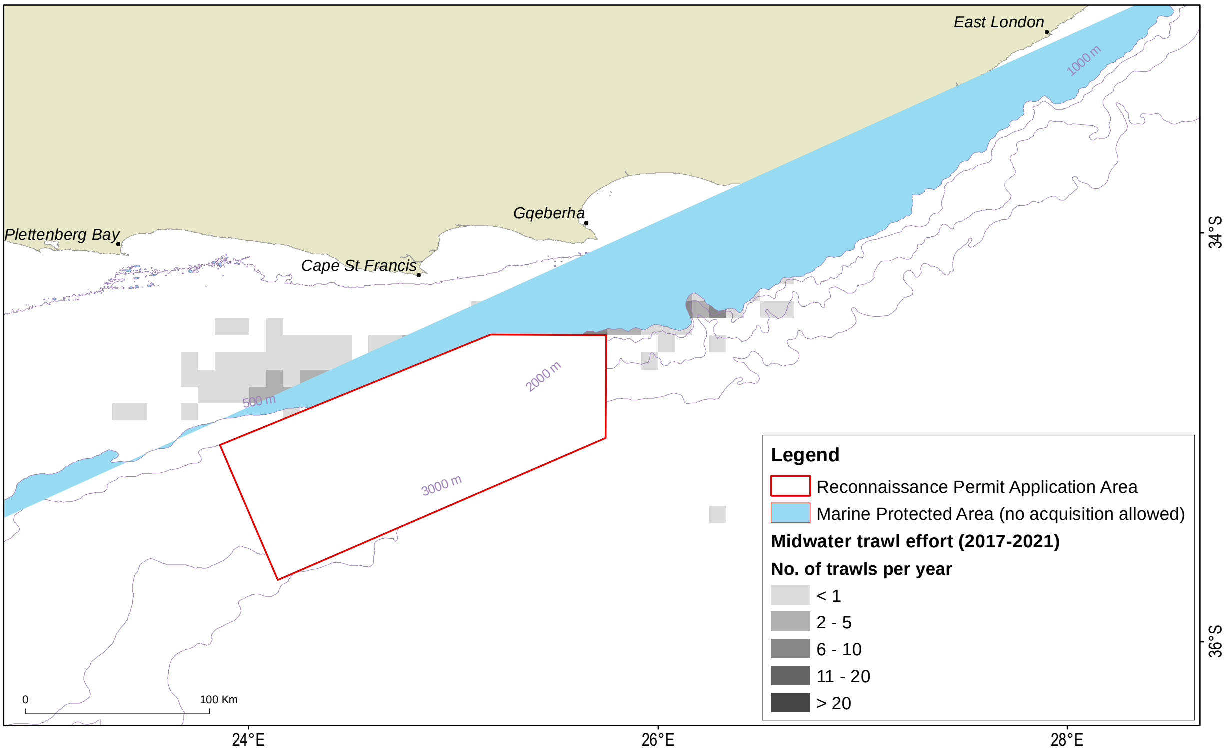


Figure 2.12: Overview of the spatial distribution of fishing effort expended by the midwater trawl sector targeting horse mackerel in relation to the Reconnaissance Permit Application area.

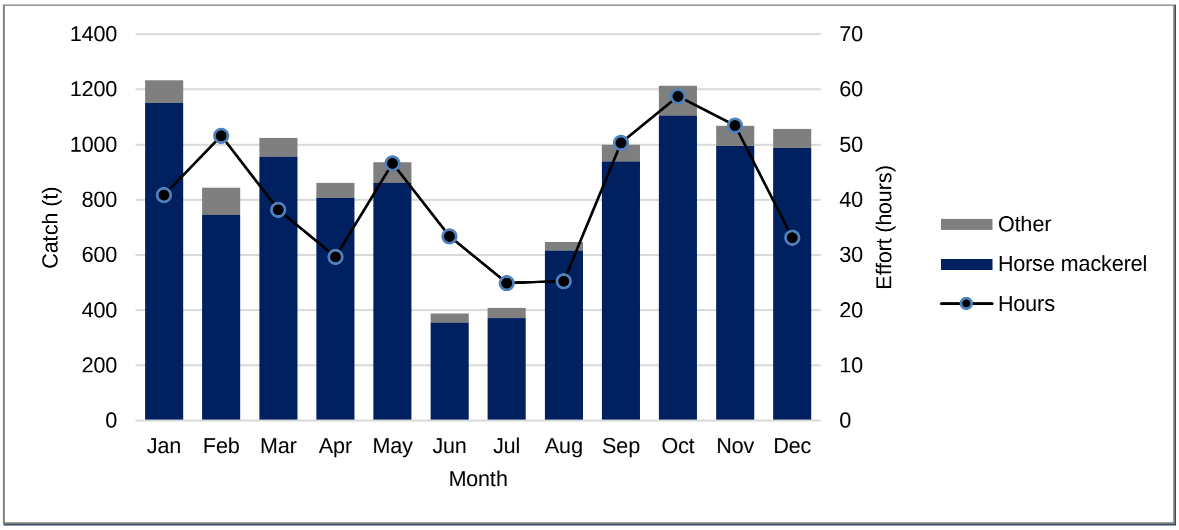


Figure 2.13: Midwater trawl catch and effort by month in the vicinity of the reconnaissance permit area (average annual values over the period 2008 to 2016).

2.3.3 HAKE DEMERSAL LONGLINE

Like the demersal trawl fishery, the target species of the long-line 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. Refer to Figure 2.14 for a photograph of a hake longline vessel and Figure 2.15 for a schematic representation of the gear configuration used by the demersal longline fleet.

Figure 2.14: a) Photograph of a registered hake longline fishing vessel (above); b) Hauling operations (left)

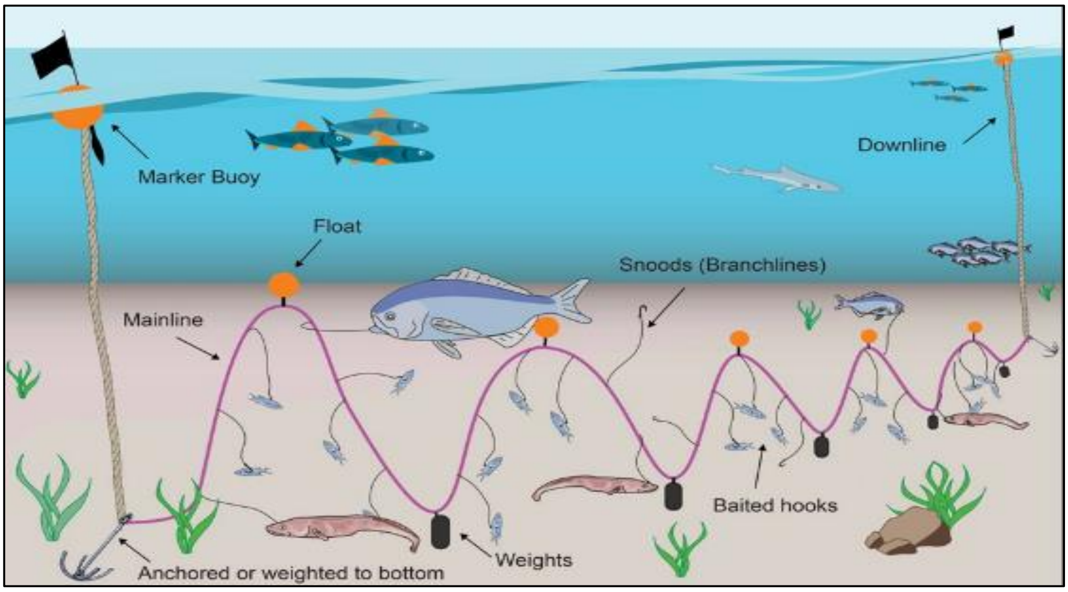


Figure 2.15: Typical configuration of demersal longline gear used in the South African hake-directed fishery (Source: http://www.afma.gov.au/portfolio-item/longlining).

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.

Figure 2.16 shows the amount of fishing effort in relation to the reconnaissance permit area. Demersal longline activity occurs across the inshore portion of the reconnaissance permit area, and concentrated shoreward of the 500 m bathymetric contour. Over the period 2000 to 2019, an average of 2.1 million hooks (166 lines) per year were set within the area yielding 549 tons of catch. This is equivalent to 6.2% and 6.7% of the overall effort and catch (hake) recorded annually by the sector.

The sector operates year-round but shows a clear increase in effort in the vicinity of the reconnaissance permit area during the period September to December (see Figure 2.17).

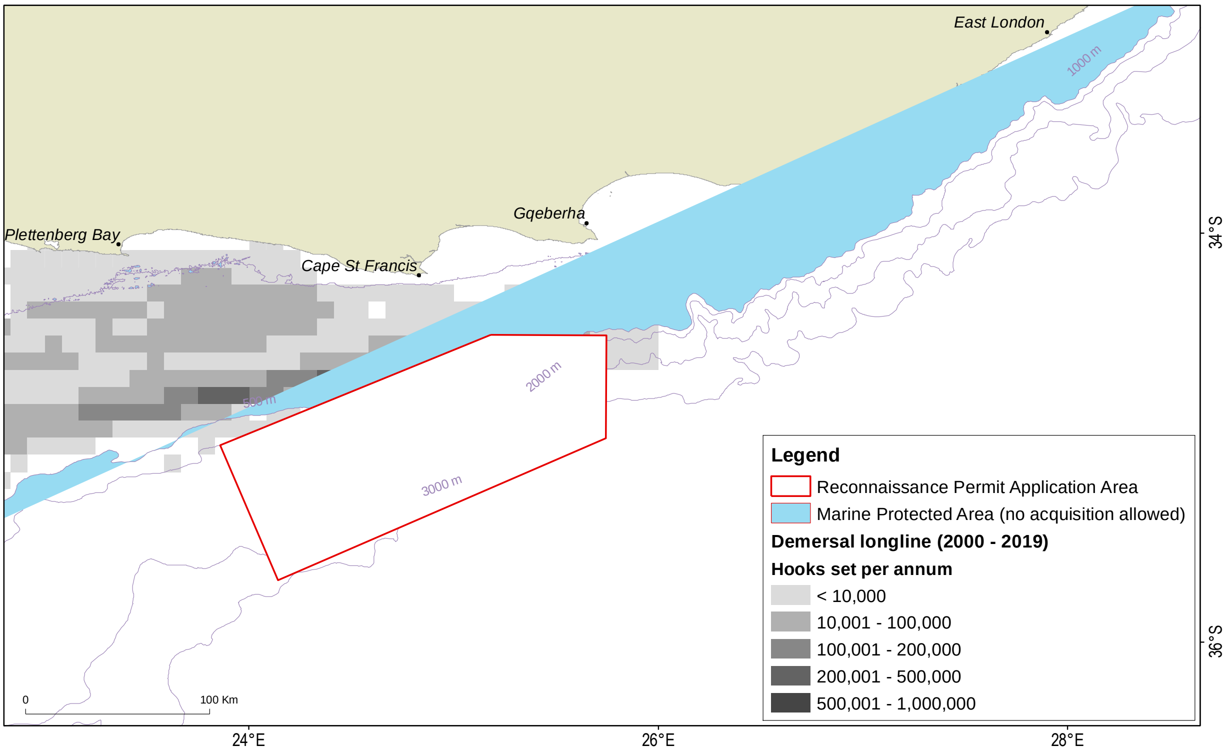


Figure 2.16: Overview of the spatial distribution of fishing effort expended by the demersal longline sector targeting hake in relation to the reconnaissance permit area.

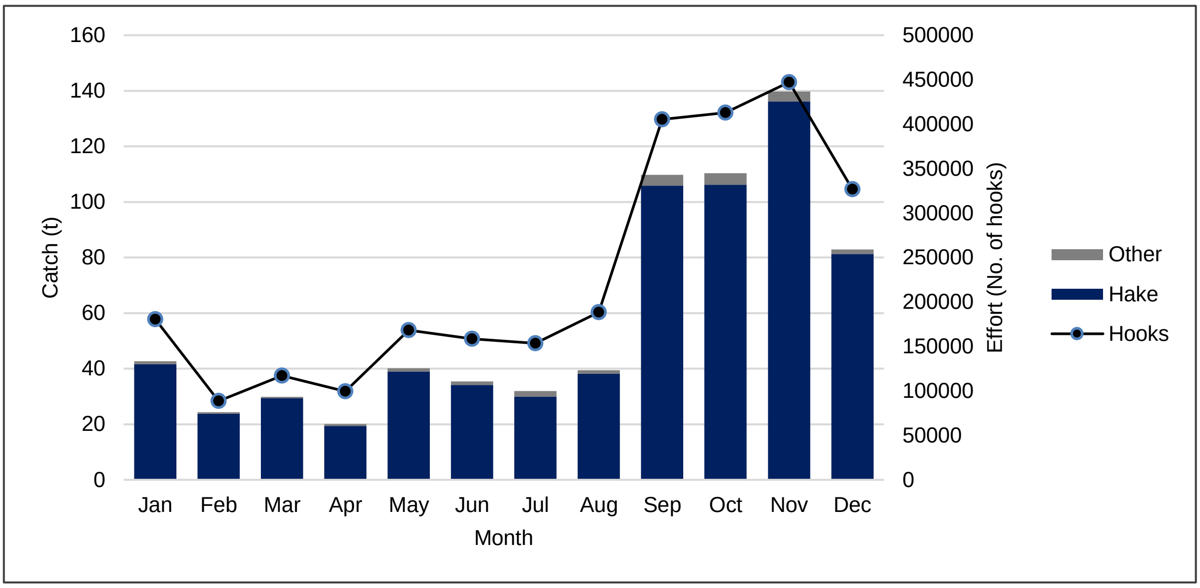


Figure 2.17: Demersal longline catch and effort by month in the vicinity of the reconnaissance permit area (average annual values over the period 2000 to 2019).

2.3.4 SHARK DEMERSAL 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 2.4 lists 2018 landings of the main demersal shark and skate species caught by line.

Table 2.4: 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 2.18 shows the spatial distribution of catch between 2017 and 2019 in relation to the reconnaissance permit area. Fishing effort is predominately directed in waters shallower than 100 m depth contour. The reconnaissance permit does not overlap the outer range of fishing effort expended by the sector in the vicinity of Gqeberha; however, fishing activity could be expected inshore of the area.

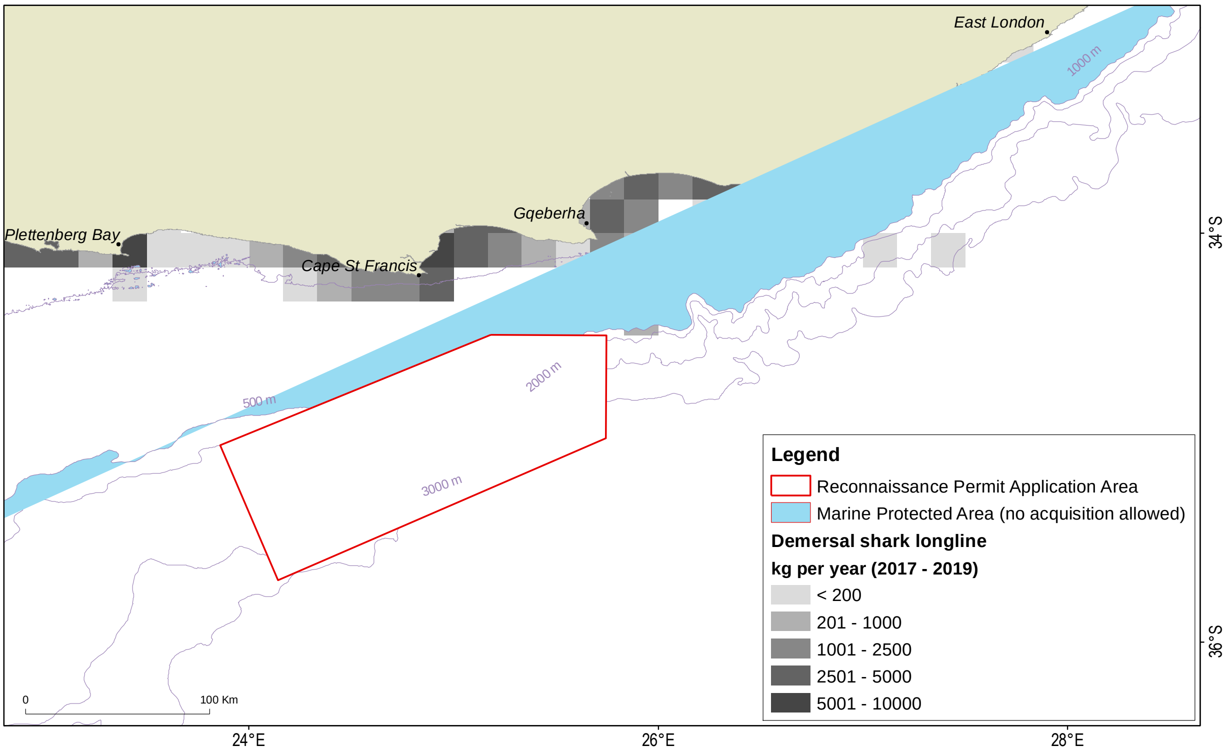


Figure 2.18: Spatial distribution of catch taken by the demersal shark longline fishery (2017 – 2019) in relation to reconnaissance permit area.

2.3.5 SMALL PELAGIC PURSE-SEINE

The pelagic-directed purse-seine fishery targets adult sardine (*Sardinops sagax)* and anchovy (*Engraulis encrasicolus*). 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 45% from 395 000 t in 2016 to 219 000 t in 2019, due mainly to a substantial decrease in the catch of anchovy from 262 000 t in 2016 to only 166 000 t in 2019. Despite this decline, the average combined catch over the last five years of 322 000 t is only slightly lower than the long-term (1949–2019) average annual catch of 334 000 t (Figure 2.19).

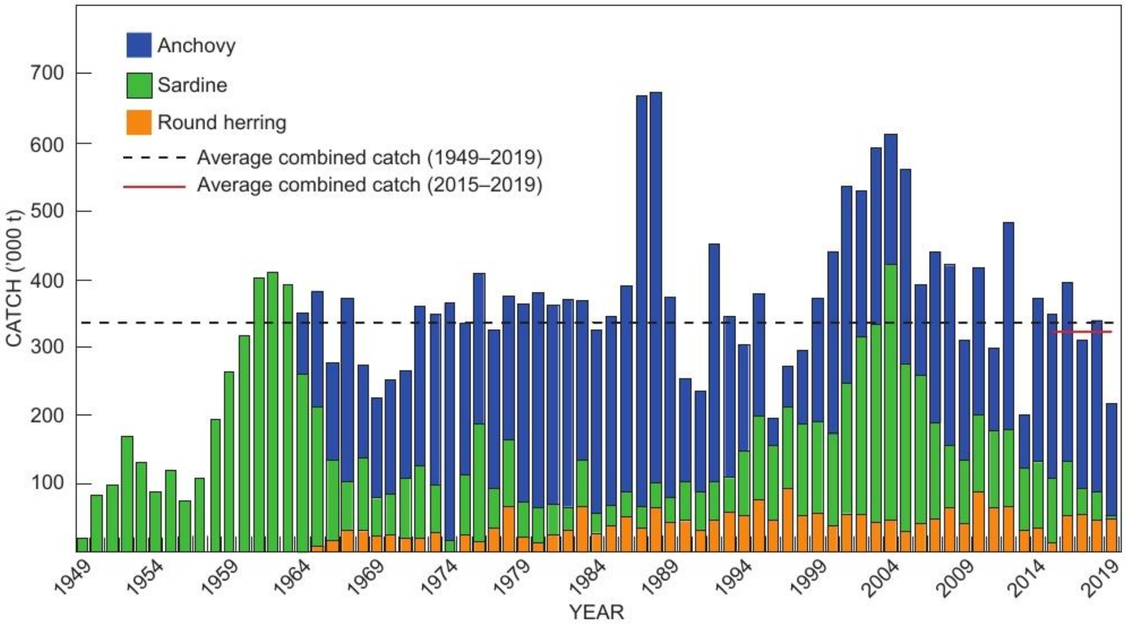


Figure 2.19: The annual combined catch of anchovy, sardine and round herring. Also shown is the average combined catch since the start of the fishery (1949-2019; black dashed line) and for the past five years (2015-2019; red solid line). Source DEFF, 2021.

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 inshore of the 200 m bathycontour, along the West and South Coasts of the Western Cape and the Eastern Cape coast.

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 2.20). 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.

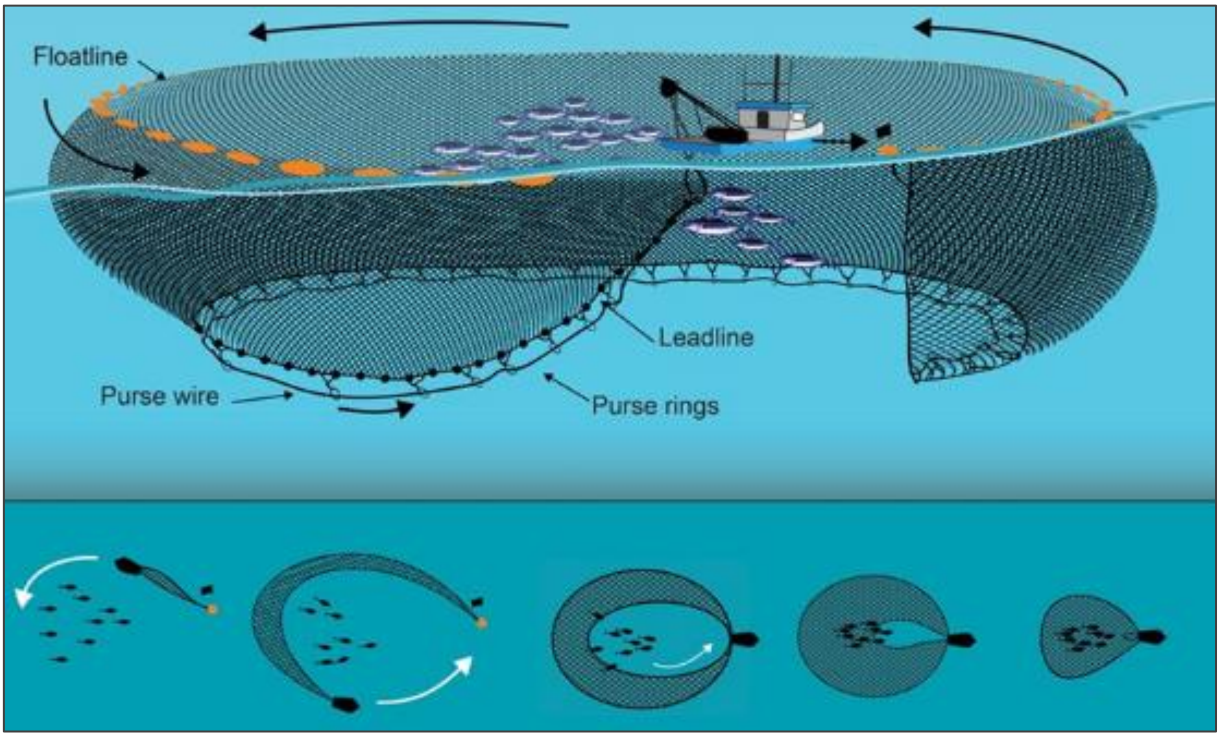


Figure 2.20: (Above) Photograph of a purse-seine vessel registered to fish for small pelagic species. (Below) Typical configuration and deployment of a small pelagic purse seine for targeting anchovy, sardine and round herring as used in South African waters (Source: http://www.afma.gov.au/portfolio-item/purse-seine).

The majority of the fleet operate from St Helena Bay, Laaiplek, Saldanha Bay and Hout Bay with fewer vessels operating on the South and East Coasts from the harbours of Gansbaai, Mossel Bay and Gqeberha. 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 Gqeberha. 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. Current permit conditions (2023) include the interim closures around African penguin breeding colonies between 15 January and 15 April 2023. These areas include the Algoa Bay area in the vicinity of St Croix and Bird Islands, Dassen Island and Robben Island (West Coast), Stony Point (Betty's Bay) and Dyer Island (Gansbaai).

Figure 2.21 shows fishing grounds in relation to the reconnaissance permit area. The fishery is unlikely to operate deeper than the 200 m isobath and there is no recorded fishing activity within the area itself which is situated approximately 17 km from the closest fishing ground.

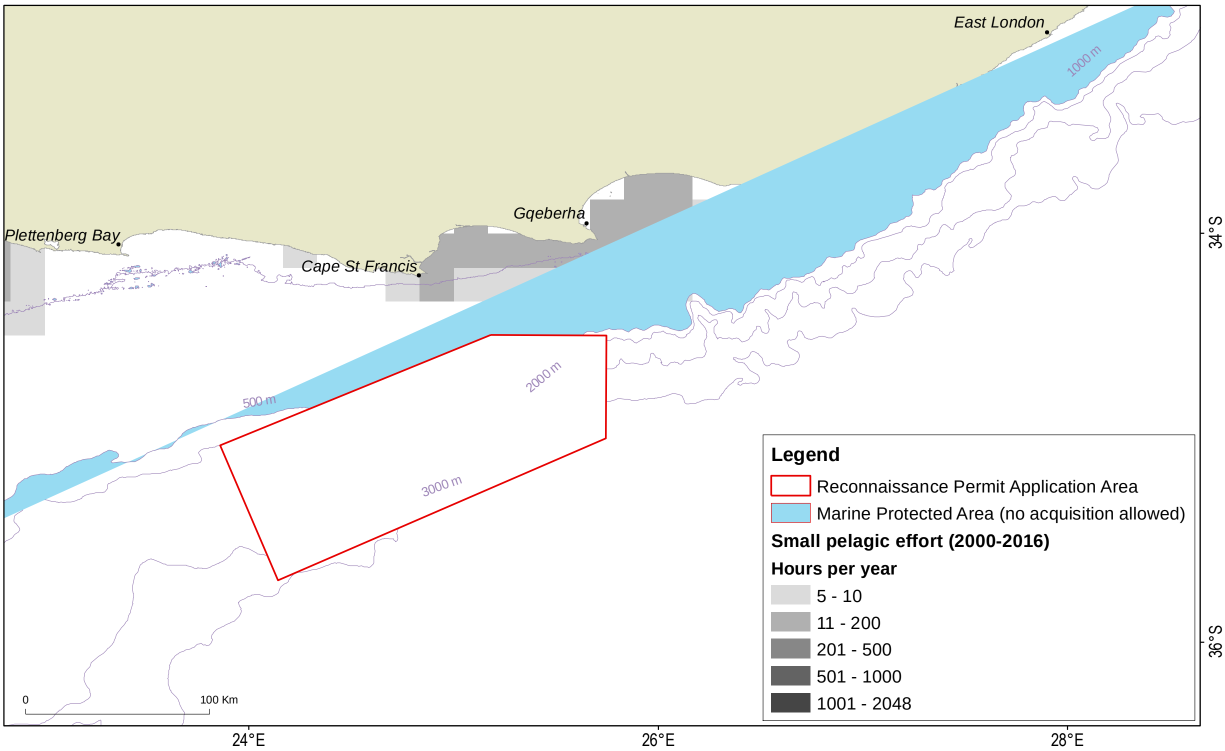


Figure 2.21: Overview of the spatial distribution of fishing effort expended by the small pelagic purse-seine sector in relation to the reconnaissance permit area.

2.3.6 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). 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 long-line vessels within South African waters is 22, 18 of which fish 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 3 500 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 2.22 below.

Lines are usually set at night, and may be left drifting for a considerable length of time before retrieval, which is done by means of a powered hauler at a speed of approximately one knot. 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.

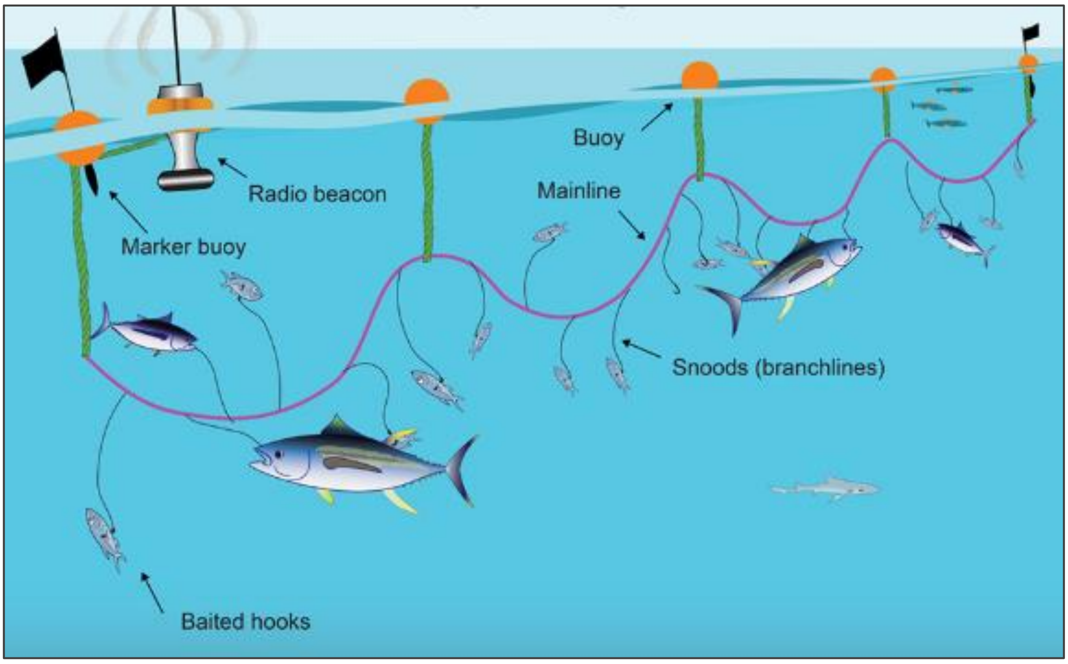


Figure 2.22: Schematic diagram showing typical configuration of longline gear targeting pelagic species (Source: http://www.afma.gov.au/portfolio-item/longlining).

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 (now Gqeberha); 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 2.23). Foreign vessels ventured further southwards than local vessels, which tended to remain within the EEZ (Figure 2.24; 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 (Figure 2.24a). 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 2.24b). Foreign vessels set an average of 2493 ± 597 (SD) hooks per line, compared to only 1282 ± 250 hooks per line used by local vessels.

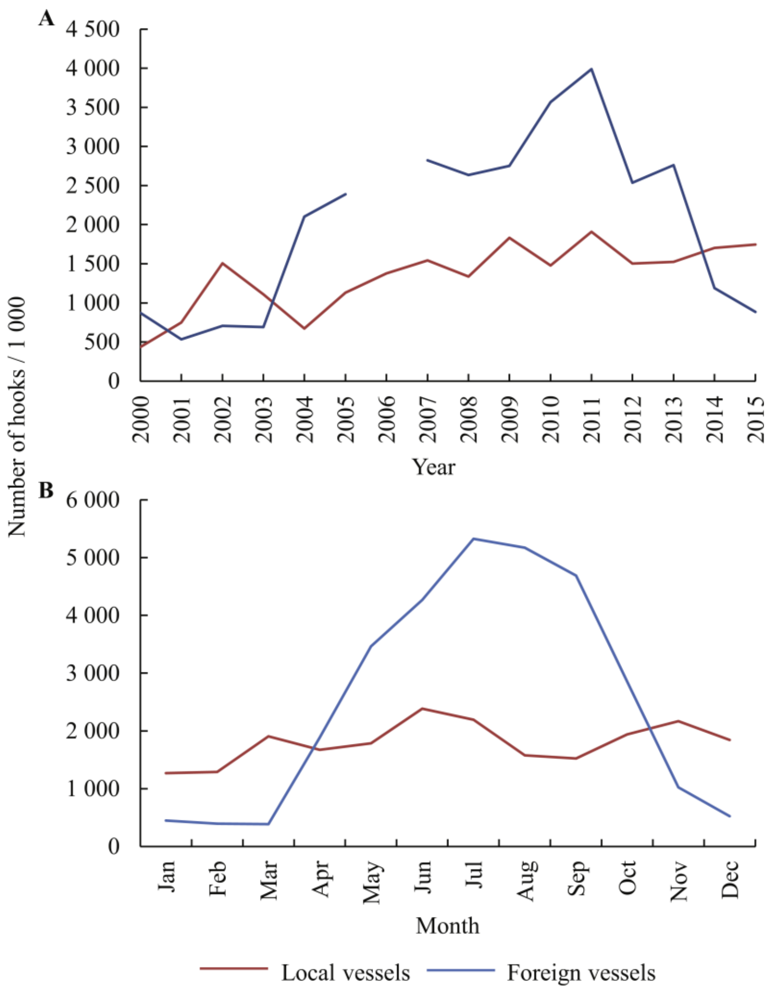


Figure 2.23: Numbers of hooks set per (A) year (2000–2015) and (B) per calendar month, as reported by local and foreign pelagic longliners fishing in the study area (Jordaan *et al.*, 2018).

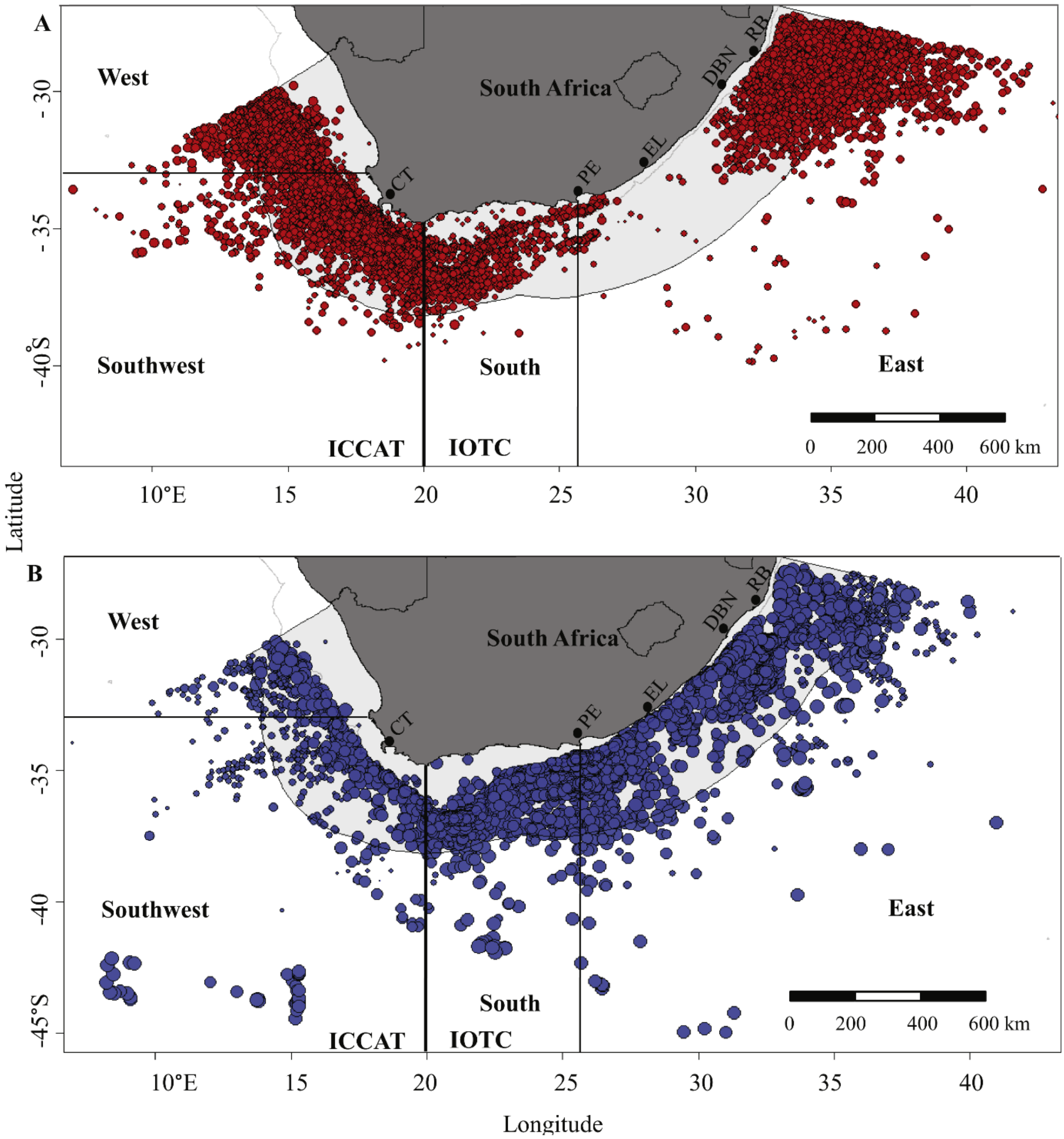


Figure 2.24: Geographical distribution of fishing effort by (A) local and (B) foreign pelagic longliners between 2000 and 2015, based on logbook data provided by vessel skippers (Jordaan *et al.*, 2018).

Catch by species and number of active vessels for each year from 2005 to 2018 are given in Table 2.5. Total catch and effort figures reported by the fishery for the years 2000 to 2018 are shown in Figure 2.25.

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. Eighteen vessels were active in 2018.

Table 2.5: 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		

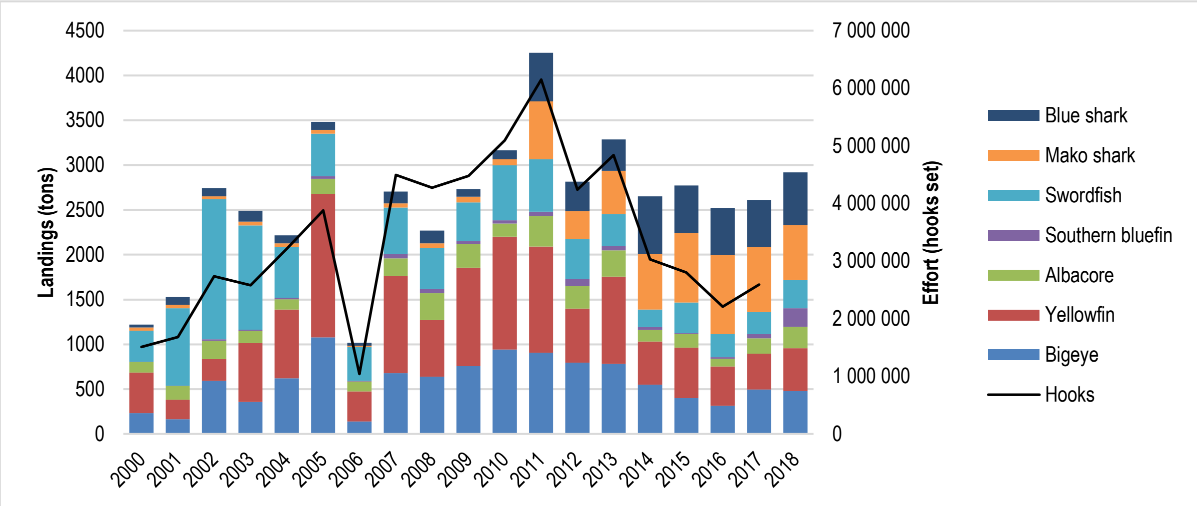


Figure 2.25: Inter-annual variation of catch landed and effort expended by the large pelagic longline sector in South African waters as reported to the two regional management organisations, ICCAT and IOTC (2000 - 2018).

The fishery operates extensively within the South African EEZ, primarily along the continental shelf break and further offshore. Catch reported in the vicinity of the reconnaissance permit area is shown in Figure 2.26. Fishing takes place across the extent of the reconnaissance permit area with effort concentrated along the shallower section of the area off Gqeberha. An average of 141 lines per year were set within the reconnaissance permit area over the period 2017 to 2019 yielding 233 tons of catch. This is equivalent to 3.4% and 3.3% of the overall effort and catch recorded annually by the sector on a national scale.

Figure 2.27 shows catch and effort by month in the vicinity of the reconnaissance permit area and there is a clear peak in fishing activity over the period May to August.

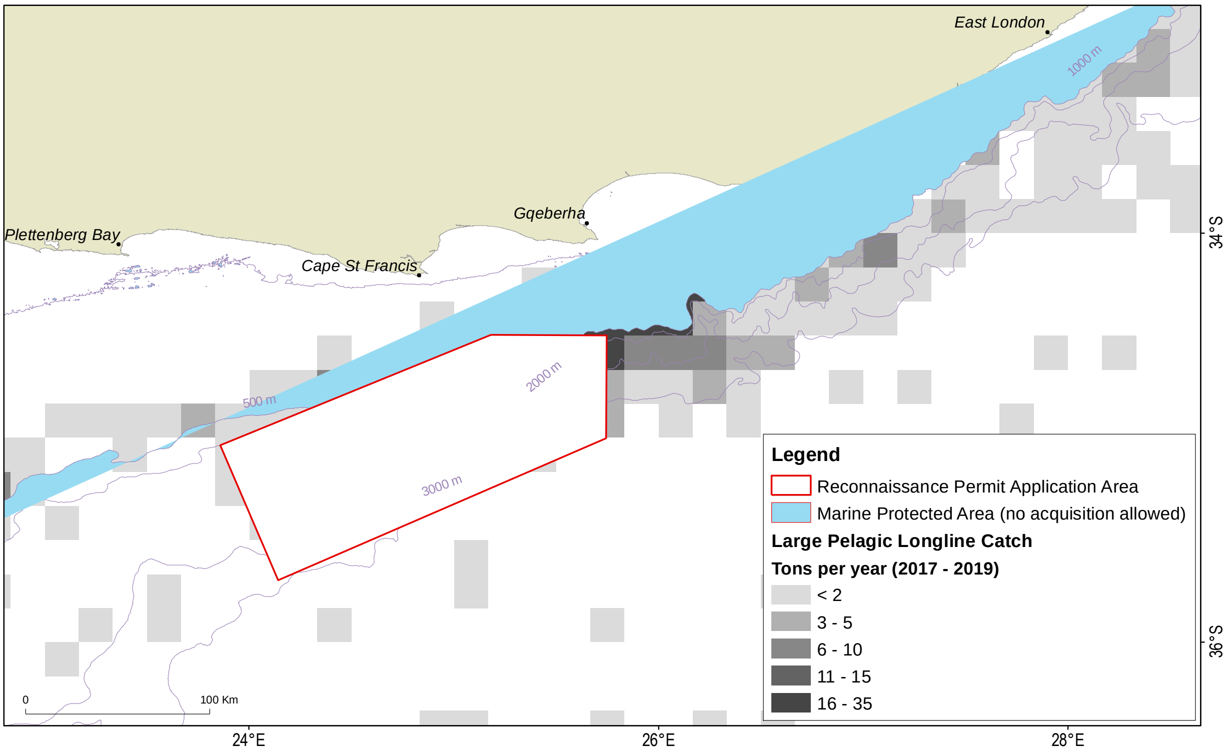


Figure 2.26: Spatial distribution of catch by the longline sector targeting large pelagic fish species in relation to the reconnaissance permit area. Catch is shown in tons per year (2017 – 2019) at a gridded resolution of 10x10 minutes.

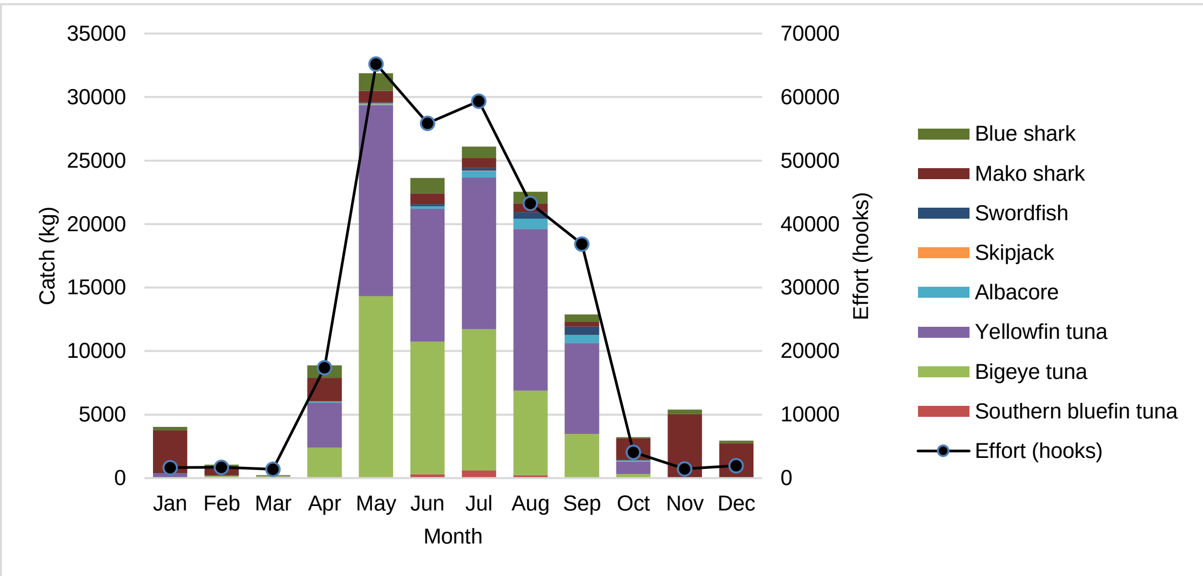


Figure 2.27: Large pelagic longline catch and effort by month in the vicinity of the reconnaissance permit area (average figures for the period 2006 – 2016).

2.3.7 TRADITIONAL LINEFISH

The traditional line fishery 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). In 2017, the wholesale value of catch was reported as R122.1 million. Table 2.6 lists the catch of important linefish species for the years 2010 to 2018.

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. 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.

Table 2.6: Annual catch (t) of the eight most important linefish species for the period 2010 to 2018 (DEFF, 2021).

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

The traditional line fishery is a boat-based activity and has since December 2000 consisted of 3450 crew operating from 455 commercial vessels. The number of rights holders nationally is 425 (valid rights until 31 December 2020). 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 2.3.10). 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.

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 2.7 lists the annual Total Allowable Effort (TAE) and activated effort per line fish management zone from 2007 to 2019. The reconnaissance permit area is situated within Zone B which currently has an allocation of 103 vessels and 692 crew.

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. 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.

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. This fishery's operational footprint may at times be limited by operating costs and is sensitive to local reports of fish availability.

Table 2.7: Annual total allowable effort (TAE) and activated commercial line fish effort per management zone from 2007 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
2007	455	353	301	231	103	85	51	37
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

Figure 2.28 shows recent linefish catch (2017 – 2019) in relation to the reconnaissance permit area. Operating ranges vary greatly but most of the activity is conducted within 15 km of a launch site and therefore usually shallower than the 200 m depth contour. In relation to the proposed survey location, the closest fishing activity would be situated off Cape Recife, Gqeberha, approximately 25 km from the reconnaissance permit area. Fishing in this area takes place throughout the year.

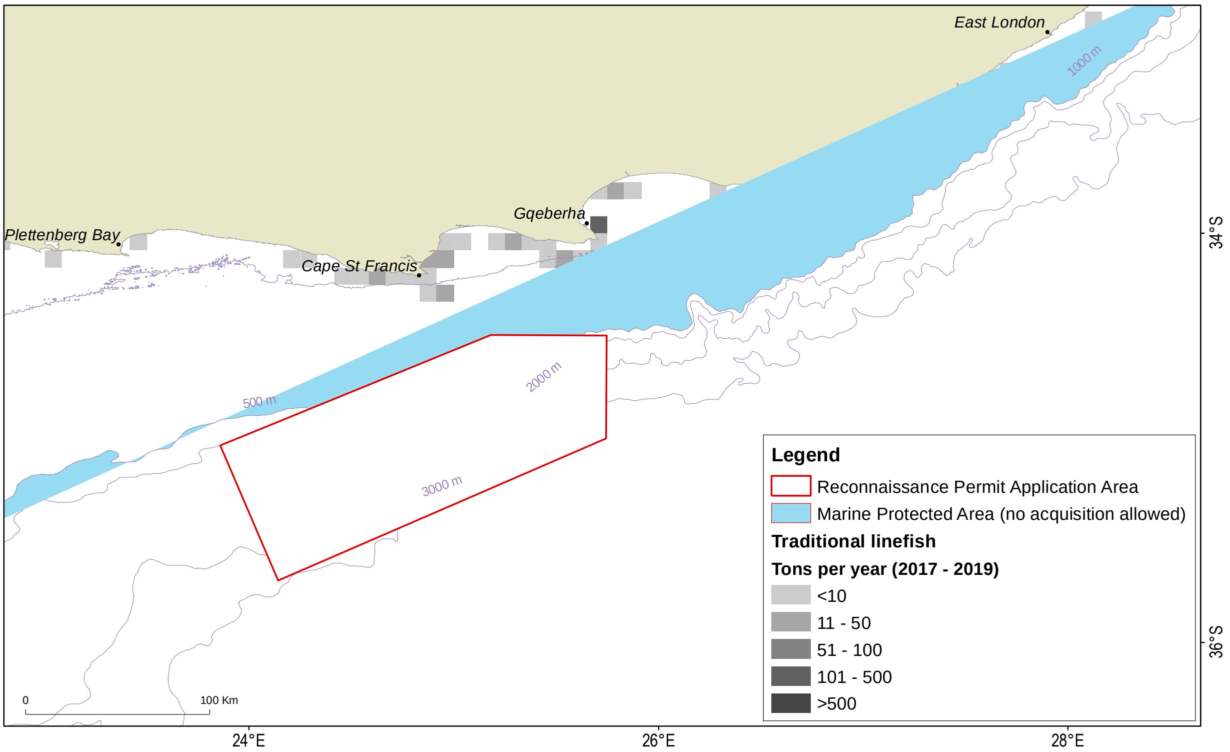


Figure 2.28: Spatial distribution of catch by the traditional and commercial linefish sector in relation to the reconnaissance permit area.

2.3.8 SOUTH COAST ROCK LOBSTER

South Coast rock lobsters (*Palinurus gilchristi*) are endemic to the southern coast of South Africa, where they occur on the continental shelf at a depth range of 50 m to 200 m. The fishery operates between East London and Cape Point and up to 250 km offshore along the outer edge of the Agulhas Bank. The stock is fished in commercially viable quantities in two areas off the South Coast, the first is on the Agulhas Bank approximately 200 km offshore, and the second is within 50 km of the shoreline between Mossel Bay and East London. It is the second-largest rock lobster fishery in South Africa and is capital-intensive, requiring specialised equipment and large, ocean-going vessels. Products (frozen tails, whole or live lobster) are exported to the USA, Europe and the Far East.

The South Coast rock lobster fishery is a deep-water longline trap fishery. Barrel-shaped plastic traps are set for periods ranging from 24 hours to several days. Each vessel typically hauls and resets approximately 2 000 traps per day in sets of 100 to 200 traps per line. They set between ten and 16 lines per day, each of which may be up to 2 km in length. Each line is weighted to lie along the seafloor and is connected at each end to a marker buoy at the sea surface. Vessels are large, ranging from 30 m to 60 m in length. Those that have on-board freezing capacity remain at sea for up to 40 days per trip, while those retaining live catch remain at sea between seven and 10 days before discharging at port. Longline trap-fishing is labour intensive and as such each boat requires approximately 30 officers and crew. The total sea-going complement of the fleet is about 300 individuals. In addition to sea-going personnel, the sector employs approximately 100 land-based factory (processing) and administrative personnel.

During the 2018/19 season, eight vessels were active in the fishery. The sector landed a total lobster tail weight of 340 t in 2018. Historical records of TAC, TAE, catch and standardised Catch per Unit Effort (CPUE) are included in Table 2.8.

Table 2.8: South Coast rock lobster historical records of TAC, TAE, catch and standardised CPUE (kg trap^{-1}) (DEFF, 2020).

Season	TAC (tonnes tail mass)	TAE (allocated seadays)	Standardised CPUE (kg trap^{-1})		
			Area 1E	Area 1W	Area 2 & 3
2006/7	382	2089	1.34	0.78	0.83
2007/8	382	2089	1.09	1.09	1.11
2008/9	363	2675	1.42	1.24	1.15
2009/10	345	2882	1.17	1.18	0.85
2010/11	328	2550	1.37	1.22	0.94
2011/12	323	2443	0.96	1.09	0.95
2012/13	326	2250	0.86	0.90	0.97
2013/14	342	2536	1.41	1.30	1.41
2014/15	359	2805	1.36	1.43	1.28
2015/16	341	2858	1.97	1.50	1.04
2016/17	332	2029	1.63	1.24	0.96
2017/18	321	2148	1.61	1.38	1.41

Figure 2.29 shows fishing effort in relation to reconnaissance permit area for the period 2006/07 to 2019/20.

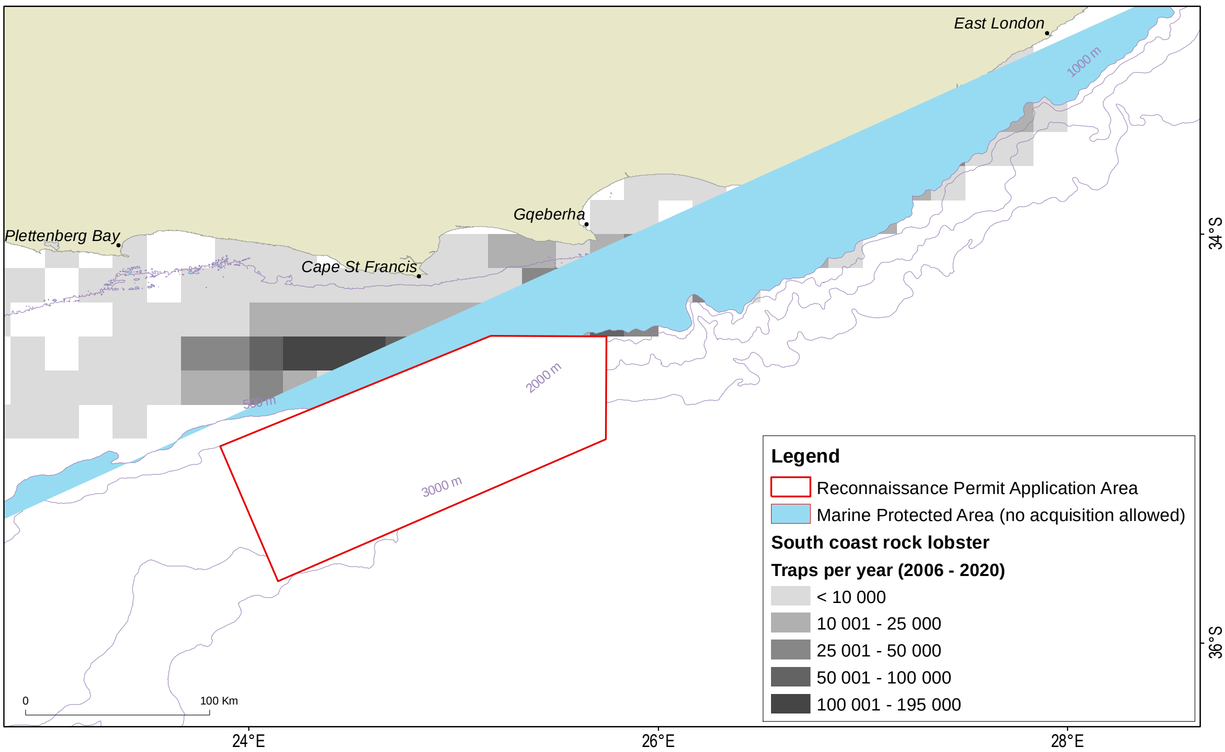


Figure 2.29: Spatial distribution of fishing effort expended by trap fishery targeting south coast rock lobster in relation to the Reconnaissance Permit Application area.

The reconnaissance permit area covers 6 fishing blocks located between 24°30´E and 25°30´E with fishing activity in the area ranging between the 65 m and 130 m contours. Over the period 2006 to 2020, an annual average of 38 800 traps were set within the reconnaissance permit area yielding 6.2 tons of rock lobster (tail weight) which is equivalent to 1.7% and 1.9% of the overall effort and catch recorded annually by the sector.

There is a risk that the seismic vessel would encounter deployed rock lobster trap gear if the survey vessel transits inshore of the reconnaissance permit area. The nature of this fishery entails the deployment of traps on the seafloor which are difficult to remove at short notice.

Inshore of the reconnaissance permit area, the sector operates year-round with no clear seasonality evident apart from a slight increase in fishing effort during November and December (see Figure 2.30).

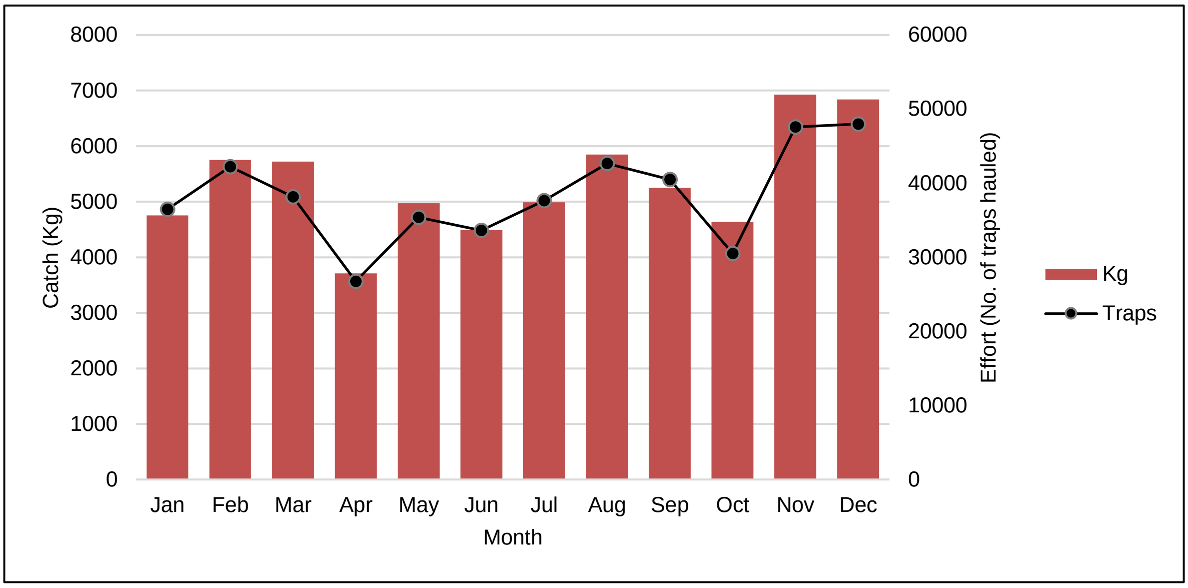


Figure 2.30: South coast rock lobster catch and effort by month in the vicinity of the reconnaissance permit area (average annual values over the period 2006 to 2016).

2.3.9 SQUID JIG

Chokka squid (*Loligo vulgaris reynaudii*) is distributed from the border of Namibia to the Wild Coast. It occurs extensively on the Agulhas Bank out to the shelf edge, increasing in abundance towards the eastern boundary of the South Coast, especially between Plettenberg Bay and Algoa Bay (Augustyn 1990; Sauer *et al.* 1992; Augustyn *et al.* 1994). Along the South Coast adult squid is targeted in spawning aggregations on shallow-water fishing grounds extending from Plettenberg Bay to Port Alfred between 20 m and 130 m depths (Augustyn 1990; Downey 2014). The most important spawning grounds are between Plettenberg Bay and Algoa Bay (Augustyn 1990), these having been linked to specific spawning habitat requirements (Roberts & Sauer 1994; Roberts 2005). Spawning aggregations are a seasonal occurrence reaching a peak between September and December (Augustyn *et al.* 1992). The method of fishing involves hand-held jigs and bright lights which are used to attract squid at night. A squid jig is defined as a lure like object with a row or number of rows of barbless "hooks" at one end and an "eye" at the opposite end. Jigging operations involve the use of one or more jigs attached to a handline at the "eye" of the jig and moved up and down in a series of short movements in the water (Squid Permit Condition, DFFE). The catch is frozen at sea or at land-based facilities at harbours between Plettenberg Bay and Port Alfred. Vessels predominantly operate out of Cape St Francis and Gqeberha harbours.

The squid fishery is managed in terms of the Total Allowable Effort (TAE) allowed within the fishery. The TAE (2020/2021) is based on the number of crew permitted to harvest squid across the fishery (2443) and the maximum number of person days fishing during the season (295 000). Of the overall TAE, 75% (221 250 person days) is apportioned to commercial fishing, and 25% (73 750 person days) is apportioned to small-scale fishing. Skippers record how many of their crew fish, and for how many hours each day. There are two closed seasons totaling slightly more than four months: a permanent closed period of five weeks between October and November to allow for summer spawning, and an additional three months in winter to prevent the man-days from exceeding the maximum. During the enforced annual five-week closure between October and November, the DFFE undertakes a survey on spawning aggregations in the bay areas. In 2018 this closure was in effect from 19 October to 23 November. An additional industry-imposed three-month closed season was introduced in 2014. The timing of closure is typically during March, April, and May, or April, May, and June, and the decision is made during the industry's annual general meeting held in October each year. The period of closure coincides with a drop in adult spawning activity and a reduction in catches. In 2018, the additional closed season extended from April to June (DEFF, 2019). The fishery is seasonal, with most effort conducted between November and March (see Figure 2.31). Catch depths rarely exceed 60 m (99% of the catch is taken in water depths less 60 m; see Figure 2.32).

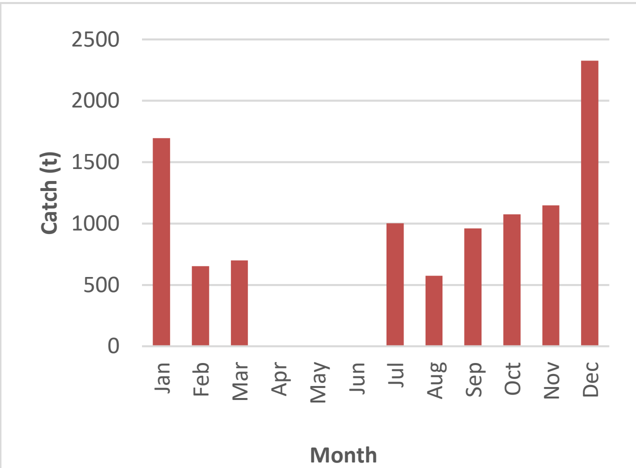


Figure 2.31: Monthly catches of chokka squid reported by the jig fishery (2017 – 2019).

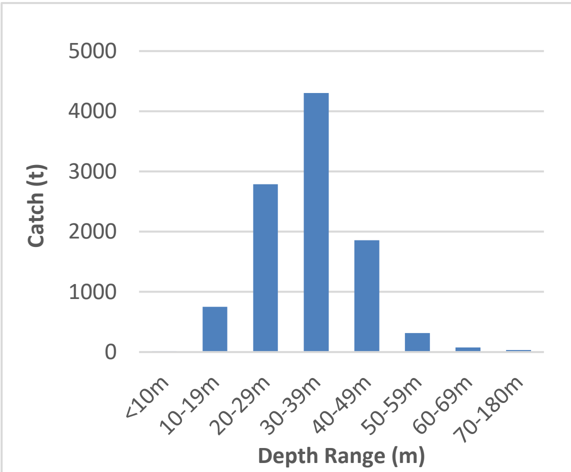


Figure 2.32: Distribution of chokka squid catch by water depth (2017 – 2019).

The squid fishery is fairly stable and provides employment for approximately 3 000 people locally. Typically annual catches range from 4 000 – 12 000 t (see Figure 2.33). Landings in 2018 amounted to 13 237 t. The industry exports all of the catch to Europe at a value of approximately R80 per kg. Depending on the season, the industry is valued anywhere between R320 Million and R1.1 billion and is South Africa's third largest fishery in monetary terms. Squid is also used as bait by linefishers. The fishery is currently in the process of rights allocation, and a proportion of the effort allocation has been set aside for small-scale fisheries (refer to section 2.3.10).

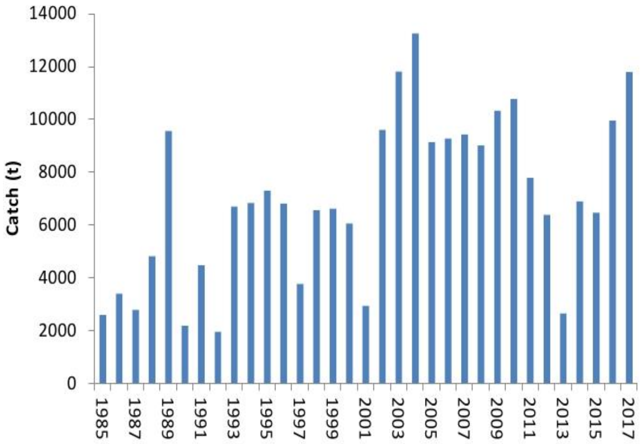


Figure 2.33: Annual chokka squid catches by the jig fishery over the period 1985 – 2017 (DEFF, 2019).

Table 2.9: Total squid catches from commercial jig, as well as squid total allowable effort (TAE) (2004 – 2019; DEFF, 2020).

Year	Squid jig catches (t)	TAE (allocated seadays)
2004	13 261	2 423 unrestricted crew* 41 restricted crew*
2005	9 147	2 423 unrestricted crew* 22 restricted crew*
2006	9 291	2 423 unrestricted crew* 138 vessels
2007	9 438	2 422 unrestricted crew* 136 vessels
2008	9 021	2 422 unrestricted crew* 136 vessels
2009	10 341	2 422 unrestricted crew* 136 vessels
2010	10 777	2 422 unrestricted crew* 136 vessels
2011	7 796	2 422 unrestricted crew* 136 vessels
2012	6 392	2 422 unrestricted crew* 136 vessels
2013	2 664	2 422 unrestricted crew* 136 vessels
2014	6 907	TAE or 250 000 person days
2015	6 479	TAE or 250 000 person days
2016	9 952	TAE or 250 000 person days
2017	11 919	TAE or 270 000 person days
2018	13 444	TAE or 270 000 person days
2019	6 689	TAE or 295 000 person days

*Unrestricted permits applied to Right Holders who were not restricted to fishing in any particular area, whereas restricted permits applied to Right Holders who were only allowed to fish off the former Ciskei (in the Eastern Cape Province). Restricted permits were eventually phased out of the fishery from 2006.

Figure 2.34 shows the spatial distribution of squid jig fishing grounds in relation to the reconnaissance permit area. Targeted fishing areas are situated inshore of the area with 99% of the catch is taken in water depths less 60 m and at least 30 km from the reconnaissance permit area. Fishing operations could range up to the 200 m depth contour but activity at this depth could be considered to be sporadic. There was no fishing activity reported by the sector within the reconnaissance permit area during the period 2016 to 2020.

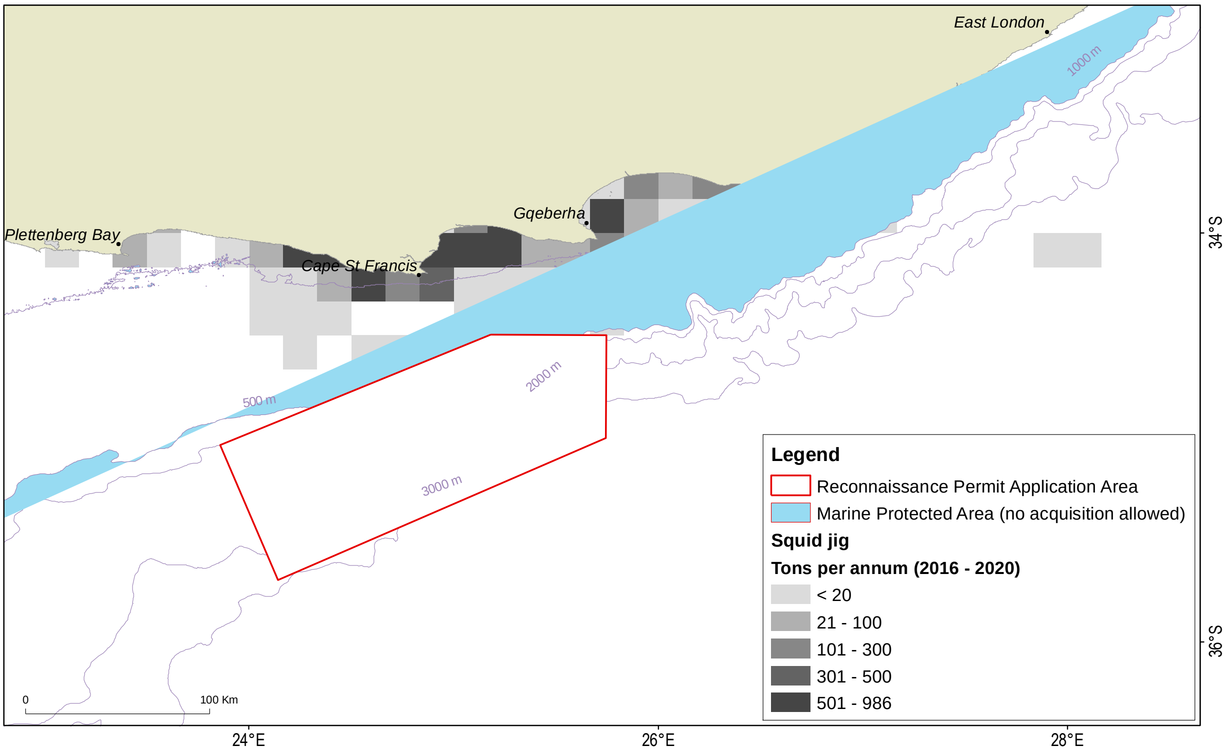


Figure 2.34: Spatial distribution of catch taken by the squid jig fishery (2016 – 2020) in relation to the reconnaissance permit area.

2.3.10 SMALL-SCALE FISHERIES

The term small-scale is usually used to distinguish between capital intensive commercial fisheries and low technology, labour intensive fishing activities (Sowman, 2006). Small-scale fishers fish to meet food and basic livelihood needs, and may also directly be involved in fishing for commercial purposes. These fishers traditionally operate on nearshore fishing grounds, using traditional, low technology or passive fishing gear 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.

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. Small scale fisheries 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.

South Africa is implementing a Small-Scale Fisheries policy (SSF) – this is in process and was gazetted in May 2019 under the Marine Living Resources Act, 1998 (Act No. 18 of 1998). A small-scale fishing right is the right to catch different species of fish in the near shore. These rights are allocated to communities and not to individuals in terms of the SSF. 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 expression of interest with the Department. The location of these coastal communities in the vicinity of the reconnaissance permit area and the number of fishers per community are shown in Figure 2.35.

The small-scale fisheries policy proposes that certain areas on the coast be prioritized and demarcated as small-scale fishing areas. In some areas access rights could be reserved exclusively for use by small-scale fishers. The community, once they are registered as a community-based legal entity, could apply for the demarcation of these areas. The policy also requires a multi-species approach to allocating rights, which will entail allocation of rights for a basket of species that may be harvested or caught within particular designated areas. DAFF recommends five basket areas: 1. Basket Area A – The Namibian border to Cape of Good Hope – 57 different resources 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.

SSF are 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 fishing sectors that will be directly affected include traditional linefish, squid, abalone, white mussel, oysters and hake handline. DFFE proposes that, commencing January 2021[4], 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). Small-scale fishermen along the south and south-east coasts are typically involved in the traditional line fishery (refer to section 2.3.7), squid jig (refer to section 2.3.9) and oyster harvesting (sub-tidal zone). Regarding the squid fishery, it is anticipated that these fishers will be subsumed in some way into the current squid fishery.

The SSF is to be implemented along the coast in series of community “co-operatives”. DFFE has split SFF by communities into district municipalities and local municipalities (refer to Appendix 1 for a comprehensive list).

In the Northern Cape, communities are grouped into the Namakwa district, comprising the Richtersveld and Kamiesberg local municipalities and there are 103 registered fishers in the province.

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 2 748 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 5 154 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.

The small-scale fishery rights cover the nearshore 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

[4] The ongoing Fishery Rights Allocation Process (“FRAP”) has, to date (September 2022), not been finalised.

communities in the Eastern Cape would be involved in traditional line, squid jig, netfish and oyster harvesting. The oyster fishery operates within the sub-tidal zone therefore there is no overlap with the reconnaissance permit area. It is unlikely that the squid jig fishery would operate within the application area with activity concentrated closer inshore in the vicinity of Gqeberha. Linefish vessels could be expected within 25 km of the application area. There are currently 222 fishers registered within the Nelson Mandela Bay municipal district and a further 348 fishers registered within the Cacadu districts of the Eastern Cape, which lie adjacent to the project area.

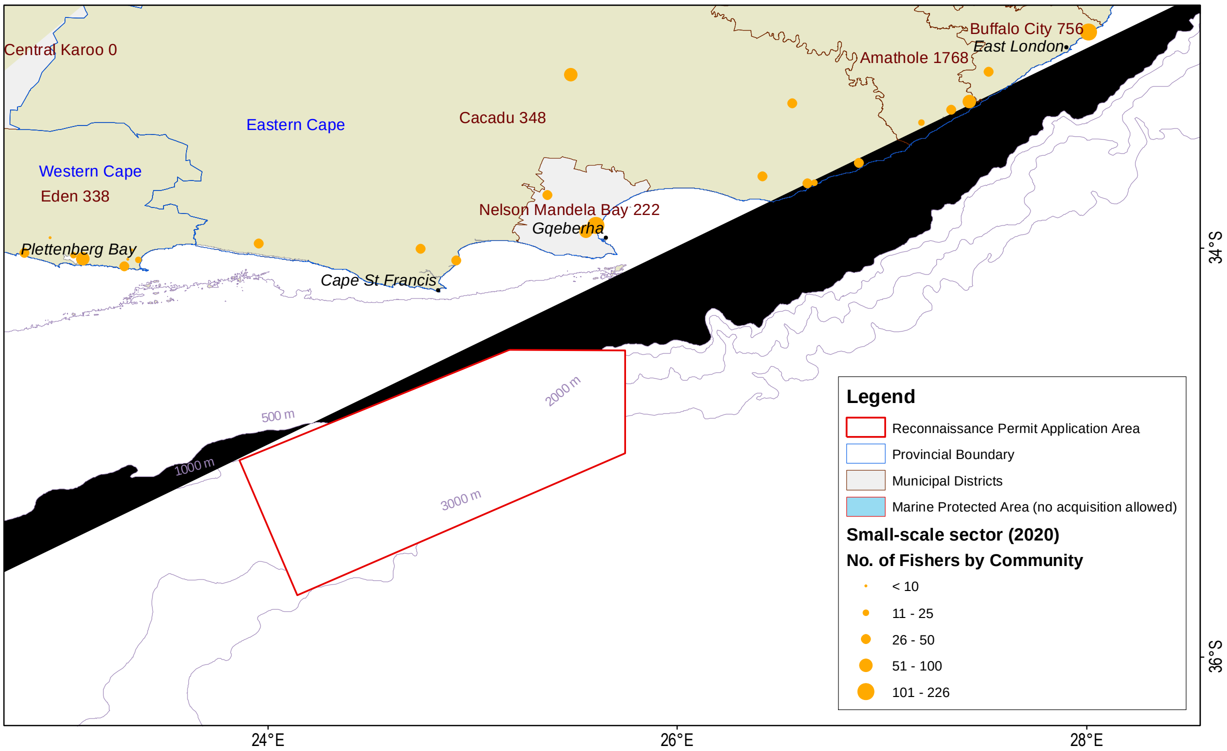


Figure 2.35: Overview of spatial distribution of small-scale fishing communities and number of participants per community in the vicinity of the reconnaissance permit area.

2.3.11 NETFISH (BEACH-SEINE AND GILL NET)

There are a number of active beach-seine and gill-net 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 gill nets, mostly (86%) along the West and South coasts. Those fishermen utilize 1 373 registered and 458 illegal nets and report an average catch of 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 composition by mass varies between 70, 74 and 90% harders off the Western, Southern and Eastern Cape coasts respectively to 88% sardine in KwaZulu-Natal. 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).

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 2.10 for the number of rights issued). 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.

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 2014).

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.

Fishing effort is coastal, with beach-seines set between 50 m and 100 m offshore and gill-nets unlikely to be set in waters deeper than 50 m. The range of gillnet and beach-seine activity does not overlap with the reconnaissance permit area.

Table 2.10: 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

2.3.12 FISHERIES RESEARCH SURVEYS

Swept-area trawl surveys of demersal fish resources are carried out twice a year by DFFE 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. 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 1000 m isobath. Figure 2.36 shows research trawl effort in relation to the reconnaissance permit area. Research trawls could be expected within the area at a depth range of 100 m to 500 m. Over the period 2013 to 2021, between 5 and 10 trawls per survey have been conducted within the area at a seafloor depth range of up to 945 m. Research trawls in the area take place each year during the period April/May.

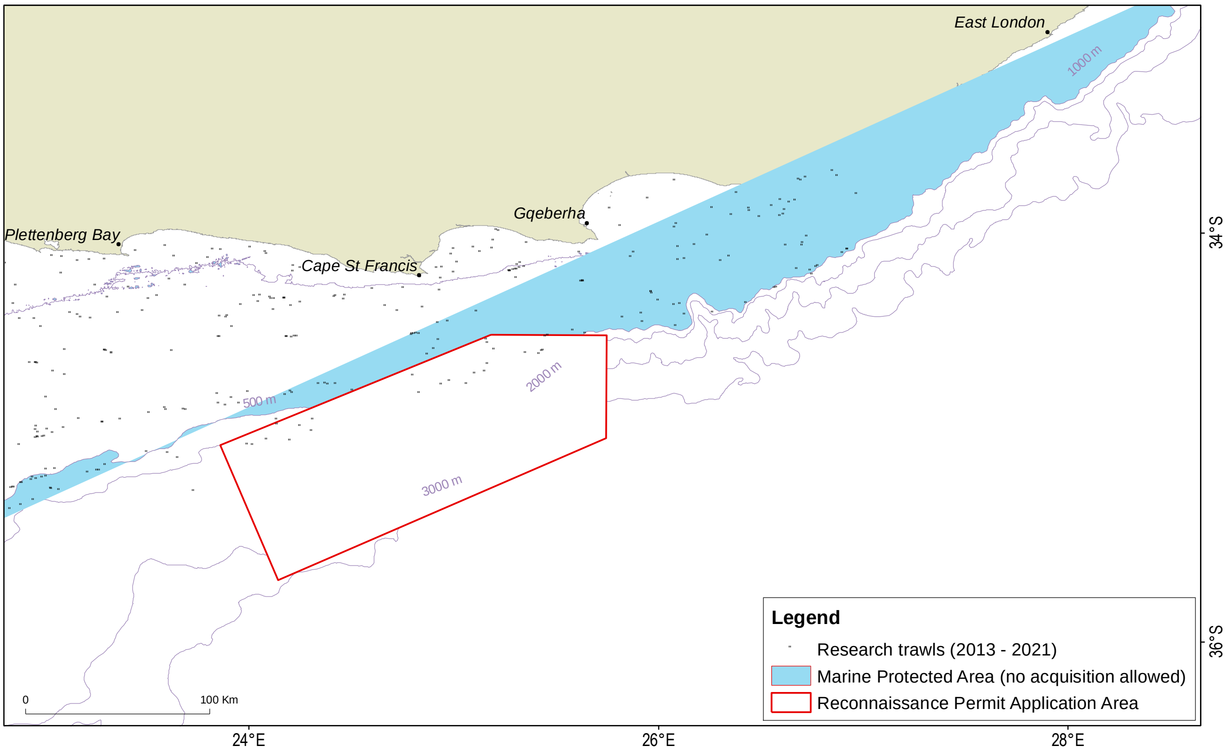


Figure 2.36: Spatial distribution of trawling effort expended during research surveys undertaken by DFFE to ascertain biomass of demersal fish species. Fishing grounds are shown in relation to the reconnaissance permit area.

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 isobath. 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 coast.

Figure 2.37 shows the distribution of survey transects and sampling stations during the November 2020 and May 2021 research surveys in relation to the reconnaissance permit area. Both of these areas overlap the operational areas of research surveys.

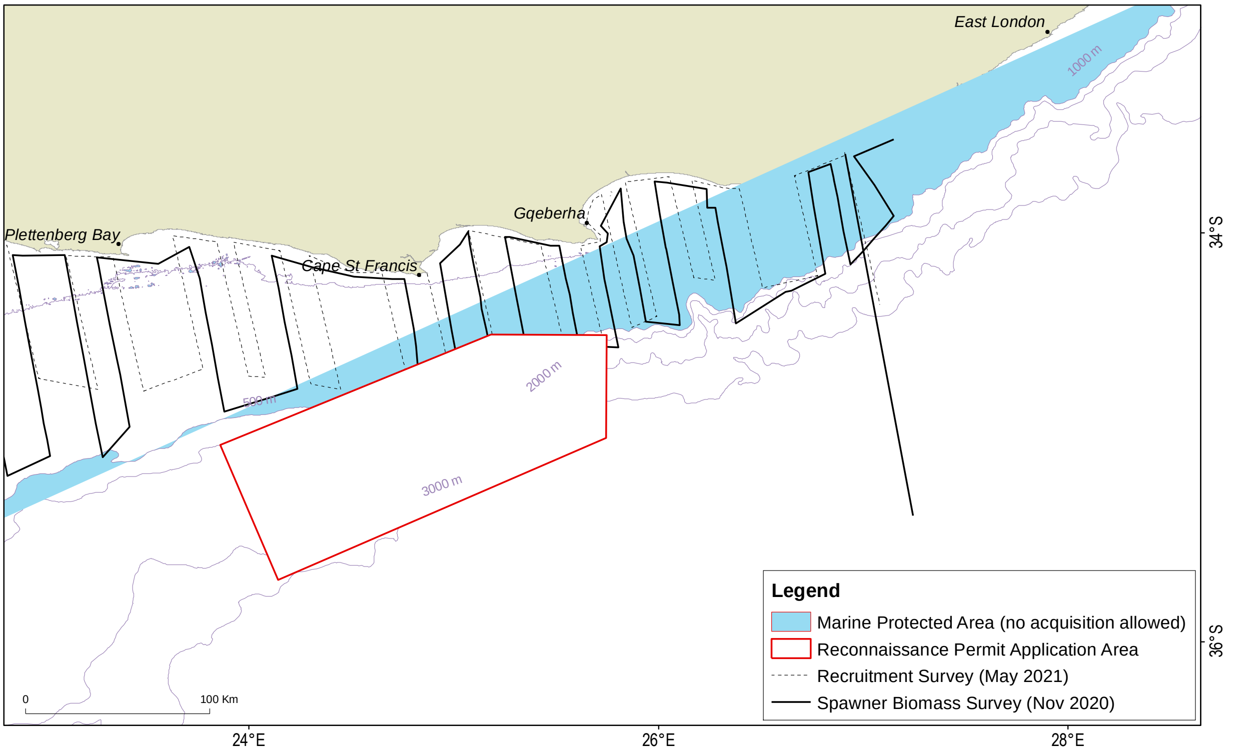


Figure 2.37: Spatial distribution survey transects undertaken during the 2020 and 2021 research surveys of small pelagic species abundance. Survey transects are shown in relation to the reconnaissance permit area.

2.4 SUMMARY TABLE OF SEASONALITY OF CATCHES FOR COMMERCIAL FISHING SECTORS IN THE RECONNAISSANCE PERMIT AREA

An overview map showing the footprint of all commercial fishing sectors in relation to the reconnaissance permit area is shown in Figure 2.38. The seasonality of each of the main commercial fishing sectors that operate in the vicinity of the proposed reconnaissance permit area is indicated in Table 2.11 – also presented is the relative intensity of fishing effort on a month-by-month basis and the likelihood of occurrence.

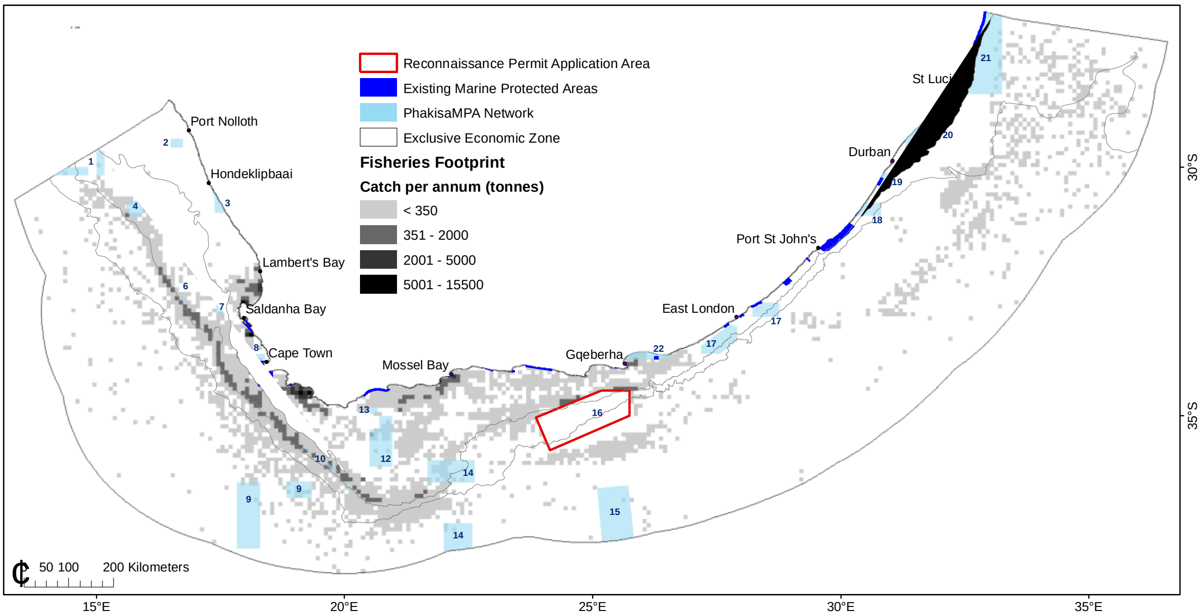


Figure 2.38: Spatial distribution of the fisheries footprint (all fishing sectors combined) within the South African EEZ and in relation to the reconnaissance permit area.

Table 2.11: Summary table showing seasonal variation in fishing effort and likelihood of presence of each commercial fisheries sectors operating in the reconnaissance permit area.

Sector	Likelihood of presence in reconnaissance permit area	Fishing Intensity by Month in the vicinity of the reconnaissance permit area H = High; M = Low to Moderate; N = None											
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Demersal Trawl	Highly Likely	H	H	H	H	M	M	M	M	M	H	H	H
Midwater Trawl	Highly Likely	M	M	M	M	M	M	M	M	M	M	M	M
Hake Demersal Longline	Highly Likely	M	M	M	M	M	M	M	M	H	H	H	H
Shark Demersal Longline	Unlikely	M	M	M	M	M	M	M	M	M	M	M	M
Small Pelagic Purse-Seine	Unlikely	M	H	H	H	H	H	H	H	H	H	H	M
Large Pelagic Longline	Highly Likely	M	M	M	M	H	H	H	H	H	M	M	M
Traditional Linefish	Unlikely	M	M	M	M	M	M	M	M	M	M	M	M
South Coast Rock Lobster	Possible	M	M	M	M	M	M	M	M	M	M	M	M
Squid Jig	Unlikely	H	M	M	N	N	N	M	M	M	M	M	H
Small-scale	Unlikely	M	M	M	M	M	M	M	M	M	M	M	M
Demersal Research Survey (trawl)	Possible	N	N	N	M	M	M	N	N	N	N	N	N
Pelagic Research Survey (acoustic)	Possible	N	N	N	N	M	M	N	N	N	M	M	M

3 IMPACT ASSESSMENT

3.1 EXCLUSION FROM FISHING GROUND

Description and Source of Impact

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

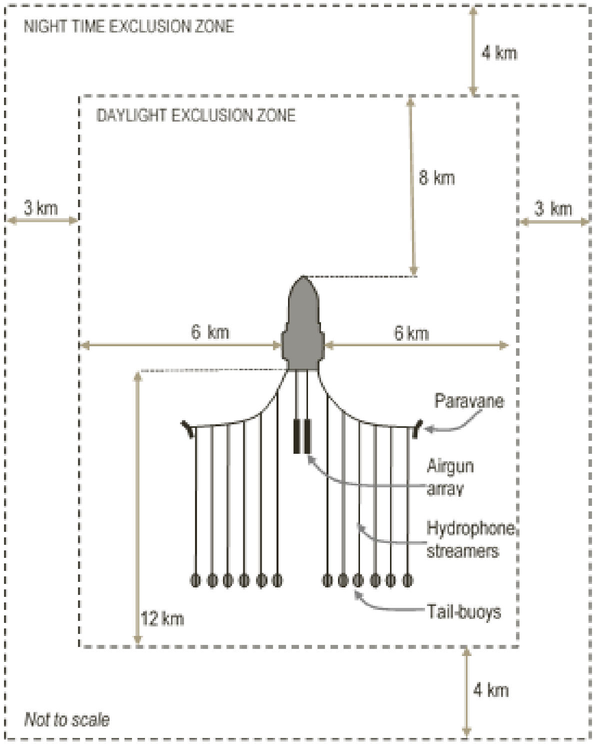
Activity phase	Activity
Mobilisation	N/A
Operation	Operation of survey vessel and seismic array
Demobilisation	N/A

A purpose-built seismic vessel would be contracted to conduct the 3D seismic survey. The receiver array would consist of 8 streamer cables extending up to a maximum of 6 km astern. The total horizontal spread of the towed streamer array would be approximately 1 600 m. The streamer cables would be towed at a variable depth of between 12 m and 18 m and would therefore not be visible to other vessels. A tailbuoy would mark the far end of each of each of the streamer cables.

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 array and the hydrophone streamers 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 zone around the survey vessel and seismic array aims 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 and seismic array poses a direct impact to fishing operations in the form of loss of access to (or 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 around the seismic vessel and array, 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 a 3D survey is illustrated in Figure 3.1.

Figure 3.1 Typical configuration and safe operational limits for a 3D seismic survey operation (SLR Consulting).

A safety zone would be enforced around the seismic vessel for the duration of the survey, resulting in the temporary exclusion of fishing operations from 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 shifting exclusion area of approximately 165 km^2 within the proposed survey area.

The 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 2.1 and 2.3, respectively. The affected fisheries sectors (receptors) have been identified based on the extent of overlap of fishing grounds with the reconnaissance permit area. The sectors that operate in the area have been identified as; **demersal trawl, midwater trawl, demersal longline (hake-directed), large pelagic longline, south coast rock lobster and fisheries research surveys**.

The sensitivity of a particular fishing sector to the impact of an exclusion zone would differ according to the degree of disruption to fishing operations. 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 (the exclusion zone) into alternative fishing areas (i.e. the % effort exerted by that sector in the area of interest). For instance, those that set fishing gear for extended periods (i.e. rock lobster traps anchored at seabed or drifting longlines) are more susceptible to exclusion than those more mobile operations (i.e. trawl nets are towed directly behind the vessel). Pelagic longline vessels set a drifting mainline, which may be up to 100 km in length, and while 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. Similarly, demersal longline and south coast rock lobster vessels are severely restricted when hauling a line. Rock lobster traps may be left in place and unattended for several days before later retrieval. In the case of the large pelagic longline sector, the targeted fish stock may only be available in a specific area for a specific period of time. As with lobster, 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 demersal trawl, midwater trawl and demersal longline sectors have been categorised as MEDIUM[5] sensitivity whereas the sensitivity of the large pelagic longline and south coast rock lobster sectors is considered to be HIGH[6].

Impact Assessment

The proposed seismic survey could potentially affect the operations of the demersal trawl, midwater trawl, demersal longline, large pelagic longline and south coast rock lobster sectors through short-term (temporary)

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

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

loss of access to fishing ground. The probability of the impact occurring is considered to be highly likely for all above-mentioned sectors. The seismic survey could also affect the operations of fisheries research surveys undertaken in the reconnaissance permit area each year by the DFFE.

Based on the proportion of catch and effort across the proposed area (which is considered to be of REGIONAL extent), the impact of exclusion was initially assessed to be of **medium** intensity to the demersal trawl, midwater trawl, demersal longline (hake-directed), large pelagic longline and south coast rock lobster sectors. However, after consultation with the commercial fishing sector it became evident that, although the national percentages are low in the survey area, the demersal trawl sector does focus their efforts in the vicinity of the survey area during the December and January period. Thus, if the survey occurs during this period the intensity of the impact on the demersal trawl sector could be high. The impact is assessed to be of **medium intensity to fisheries research surveys**. Based on the combination of the impact intensity, extent and duration, the impact is assessed to be of **high magnitude for the demersal trawl sector** and of **low magnitude for the demersal trawl, midwater trawl, demersal longline (hake-directed), large pelagic longline and south coast rock lobster sectors**.

Taking into consideration the impact magnitude and sensitivity of each sector, the overall impact significance is considered to be **MEDIUM for the demersal trawl sector (hake-directed) and LOW for the south coast rock lobster, demersal longline and midwater trawl sectors**. The impact significance if considered to be **LOW for fisheries research survey undertaken each year by DFFE within the area**.

The probability of the impact occurring is considered highly likely for the demersal trawl, demersal longline (hake-directed), midwater trawl, large pelagic longline sectors. The probability of the impact occurring is considered possible for the south coast rock lobster sector.

<u>Mitigation</u>

A list of recommended mitigation measures is included in Table 3.1.

Table 3.1: Recommended Mitigation Measures for Fisheries.

No.	Mitigation measure
1	Commence surveying in January/February in order to avoid key fishing periods.
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), South Coast Inshore Trawl Fishing Industry Association (SECIFA), South Coast Rock Lobster Association, South African Squid Management Industrial Association (SASMIA), South African Pelagic Fishing Industry Association (SAPFIA), South African Midwater Trawling Association, South African Linefish Associations (various) and SA Marine Linefish Management Association (SAMLMA). Other key stakeholders: SANHO, South African Maritime Safety Association, Ports Authority and the DFFE Vessel Monitoring, Control and Surveillance Unit in Cape Town.

No.	Mitigation measure
	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, 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	Ensure at a minimum, one FLO person (speaking English and Afrikaans) is on board the escort or survey vessel to facilitate communication in the local language with fishing vessels that are in the area.
5	For the duration of the survey, circulate a 5-day and 24-hr daily survey schedule (look-ahead), via email, to key fishing associations.
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.
8	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.
9	Implement a grievance mechanism in case of disruption to fishing or navigation.

Residual Impact

This potential impact cannot be eliminated because a safety zone will be enforced around the vessel during routine operations. The impact will reduce to LOW significance for the demersal trawl sector and will remain of LOW significance for the hake-directed longline, large pelagic longline, south coast rock lobster and midwater trawl sectors. There is no impact expected on the squid jig and small-scale sectors (see Table 3.2).

Table 3.2: Impact of Exclusion from Fishing Ground.

	IMPACT OF EXCLUSION OF FISHING OPERATIONS	
	PRE-MITIGATION IMPACT	RESIDUAL IMPACT
TYPE OF IMPACT	DIRECT	DIRECT
NATURE OF IMPACT	NEGATIVE	NEGATIVE
SENSITIVITY OF RECEPTOR	HIGH Large pelagic longline, south coast rock lobster MEDIUM Demersal trawl, demersal longline, midwater trawl, research surveys	
IMPACT MAGNITUDE	MEDIUM Demersal trawl	LOW Demersal trawl, midwater trawl, demersal longline, large pelagic longline, south coast rock lobster
	LOW midwater trawl, demersal longline, large pelagic longline, south coast rock lobster	

	IMPACT OF EXCLUSION OF FISHING OPERATIONS	
	PRE-MITIGATION IMPACT	RESIDUAL IMPACT
INTENSITY	HIGH: Demersal trawl MEDIUM midwater trawl, demersal longline, large pelagic longline, south coast rock lobster	MEDIUM Demersal trawl, midwater trawl, demersal longline, large pelagic longline, south coast rock lobster
EXTENT	REGIONAL	REGIONAL
DURATION	SHORT-TERM	SHORT-TERM
SIGNIFICANCE	MEDIUM demersal trawl LOW Demersal longline, large pelagic longline, south coast rock lobster, midwater trawl, fisheries research surveys	LOW Demersal longline, large pelagic longline, south coast rock lobster, demersal trawl, midwater trawl, fisheries research surveys
PROBABILITY	HIGHLY LIKELY Demersal trawl, midwater trawl, demersal longline, large pelagic longline, south coast rock lobster, fisheries research	
CONFIDENCE	FULLY REVERSIBLE	
REVERSIBILITY	LOW	
LOSS OF RESOURCES	VERY LOW	
MITIGATION POTENTIAL	POSSIBLE TO LIKELY Considering the potential for other seismic surveys to be conducted in the area, some cumulative impacts can be anticipated.	
CUMULATIVE POTENTIAL	POSSIBLE	

3.2 IMPACT OF SOUND ON CATCH RATES

<u>Source of Impact</u>

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 seismic survey is proposed to be the 1500LL/1900LLXT 2965 CUI Source Array. The array has 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 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 level (Pk SPL) for the 3D array is expected to be 256 dB re 1 μm @ 1m. The sound exposure level (SEL) is expected to be 232.5 dB re 1 μm @ 1m.

A Sound Transmission Loss Modelling (STLM) study for the proposed activity was undertaken 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, as well as the zones of impact for injury (permanent and temporary) and behaviour.

Table 3.3 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 3.3: 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		
	SEL, dB re 1 µPa²·s	Pk SPL, dB re 1µPa	RMS SPL, dB re 1µPa
10	214	239	232
20	203	228	221
50	194	219	213
80	190	215	208
100	188	214	207
200	183	208	200
500	176	202	189
800	171	197	182
1 000	170	195	180
2 000	164	189	173
4 000	158	183	165

Description of Impact

International research has shown that the noise energy generated during a seismic survey may cause mortality, physiological damage, masking effects and/or behavioural responses in marine fauna (Caroll *et al* 2017). The acoustic impacts of the proposed seismic survey on marine fauna have been described and assessed in a separate marine fauna specialist report (Pulfrich, 2022). Information on the effects on fish and invertebrates has been incorporated, where appropriate, into the current assessment.

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:** Behavioural responses can vary between species and sometimes extend over large distances, until the noise decreases below the background sound level. Responses to impulsive sounds are varied and include leaving the area of the noise source, changes in depth distribution and feeding behaviour, spatial changes in schooling behaviour, and startle response to short range start up or high level sounds.

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 swim bladders.
- 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 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.

- Cephalopods (e.g. squid) may be receptive to the far-field sounds of seismic airguns, with reported responses to frequencies under 400Hz including alarm response (e.g. jetting of ink), changes in behaviour (aggression and spawning), position in the water column and swimming speeds (Kaifu *et al.* 2008; Hu *et al.* 2009; Mooney *et al.* 2010; Fewtrell & McCauley 2012; Mooney *et al.* 2016). 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)[7].

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. 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). 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)). Table 3.4 lists the cumulative and peak Sound Elevation Levels (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 are expected at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected for fish species at far field distances (thousands of meters) from the source location.

[7] 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

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). Whilst adult fish can flee from airgun noise, eggs and larvae area unable to do so and therefore may be affected by an acoustic signal.

Table 3.4: Noise exposure criteria for seismic airguns – 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).

The relevance of the effects of sound on the fishing industry is assessed further in the current report as a number of studies have reported reductions in catch rates of fish during and after seismic surveys. The observed declines in catch rates differ considerably from study to study and also according to species and gear type in the same areas and events[8]. Estimated declines are of relatively short duration and range from no apparent reduction to a reduction by 79% of Atlantic cod in a longline fishery (Løkkeborg and Soldal, 1993 reported in Hirst and Rodhouse, 2000). The distance from the seismic acoustic source at which reductions in catch rates were measured also varied substantially from case to case ranging (when reported) up to 36 km. The observed duration of impacts ranged from approximately 12 hours to up to 10 days. As an example, catch reductions for the species Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and rockfish (*Sebastes spp.*) are provided in Table 3.5.

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[9] (McCauley *et al.,* 2000).

[8] Note that no in-field studies previously undertaken in situ in South Africa could be sourced to inform the current report.

[9] 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.

Table 3.5: 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

Project Controls

The seismic contractor will ensure that the proposed seismic survey is undertaken in a manner consistent with good international practice and best available techniques regarding fisheries management. At least one escort vessel with appropriate radar and communications will patrol the area during the seismic survey to ensure that other vessels adhere to the safe operational limits. This vessel would assist in alerting other vessels (e.g. fishing, cargo vessels, etc.) about the survey and the lack of manoeuvrability of the survey vessel.

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 behavioural effects from seismic sound sources is for species with swim-bladders (e.g. hake and other demersal species targeted by line and trawl fisheries and small pelagic species targeted by the purse-seine sector). 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 sector, 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.

Consequently, the large pelagic longline sector is categorised as HIGH sensitivity whereas the sensitivity of the demersal trawl, midwater trawl, demersal longline, south coast rock lobster and research sectors is

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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.

considered to be MEDIUM. Based on the distance of the acquisition area from fishing grounds, the noise levels are expected to drop to below threshold levels for behavioural disturbance before reaching areas fished by the linefish, squid, small pelagic purse-seine, netfish and small-scale sectors.

Impact Assessment

The results of the STLM study (SLR 2021) were used to identify zones of impact for fish species 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)) due either to the immediate impact from single airgun pulses or the cumulative effects of exposure to multiple airgun pulses over a period of 24 hours.

The zones of impact on fish of impulsive emissions from the array source are presented in Table 3.6. The zone of potential injury was predicted to be within 240 m of the source array for species with a swim bladder and 120 m for species without a swim bladder. The zone of physical injury was predicted to be within 240 m for fish eggs and larvae.

Table 3.6: Zones of immediate impact from single pulses (3D seismic airgun array) 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	120	>213	120
Fish: swim bladder is not involved in hearing (particle motion detection)	>207	120	>207	240
Fish: swim bladder involved in hearing (primarily pressure detection)	>207	240	>207	240
Fish eggs and fish larvae	>207	240	-	-

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 3.7. 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 10 m from the survey lines. For recoverable injury, the zones of impact are predicted to be within 10 m from the survey lines for fish without a swim bladder, and within 50 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 2 km from the survey lines for the 24-hour operation scenario 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 3.7: Zones of cumulative impact from multiple pulses (3D seismic airgun array) 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					
	Mortality and potential mortal injury		Recoverable injury		TTS	
	Criteria - SEL_{24hr} dB re 1 $\mu Pa^2 \cdot s$	Maximum threshold distance, m	Criteria - SEL_{24hr} dB re 1 $\mu Pa^2 \cdot s$	Maximum threshold distance, m	Criteria - SEL_{24hr} dB re 1 $\mu Pa^2 \cdot s$	Maximum threshold distance, m
Fish: no swim bladder (particle motion detection)	219	< 10	216	< 10	186	2 000
Fish: swim bladder is not involved in hearing (particle motion detection)	210	10	203	50	186	2 000
Fish: swim bladder involved in hearing (primarily pressure detection)	207	20	203	50	186	2 0000
Fish eggs and fish larvae	210	10	-	-	-	-

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 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 the threshold level for behavioural effects on fish. The STLM results predict a RMS SPL of 162 dB re 1μPa at a horizontal distance of 4 000 m from the airgun array (SLR 2021). For the current assessment it has been assumed that behavioural effects on fish (and disturbance to catch rates) could extend up to 4 000 m from the source.

Based on the proportion of catch and effort across the reconnaissance permit area, the impact of seismic noise was initially assessed to be of medium intensity to the demersal trawl, midwater trawl, hake-directed demersal longline, large pelagic longline and south coast rock lobster sectors. After consultation with the commercial fishing sector, it became evident that, although the national percentages are low in the survey area, the demersal trawl sector does focus their efforts in the vicinity during December and January period. Thus, if the survey occurs during this period the intensity of the impact on the demersal trawl sector could be high. The area affected by noise levels above the threshold for behavioural disturbance is considered to be of regional extent. The area of noise impact[10] does not coincide with fishing grounds of the linefish, squid jig, netfish or small-scale sectors.

Behavioural effects are generally short-term, with duration of the effect being less than or equal to the duration of exposure, although these vary between species. Although the effects on catch rates have been shown to persist for up to 10 days after the exposure, the total survey duration could be up to five months. The potential impact on catch rates could therefore be considered to be of short-term duration. There could, however, possibly be a medium term indirect impact on demersal trawl due to the impact on spawning and recruitment, if the survey coincides with the key kingklip spawning period between June to September.

The magnitude of the impact of sound on catch rates is assessed to be **HIGH** for the demersal trawl sector, **LOW for the midwater trawl, demersal longline, large pelagic longline and south coast rock lobster sectors**. **The impact ranges from LOW to VERY LOW significance.** There is **no impact expected on the linefish, small pelagic purse-seine, squid jig, netfish and small-scale sectors**, as sound levels would attenuate to below threshold levels before reaching these fishing grounds.

<u>Mitigation</u>

A list of proposed mitigation measures is included in Table 3.8.

Table 3.8: Recommended Mitigation Measures for Survey Noise Effects on Fisheries.

No.	Mitigation measure
1	Commence surveying in January/February in order to avoid sensitive squid spawning and key fishing periods.
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), South Coast Inshore Trawl Fishing Industry Association (SECIFA), South Coast Rock Lobster Association, South African Squid Management Industrial Association (SASMIA), South African Pelagic Fishing Industry Association (SAPFIA), South African Midwater Trawling Association, South African Linefish Associations (various) and SA Marine Linefish Management Association (SAMLMA). Other key stakeholders: SANHO, SAMSA, 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.

[10] Above threshold levels for behavioural disturbance.

No.	Mitigation measure
3	Request, in writing, 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	Ensure at a minimum, one FLO person (speaking English and Afrikaans) is on board the escort or survey vessel to facilitate communication in the local language with fishing vessels that are in the area.
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 5-day and 24-hr 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

The residual impact of sound produced during the proposed survey is assessed to be of LOW overall significance to the demersal trawl, midwater trawl, demersal longline, large pelagic longline, south coast rock lobster sectors (and DFFE research surveys). There is no impact expected on the small pelagic purse-seine, squid jig, linefish, netfish or small-scale sectors (refer to Table 3.9).

Table 3.9: Impact of Sound on Catch Rates.

2	IMPACT OF SEISMIC AIRGUN SOUND ON FISHING OPERATIONS	
	PRE-MITIGATION IMPACT	RESIDUAL IMPACT
TYPE OF IMPACT	DIRECT	DIRECT
NATURE OF IMPACT	NEGATIVE	NEGATIVE
SENSITIVITY OF RECEPTOR	HIGH Large pelagic longline MEDIUM Demersal trawl, midwater trawl, demersal longline (hake-directed), South coast rock lobster, research surveys	
IMPACT MAGNITUDE	HIGH Demersal trawl LOW midwater trawl, demersal longline, large pelagic longline, south coast rock lobster, research surveys	LOW Demersal trawl, midwater trawl, demersal longline, large pelagic longline, south coast rock lobster
INTENSITY	HIGH Demersal trawl MEDIUM midwater trawl, demersal longline, large pelagic longline, south coast rock lobster	MEDIUM Demersal trawl, midwater trawl, demersal longline, large pelagic longline, south coast rock lobster
EXTENT	REGIONAL	REGIONAL
DURATION	SHORT-TERM MEDIUM TERM (Demersal trawl)	SHORT-TERM
PROBABILITY	LIKELY Demersal trawl, midwater trawl, hake-directed demersal longline, large pelagic longline, research surveys POSSIBLE south coast rock lobster	
CONFIDENCE	MEDIUM	MEDIUM
SIGNIFICANCE	HIGH Demersal trawl LOW midwater trawl, demersal longline, large pelagic longline, south coast rock lobster, research surveys	LOW Demersal trawl, midwater trawl, demersal longline, large pelagic longline, south coast rock lobster, research surveys
REVERSIBILITY	FULLY REVERSIBLE	
LOSS OF RESOURCES	LOW	
MITIGATION POTENTIAL	MEDIUM	
CUMULATIVE POTENTIAL	POSSIBLE TO LIKELY Considering the potential for other seismic surveys to be conducted in the area, some cumulative impacts can be anticipated.	

3.3 UNPLANNED EVENTS

3.3.1 ACCIDENTAL RELEASE OF OIL AT SEA

Description and Source of Impact

The project activities likely to 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 (or event) 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 will 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 (e.g. in Gqeberha) 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 survey area is located in the offshore marine environment, more than 45 km offshore at its closest point, far removed from any sensitive coastal receptors (e.g. mariculture areas); however, discharges could still directly affect migratory pelagic species transiting through the survey area. The sensitivity of the various fishing sectors that operate in the area of interest for 3D acquisition is considered to be medium, as a diesel slick would be blown in a south-westerly direction due to the dominant winds and currents off the South Coast, away for the more actively fished inshore areas, after which it would evaporate or naturally disperse within a few days or less (NOAA 1998).

Diesel spills or accidents en route to the onshore supply base at Gqeberha, although unlikely, could result in fuel loss closer to shore. Algoa Bay supports near shore mariculture activities (oysters). These activities are far removed from the area of interest for 3D acquisition and proposed operation activities (e.g. bunkering) 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 demersal trawl, midwater trawl, hake-directed demersal longline, large pelagic longline and south coast rock lobster sectors. Thus, any spill within the reconnaissance permit area, could impact these sectors. The dominant wind and current direction will ensure that any spill in the survey area is dispersed in a south-westerly direction away from the coast and more actively fished inshore areas of the proposed area of interest for seismic acquisition. Thus, any spill offshore, which will disperse rapidly (days), is unlikely to have an impact on more sensitive features in the inshore areas of the proposed survey area.

The potential impact on the offshore fishing sectors is considered to be of local extent for small instantaneous spills and regional for larger volume spills and of low intensity in the short-term. Thus, in offshore waters, the magnitude of a small spill on all fisheries is considered to be very low. Based on the **medium sensitivity** of receptors and the **very low magnitude**, the potential impact on commercial fishing are of **very low** significance without mitigation.

The effects of an oil spill would, however, potentially have the greatest impact on sessile filter feeding (e.g. mussels and oysters) and grazing species (e.g. abalone) resulting in mortality through physical clogging and or direct absorption. In the case of a spill *en route* to the survey area (during a vessel accident), the spill may reach the shore affecting mariculture operations, abalone harvests and small-scale sectors. In this case the **intensity** would be considered **high**, but of local extent over the short-term. In nearshore waters, the **magnitude** of a small accidental spill is expected to be **low**. Based on the medium sensitivity of receptors and the low magnitude, the potential impact on a nearshore spill of **low significance** without mitigation.

<u>**Mitigation Measures**</u>

The following measures are recommended:

Table 3.11: 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 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.

<u>**Residual impact**</u>

With the implementation of the above-mentioned intrinsic mitigation measures (refer to Table 3.11), the residual impact would be of VERY LOW significance for offshore spills and LOW for nearshore spills (see Table 3.12).

Table 3.12: Impact of Accidental Release of Oil at Sea on Fisheries Sectors.

3	IMPACT OF ACCIDENTAL RELEASE OF OIL AT SEA	
	PRE-MITIGATION IMPACT	RESIDUAL IMPACT
TYPE OF IMPACT	DIRECT	DIRECT
NATURE OF IMPACT	NEGATIVE	NEGATIVE
SENSITIVITY OF RECEPTOR	MEDIUM Fishing operators are susceptible to project-related changes given they are not fully resilient to the survey-related impacts but are generally able to adapt to such changes albeit with some diminished quality of life.	
MAGNITUDE	VERY LOW (OFFSHORE) LOW (NEARSHORE)	VERY LOW (OFFSHORE) LOW (NEARSHORE)
INTENSITY	LOW (OFFSHORE) HIGH (NEARSHORE)	LOW (OFFSHORE) HIGH (NEARSHORE)
EXTENT	LOCAL	LOCAL
DURATION	SHORT TERM	SHORT TERM
SIGNIFICANCE	VERY LOW (Offshore)	VERY LOW (Offshore)
	LOW (Nearshore)	LOW (Nearshore)
PROBABILITY	POSSIBLE - UNLIKELY	POSSIBLE - UNLIKELY
CONFIDENCE	MEDIUM	MEDIUM
REVERSIBILITY	FULLY REVERSIBLE	
LOSS OF RESOURCES	LOW	
MITIGATION POTENTIAL	LOW	
CUMULATIVE POTENTIAL	UNLIKELY	

3.3.2 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.

<u>Project Controls</u>

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.

<u>Sensitivity of Receptors</u>

Sensitivity here refers to the ability of the sector to operate as expected considering a project-induced events. Considering lost equipment on the seafloor, the demersal trawl sector gear may be snagged or damaged. Similarly, 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**.

<u>Impact Assessment</u>

The accidental loss of equipment onto the seafloor would provide a localised area of hard substrate in an area of otherwise unconsolidated sediments. The survey area coincides with fishing grounds of several demersal fishing sectors thus snagging of demersal gear is possible. The impact **magnitude** for equipment lost to the seabed, therefore, considered **low** and of **VERY LOW overall significance to the demersal trawl and demersal longline sectors.**

The loss of streamers and floats would 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 low and of **VERY LOW overall significance** to the large pelagic longline fishery.

Mitigation Measures

The following measures are recommended:

Table 3.13: Recommended Mitigation Measures for Loss of Equipment at Sea.

No.	Mitigation measure
1	Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.
2	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.
3	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.
4	Ensure at a minimum, one FLO person (speaking English and Afrikaans) is on board the escort or survey 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 3.13) will reduce the impact; however, the residual impact will remain of small magnitude and of VERY LOW significance (refer to Table 3.14).

Table 3.14: Impact on Fisheries Sectors of Loss of Equipment at Sea.

4	LOSS OF EQUIPMENT TO SEA	
	PRE-MITIGATION IMPACT	RESIDUAL IMPACT
TYPE OF IMPACT	DIRECT	DIRECT
NATURE OF IMPACT	NEGATIVE	NEGATIVE
SENSITIVITY OF RECEPTOR	MEDIUM	
MAGNITUDE	VERY LOW	VERY LOW
SCALE	LOW	LOW
EXTENT	SITE	SITE
DURATION	SHORT-TERM	SHORT-TERM
SIGNIFICANCE	VERY LOW	VERY LOW
PROBABILITY	POSSIBLE	POSSIBLE
CONFIDENCE	MEDIUM	MEDIUM
REVERSIBILITY	FULLY REVERSIBLE if object is retrieved PARTIALLY REVERSIBLE if object sinks	
LOSS OF RESOURCES	LOW	
MITIGATION POTENTIAL	LOW	
CUMULATIVE POTENTIAL	UNLIKELY	

3.4 CUMULATIVE IMPACTS

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[11].

The impacts on each of the above fishing sectors could be increased due to the combination of impacts from other exploration projects / activities that may take place during the same period in the South Coast offshore environment. Concurrent activities such as the drilling of additional wells in the neighbouring Licence Block 11B/12B and other planned seismic surveys could add to the cumulative impact on fisheries, especially the activities are concurrent. The cumulative impact on any one fishery is expected to be of LOW significance. Once completed there is not expected to be any residual impact. This would thus further mitigate any cumulative impact across fishery sectors. The potential that cumulative impacts of other hydrocarbon exploration activities on the fishing industry arise is considered to possible to likely.

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

4 CONCLUSIONS AND RECOMMENDATIONS

The potential impacts of the proposed seismic survey 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.

A safety zone would be enforced around the seismic vessel for the duration of the project, resulting in a temporary (short-term) exclusion from fishing ground. 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 affected area. 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.

With the survey area largely avoiding key fishing areas, January/February commencement and the implementation of the project controls and mitigation measures, the residual impact of exclusion on fishing operations was assessed to be of LOW significance for the demersal longline, large pelagic longline, south coast rock lobster, demersal trawl and midwater trawl sectors as well as fisheries research surveys (undertaken by DFFE). There is no impact of exclusion to fishing operations expected on demersal (shark-directed) longline, small pelagic purse-seine, linefish, squid jig, netfish and small-scale sectors which operate inshore of the area. The impact of elevated sound levels on fishing operations was assessed to be of overall LOW significance for the demersal trawl, midwater trawl, demersal longline, large pelagic longline and south coast rock lobster sectors (and DFFE research surveys). There is no impact expected on the small pelagic purse-seine, squid jig, linefish, netfish and small-scale sectors as these fishing grounds are situated beyond the range at which behavioural disturbance would be expected. The potential for mitigation of the noise effects on catch rates of affected sectors 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 would be possible for some sectors to relocate fishing effort into areas of the acquisition 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 seasonality of each of the main commercial fishing sectors that operate in the vicinity of the proposed survey areas is indicated in Table 4.1. Based on a seasonal increase in fishing effort of several fishing sectors over the period December to March, taking cognisance of survey duration, it is recommended the survey be initiated in January/February. This could reduce the disruption to the demersal trawl, demersal longline and south coast rock lobster sectors, but would, however, not affect the overall significance ratings of the impact on these sectors. Although the increase in underwater noise is not expected to impact the squid resource, which is targeted from November to March inshore of the survey area, as a precautionary approach it is recommended that shallow-water acquisition be undertaken during April and/or May, during which time the squid fishery is closed. It is, however, acknowledged that this might not be technically feasible due to the Agulhas current and related survey lines orientation.

Table 4.1: Summary table of fisheries activity showing seasonality of fishing effort expended by each of the commercial fisheries sectors operating in the vicinity of the reconnaissance permit area and likelihood of presence.

Sector	Likelihood of presence in reconnaissance permit area	Fishing Intensity by Month in the vicinity of the reconnaissance permit area H = High; M = Low to Moderate; N = None											
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Demersal Trawl	Highly likely	H	H	H	H	M	M	M	M	M	H	H	H
Midwater Trawl	Highly likely	M	M	M	M	M	M	M	M	M	M	M	M
Hake Demersal Longline	Highly likely	M	M	M	M	M	M	M	M	H	H	H	H
Shark Demersal Longline	Unlikely	M	M	M	M	M	M	M	M	M	M	M	M
Small Pelagic Purse-Seine	Unlikely	M	H	H	H	H	H	H	H	H	H	H	M
Large Pelagic Longline	Highly likely	M	M	M	M	H	H	H	H	H	M	M	M
Traditional Linefish	Unlikely	M	M	M	M	M	M	M	M	M	M	M	M
South Coast Rock Lobster	Possible	M	M	M	M	M	M	M	M	M	M	M	M
Squid Jig	Unlikely	H	M	M	N	N	N	M	M	M	M	M	H
Small-scale	Unlikely	M	M	M	M	M	M	M	M	M	M	M	M
Demersal Research Survey (trawl)	Possible	N	N	N	M	M	M	N	N	N	N	N	N
Pelagic Research Survey (acoustic)	Possible	N	N	N	N	M	M	N	N	N	M	M	M

Table 4.2 Recommended Mitigation Measures for Fisheries.

No.	Mitigation measures
1	Commence surveying in January/February in order to avoid sensitive squid spawning and key fishing periods.
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 (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 vessels): 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), South Coast Inshore Trawl Fishing Industry Association (SECIFA), South Coast Rock Lobster Association, South African Squid Management Industrial Association (SASMIA), South African Pelagic Fishing Industry Association (SAPFIA), South African Midwater Trawling Association, South African Linefish Associations (various) and SA Marine Linefish Management Association (SAMLMA).

No.	Mitigation measures
	Other key stakeholders: 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, 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	For the duration of the survey, circulate a 5-day and 24-hr daily survey schedule (look-ahead), via email, to key fishing associations.
5	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.
6	Ensure at a minimum, one FLO person (speaking English and Afrikaans) is on board the escort or survey vessel to facilitate communication in the local language with the fishing vessels that are in the area.
7	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.
8	Ensure project vessels fly standard flags and lights to indicate that they are engaged in towing surveys and are restricted in manoeuvrability.
9	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.
10	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.
11	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).
12	Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.

No.	Mitigation measures
13	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.
14	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.

5 REFERENCES

1972 Convention on the International Regulations for Preventing Collisions at Sea (COLREGs). International Maritime Organisation.

Andreiguetto-Filho J.M, Ostrensky A., Pie M.R., Silva U.A., Boeger W.A. (2005). Evaluating the impact of seismic prospecting on artisanal shrimp fisheries. Continental Shelf Research, 25: 1720–1727.

Carroll A.G., Przeslawski R., Duncan A., Gunning, M. and B. Bruce (2017). A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. Marine Poll. Bulletin 114: 9-24.

Cochrane K.L. and S. Wilkinson (2015). Assessment of the Potential Impacts on the Small Pelagic Fishery of the proposed 2D Seismic Survey by Rhino Oil and Gas Exploration South Africa (Pty) Ltd in the inshore area between Saldanha Bay and Cape Agulhas. Unpublished Report as part of the EIA undertaken on behalf of CapMarine (Pty) Ltd for Rhino Oil and Gas Exploration South Africa (Pty) Ltd. December 2015, pp20.

Crawford R.J.M., Shannon L.V., Pollock D.E. (1987). The Benguela Ecosystem. Part IV. The major fish and invertebrate resources. Oceanogr. Mar. Biol. Ann. Rev. 25: 353-505.

Crowther Campbell & Associates and Centre for Marine Studies (2001). Generic Environmental Management Programme Reports for oil and gas prospecting off the coast of South Africa. Petroleum Agency SA, Cape Town, South Africa, Revision 2001. 5 Volumes.

Dalen J., Ona E., Sodal A.V. and R. Sætre (1996). Seismic investigations at sea; an evaluation for fish and fisheries. *Fisken og Havet* 9: 26

DAFF (Department of Agriculture, Forestry and Fisheries). 2008. Annual report of South Africa: Part 1 (Submitted to ICCAT).

DAFF (Department of Agriculture, Forestry and Fisheries). 2016. Small-Scale Fisheries. A guide to the small-scale fisheries sector. http://small-scalefisheries.co.za/wp-content/downloads/SSF%20Booklet%20English.pdf

DAFF (Department of Agriculture, Forestry and Fisheries). 2016. Status of the South African marine fishery resources 2016. Cape Town: DAFF.

DAFF (Department of Agriculture, Forestry and Fisheries). Fishing Industry Handbook: South Africa, Namibia & Mozambique: 2019 47th Edition. George Warman Publications. Cape Town.

DAFF (Department of Agriculture, Forestry and Fisheries) media release: 09 February 2016. Small-scale fisheries sector – establishing the legal framework and moving towards implementation.

Day R.D. *et al.* 2019. Seismic air guns damage rock lobster mechanosensory organs and impair righting reflex. Pro.R.Soc. B 286: 20191424.http://dx.doi.org/10.1098/rspb.2019.1424

Engås A., Løkkeborg S., Ona E. and A.V. Soldal (1996). Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*), Can. J. Fish. Aquat. Sci. 53, 2238-2249.

Fewtrell J.L., McCauley R.D. (2012). Impact of air gun noise on the behaviour of marine fish and squid. Marine Pollution Bulletin, 64: 984–993.

Fishing Industry Handbook South Africa, Namibia and Moçambique (2017). 45th edition George Warman Publications

Gausland I. (2003). Seismic Survey Impact on Fish and Fisheries. Stravanger, Norwegian Oil Industry Association

Hirst A.G. and P.G. Rodhouse (2000). Impacts of geophysical seismic surveying on fishing success. Reviews in Fish Biology and Fisheries 10: 113-118.

Hutchings L., Beckley L.E., Griffiths M.H., Roberts M.J., Sundby S. and C. van der Lingen (2002). Spawning on the edge: spawning grounds and nursery areas around the southern African coastline. Mar. Freshwater Res.53: 307–318.

Løkkeborg S., Ona E., Vold A. and A. Salthaug (2012). Sounds from seismic air guns: gear and species specific effects on catch rates and fish distribution. Can. J. Fish. Aquat. Sci. 69, 1278-1291.

Marine Traffic Act 1981 (Act 2/1981). To regulate marine traffic in the Republic of South Africa; and to provide for matters connected therewith. Gazzetted: GN282/7408/13Feb1981. Commencement: 28 December 1984 (Proc211/9538/28Dec1984)

McCauley R.D., Ryan D.D., Swadling K.M., Fitzgibbon Q.P., Watson R.A., and Semmens J.M. (2017). Widely used marine seismic survey air gun operations negatively impact zooplankton. Nat. Ecol. Evol. 1, 0195.

McCauley R.D. (1994). Seismic surveys. In: Swan, J.M., Neff, J.M., Young, P.C. (Eds.). Environmental implications of offshore oil and gas development in Australia - The findings of an Independent Scientific Review. APEA, Sydney, Australia, 695 pp.

Myrberg Jr A.A. (2001). The acoustical biology of elasmobranchs, Environ. Biol. Fish 60.31-45.

NOAA, 1998. Fact Sheet: Small Diesel Spills (500-5000 gallons) Available at: http://response.restoration.noaa.gov/oilaids/diesel.pdf.

Parry G.D., Gasson A. (2006). The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia, Fish. Res., 79: 272–284.

Pulfrich A. (2019). Additional environment impact studies in order to strengthen the current EMPr for Block 11B/12B. Marine Faunal Assessment for seismic acquisition, drill cuttings discharge, and marine noise. Prepared for SLR Consulting (Pty) Ltd. on behalf of Total E&P South Africa B.V. pp158

Pulfrich A. (2022). Marine Faunal Assessment as part of a Basic Assessment for a Speculative 3D Seismic Survey off the Eastern Cape Coast, South Africa.

Popper A.N., Fay R.R., Platt C. and O. Sand (2003). Sound detection mechanisms and capabilities of teleost fishes, Sensory Processing in Aquatic Environments. Springer, pp 3-38.

Popper A.N. and C.R. Schilt (2008). Hearing and acoustic behaviour: basic and applied considerations. Fish Bioacoustics, Springer pp. 17-48

Punsly R. and H. Nakano (1992). Analysis of variance and standardization of longline hook rates of bigeye (*Thunnus obesus*) and yellowfin *(Z'hunnus albacares)* tunas in the Eastem Pacific Ocean during 1975-1987. Bulletin of Inter-American Tropical Tuna Commission, La Jolla, California, USA, 2d4): 167-177.

Shannon L.V. and Pillar S.C. (1986). The Benguela ecosystem 3. Plankton. In Oceanography and Marine Biology. An Annual Review 24. Barnes M. (Ed.). Aberdeen; University Press: 65-170.

Skalski J.R., Pearson W.H. and C.I. Malme (1992). Effects of sound from geophysical surveys device on catch per-unit-effort in a hook-an –line fishery for rockfish (*Sebastes spp.*). Canadian Journal of Fisheries and Aquatic Sciences Vol. 49, pp. 1357-1365.

South African Deep-Sea Trawling Industry Association: Spatial boundaries for the South African hake-directed trawling industry. Prepared by Capricorn Fisheries Monitoring cc (July 2008).

Sowman M. (2006). Subsistence and small-scale fisheries in South Africa: a ten-year review. Marine Policy 30: 60-73.

van der Lingen C.D. and J.J. van der Westhuizen (2013). Spatial distribution of directed sardine catches around South Africa, 1987-2012. Scientific Working Group document, Department of Agriculture, Forestry and Fisheries, FISHERIES/2013/OCT/SWG-PEL/33, 9 pp.

Wardle C.S., Carter T.J., Urquhart G.G., Johnstone A.D.F., Ziolkowski A.M., Hampson G., Mackie D. (2001). Effects of seismic air guns on marine fish. Cont. Shelf Res., 21: 1005-1027.

APPENDIX 1: ASSESSMENT METHODOLOGY

The convention used to evaluate the significance of the impact is provided below. The sensitivity of the receptor was derived from the baseline information. The impact magnitude (or consequence) was determined based on a combination of the "intensity", "duration" and "extent" of the impact. Magnitude 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. Terminology, criteria and ratings are outlined further below.

Term	Definition
Nature of Impact	The direction of impact and whether it leads to an adverse effect (negative), beneficial effect (positive) or no effect (neutral)
Positive	An impact that is considered to represent an improvement to the baseline conditions or introduces a positive change to a receptor.
Negative	An impact that is considered to represent an adverse change from the baseline conditions or receptor, or introduces a new adverse effect.
Neutral	An impact that has no or negligible effect on the receptor.
Type	Cause and effect relationship between the project activity and the nature of effect on receptor
Direct	Impacts that result from a direct interaction between a proposed project activity and the receiving environment (e.g. effluent discharge and receiving water quality). Sometimes referred to as primary impacts.
Indirect	Impacts that are not a direct result of a proposed project, often produced away from or as a result of a complex impact pathway. Sometimes referred to as secondary impacts.
Induced	A type of indirect impact resulting from factors or activities caused by the presence of the Project but which are not always planned or expected (e.g. human in-migration along new access or for jobs creating increased demand on resources).
Residual	The impacts that remain after implementation of the project and all associated mitigation and other environmental management measures.

DEFINITIONS OF IMPACT ASSESSMENT CRITERIA AND CATEGORIES APPLIED

Definitions of the criteria used in assessing impact significance and the assigned categories, and the additional criteria used to describe the impacts, are summarised in the table below.

Criterion	Definition	Categories
Sensitivity	Sensitivity is a rating given to the importance and/ or vulnerability of a receptor (e.g. conservation value of a biodiversity feature or cultural heritage resource or social receptor.	Very Low/ Low Medium/ High/ Very High
Magnitude (or consequence)	A term describing the actual change predicted to occur to a resource or receptor caused by an action or activity or linked effect. It is derived from a combination of Intensity, Extent and Duration and takes into account scale, frequency and degree of reversibility	Very Low/ Low/ Medium/ High/ Very High
Intensity	A descriptor for the degree of change an impact is likely to have on the receptor which takes into account scale and frequency of occurrence.	Very Low/ Low Medium/ High

Criterion	Definition	Categories
Extent	The spatial scale over which the impact will occur.	Site/ Local/ National Regional/ International /Transboundary
Duration	Time scale over which the consequence of the effect on the receptor/s will last. [Note that this does not apply to the duration of the project activity]. The terms 'Intermittent' and 'Temporary' may be used to describe the duration of an impact.	Short-term Medium-term Long-term Permanent
Probability	A descriptor for the likelihood of the impact occurring. Most assessed impacts are likely to occur but Probability is typically used to qualify and contextualise the significance of unplanned events or major accidents.	Unlikely/ Possible Likely/ Highly Likely Definite
Confidence	A descriptor for the degree of confidence in the evaluation of impact significance.	Low/ Medium High/ Certain
Mitigation potential	A descriptor for the degree to which the impact can be mitigated to an acceptable level.	None/ Very Low Low/ Medium/ High
Loss of Irreplaceable resources	A descriptor for the degree to which irreplaceable resources will be lost, fragmented or damaged.	Low/ Medium/ High
Reversibility	A descriptor for the degree to which an impact can be reversed.	Irreversible Partially Reversible Fully Reversible
Cumulative	A descriptor of the potential for an impact to have cumulative impacts to arise.	Unlikely/ Possible Likely

Sensitivity is a term that covers the 'importance' (e.g. value of an ecological receptor or heritage resource) or 'vulnerability' (e.g. ability of a social receptor to cope with change) of a receptor to a project-induced change. It takes into account 'Irreplaceability' - measure of the value of, and level of dependence on, impacted resources to society and/ or local communities, as well as of consistency with policy (e.g. conservation) targets or thresholds. Broad definitions of sensitivity ratings for abiotic receptors are defined below.

Sensitivity Rating	Definition
Social Receptors	**Individuals, communities or groups of stakeholders**
Very Low	Receptors who are not vulnerable or susceptible to project-related changes and have substantive resources and support to understand and anticipate Project impacts. Such receptors have the ability to avoid negative Project impacts, or to cope with, resist or recover from the consequences of a such an impact with negligible changes to their lives, or will derive little benefit or opportunities from the project.
Low	Receptors who have few vulnerabilities and are marginally susceptible to project-related changes but still have substantive resources and support to understand and anticipate a Project impact. Such receptors are able to easily adapt to changes brought about by the project with marginal impacts on their living conditions, livelihoods, health and safety, and community well-being, or will derive marginal benefits or opportunities from the project.
Medium	Receptors have some vulnerabilities and are more susceptible to project-related changes given they only have moderate access to resources, support, or capacity to understand and anticipate a Project impact. Such receptors are not fully resilient to Project impacts but are generally able to adapt to such changes albeit with some diminished quality of life. For positive impacts, these receptors are likely to derive a moderate level of benefit or opportunities from the project.
High	Receptors are vulnerable and susceptible to project-related changes, and have minimal access to resources, support, or capacity to understand and anticipate a Project impact. Such receptors are not resilient to Project impacts and will not be able to adapt to such changes without substantive adverse consequences on their quality of life.

Sensitivity Rating	Definition
	For positive impacts, these receptors are likely to derive a substantial level of benefits or opportunities from the project.
Very High	Receptors are highly vulnerable and have very low resilience to project-related changes. By fact of their unique social setting or context, such receptors have a diminished or lack of capacity to understand, anticipate, cope with, resist or recover from the consequences of a potential impact without substantive external support. For positive impacts, receptors are likely to derive substantial benefits or opportunities from the project which could lead to significant and sustained improvement in their quality of life.

DETERMINATION OF MAGNITUDE (OR CONSEQUENCE)

Definitions of Criteria Used to Derive Magnitude

The term 'magnitude' (or 'consequence') describes and encompasses all the dimensions of the predicted impact including:

- the nature of the change (what is affected and how);
- its size, scale or intensity;
- degree of reversibility; and
- its geographical extent and distribution.

Taking the above into account, Magnitude (or consequence) is derived from a combination of 'Intensity', 'Duration' and 'Extent'.

The criteria for deriving Intensity, Extent and Duration are summarised below.

Criteria	Rating	Description
Criteria for ranking of the INTENSITY of environmental impacts taking into account reversibility and scale	**VERY LOW**	Negligible change, disturbance or nuisance which is barely noticeable or may have minimal effect on receptors or affect a tiny proportion of the receptors.
	LOW	Minor (Slight) change, disturbance or nuisance which is easily tolerated and/or reversible in the short term without intervention, or which may affect a small proportion of receptors.
	MEDIUM	Moderate change, disturbance or discomfort caused to receptors or which is reversible over the medium term, and/or which may affect a moderate proportion of receptors.
	HIGH	Prominent change, or large degree of modification, disturbance or degradation caused to receptors or which may affect a large proportion of receptors, possibly entire species or community and which is not easily reversed.
Criteria for ranking the EXTENT / SPATIAL SCALE of impacts	**SITE**	Impact is limited to the immediate footprint of the activity and immediate surrounds within a confined area.
	LOCAL	Impact is confined to within the project concession / licence area and its nearby surroundings.
	REGIONAL	Impact is confined to the region, e.g. coast, basin, catchment, municipal region, district, etc.
	NATIONAL	Impact may extend beyond district or regional boundaries with national implications.

Criteria	Rating	Description
	INTERNATIONAL	Impact extends beyond the national scale or may be transboundary.
Criteria for ranking the DURATION of impacts	**SHORT TERM**	The duration of the impact will be < 1 year or may be intermittent.
	MEDIUM TERM	The duration of the impact will be 1-5 years.
	LONG TERM	The duration of the impact will be 5-25 years, but where the impact will eventually cease either because of natural processes or by human intervention.
	PERMANENT	The impact will endure for the reasonably foreseeable future (>25 years) and where recovery is not possible either by natural processes or by human intervention.

DETERMINING MAGNITUDE (OF CONSEQUENCE) RATINGS

Once the intensity, extent and duration are defined based on the definitions set out above, the magnitude (or consequence) of negative and positive impacts is derived based on the table below. It should be noted that there may be times when these definitions may need to be adjusted to suit the specific impact where justification should be provided. For instance, the permanent loss of the only known occurrence of a species in a localised area of impact can only achieve a "High" magnitude rating but could, in this instance, warrant a Very High rating. The justification for amending the rating should be indicated in the impact table.

Magnitude/ Consequence Rating	Description
VERY HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***long term***; OR of ***high intensity*** at a ***national level*** in the ***medium or long term***; OR of ***medium intensity*** at a ***national level*** in the ***long term.***
HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***high intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***national level*** in the ***long term***; OR of ***high intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***regional level*** in the ***long term.***
MEDIUM	Impacts could be EITHER: of ***high intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***medium intensity*** at a ***regional level*** in the ***medium term***; OR of ***high intensity*** at a ***regional level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***local level*** in the ***long term***; OR of ***low intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***regional level*** in the ***long term.***
LOW	Impacts could be EITHER of ***low intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***national level*** in the ***short term***; OR of ***high intensity*** at a ***local level*** and endure in the ***short term***; OR of ***medium intensity*** at a ***regional level*** in the ***short term***; OR of ***low intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.***

Magnitude/ Consequence Rating	Description
VERY LOW	Impacts could be EITHER of ***low intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***; OR of ***low or medium intensity*** at a ***local level*** and endure in the ***short term.*** OR **Zero to very low *intensity*** with any combination of extent and duration.

DETERMINATION OF IMPACT SIGNIFICANCE

The significance of an impact is based on expert judgement of the sensitivity (importance or vulnerability) of a receptor and the magnitude (or consequence) of the effect that will be caused by a project-induced change.

In summary, the impact assessment method is based on the following approach:

Significance = Magnitude x Sensitivity

Where Magnitude = Intensity +Extent + Duration

Once ratings are applied to each of these parameters the following matrix is used to derive Significance:

		SENSITIVITY				
		VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
MAGNITUDE (or CONSEQUENCE)	VERY LOW	NEGLIGIBLE	NEGLIGIBLE	VERY LOW	LOW	LOW
	LOW	VERY LOW	VERY LOW	LOW	LOW	MEDIUM
	MEDIUM	LOW	LOW	MEDIUM	MEDIUM	HIGH
	HIGH	MEDIUM	MEDIUM	HIGH	HIGH	VERY HIGH
	VERY HIGH	HIGH	HIGH	HIGH	VERY HIGH	VERY HIGH

The definitions and approach to determining "sensitivity" and "intensity" criteria are described below.

Broad definitions of impact significance ratings are provided in the table below. Impacts of 'High' and 'Very High' significance require careful evaluation during decision-making and need to be weighed up against potential long-term socioeconomic benefits of the project to inform project authorisation. Where there are residual biodiversity impacts of 'High' and 'Very High' significance this will require careful examination of offset feasibility and confirmation that an offset is possible prior to decision-making.

Significance Rating	Interpretation
Very High	**Impacts** where an accepted limit or standard is far exceeded, changes are well outside the range of normal variation, or where long-term to permanent impacts of large magnitude (or consequence) occur to highly sensitive resources or receptors. For **adverse residual impacts** of very high significance, there is no possible further feasible mitigation that could reduce the impact to an acceptable level or offset the impact, and natural recovery or restoration is unlikely. The impact may represent a possible fatal flaw and decision-making will need to evaluate the trade-offs with potential social or economic benefits. **Positive** social impacts of very high significance would be those where substantial economic or social benefits are obtained from the project for significant duration (many years).
High	**Impacts** where an accepted limit or standard is exceeded; impacts are outside the range of normal variation or adverse changes to a receptor are long-term. Natural recovery is unlikely or may only

Significance Rating	Interpretation
	occur in the long-term and assisted and ongoing rehabilitation is likely to is required to reduce the impact to an acceptable level. High significance **residual impacts** warrant close scrutiny in decision-making and strict conditions and monitoring to ensure compliance with mitigation or other compensation requirements. **Positive** social impacts of high significance would be those where considerable economic or social benefits are obtained from the project for an extended duration in the order of several years.
Medium	Moderate **adverse changes** to a receptor where changes may exceed the range of natural variation or where accepted limits or standards are exceeded at times. Potential for natural recovery in the medium-term is good, although a low level of residual impact may remain. Medium impacts will require mitigation to be undertaken and demonstration that the impact has been reduced to as low as reasonably practicable (even if the **residual impact** is not reduced to Low significance). **Positive** social impacts of medium significance would be those where a moderate level of benefit is obtained by several people or a community, or the local, regional or national economy for a sustained period, generally more than a year.
Low	**Minor effects** will be experienced, but the impact magnitude (or consequence) is sufficiently small (with and without mitigation) and well within the range of normal variation or accepted standards, or where effects are short-lived. Natural recovery is expected in the short-term, although a low level of localised residual impact may remain. In general, impacts of low significance can be controlled by normal good practice but may require monitoring to ensure operational controls or mitigation is effective. **Positive** social impacts of low significance would be those where a few people or a small proportion of a community in a localised area may benefit for a few months.
Very Low	Very minor effects on resources or receptors are possible but the predicted effect represents a minimal change to the distribution, presence, function or health of the affected receptor, and **no mitigation is required**.
Negligible	Predicted impacts on resources or receptors of very low or low sensitivity are imperceptible or indistinguishable from natural background variations, and **no mitigation is required**.

ADDITIONAL ASSESSMENT CRITERIA

Additional criteria that are taken into consideration in the impact assessment process and specified separately to further describe the impact and support the interpretation of significance, include the following:

- **Probability (Likelihood) of the impact occurring** (which is taken into account mainly for unplanned events);
- **Degree of Confidence in the impact prediction;**
- **Degree to which the impact can be mitigated;**
- **Degree of Resource Loss** (i.e. the extent to which the affected resource/s will be lost, taking into account irreplaceability); and
- **Reversibility** – the degree to which the impact can be reversed.
- **Cumulative Potential –** potential for cumulative impacts with other planned projects or activities.

Definitions for these supporting criteria are indicated below.

Criteria	Rating	Description
Criteria for determining the PROBABILITY of impacts	**UNLIKELY**	Where the possibility of the impact to materialise is very low either because of design or historic experience, i.e. ≤ 5% chance of occurring.
	POSSIBLE	Where the impact could occur but is not reasonably expected to occur i.e. 5-35% chance of occurring.
	LIKELY	Where there is a reasonable probability that the impact would occur, i.e. > >35 to ≤75% chance of occurring.

Criteria	Rating	Description
	HIGHLY LIKELY	Where there is high probability that the impact would occur i.e. >75 to <99% chance of occurring.
	DEFINITE	Where the impact would occur regardless of any prevention measures, i.e. 100% chance of occurring.
Criteria for determining the DEGREE OF CONFIDENCE of the assessment	LOW	Low confidence in impact prediction (≤ 35%)
	MEDIUM	Moderate confidence in impact prediction (between 35% and ≤ 70%)
	HIGH	High confidence in impact prediction (> 70%).
	CERTAIN	Absolute certainty in the impact prediction (100%)
Criteria for the DEGREE TO WHICH IMPACT CAN BE MITIGATED	NONE	No mitigation is possible or mitigation even if applied would not change the residual impact.
	VERY LOW	Some mitigation is possible but will have marginal effect in reducing the residual impact or its significance rating.
	LOW	Some mitigation is possible and may reduce the residual impact, possibly reducing the impact significance.
	MEDIUM	Mitigation is feasible and will reduce the residual impact and may reduce the impact significance rating.
	HIGH	Mitigation can be easily applied or is considered standard operating practice for the activity and will reduce the residual impact and impact significance rating.
Criteria for DEGREE OF IRREPLACEABLE RESOURCE LOSS	LOW	Where the activity results in a marginal effect on an irreplaceable resource.
	MEDIUM	Where an impact results in a moderate loss, fragmentation or damage to an irreplaceable receptor or resource.
	HIGH	Where the activity results in an extensive or high proportion of loss, fragmentation or damage to an irreplaceable receptor or resource.
Criteria for REVERSIBILITY - the degree to which an impact can be reversed	IRREVERSIBLE	Where the impact cannot be reversed and is **permanent**.
	PARTIALLY REVERSIBLE	Where the impact can be partially reversed and is temporary
	FULLY REVERSIBLE	Where the impact can be completely reversed.
Criteria for POTENTIAL FOR CUMULATIVE IMPACTS – the extent to which cumulative impacts may arise from interaction or combination from other planned activities or projects	UNLIKELY	Low likelihood of cumulative impacts arising.
	POSSIBLE	Cumulative impacts with other activities or projects may arise.
	LIKELY	Cumulative impacts with other activities or projects either through interaction or in combination can be expected.