Fisheries

Annex D2

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR A PROPOSED EXPLORATION DRILLING CAMPAIGN WITHIN BLOCK ER236 OFF THE EAST COAST OF SOUTH AFRICA

FISHERIES SPECIALIST STUDY

April 2018

Prepared for the Environmental Assessment Practitioner:

Environmental Resources Management

On behalf of the applicant:

Eni South Africa B.V.

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This specialist report was compiled for Environmental Resources Management (ERM) for their use in compiling a Scoping Report and Environmental Impact Assessment (EIA) for the proposed Exploration Well Drilling Programme in Exploration Rights Block 236, situated off the East Coast of South Africa. We do hereby declare that we are financially and otherwise independent of the Applicant and of ERM.

Dave Japp

Sarah Wilkinson

EXECUTIVE SUMMARY

Eni South Africa BV (Eni), and Sasol Africa Limited (Sasol) hold an Exploration Right (ER236), offshore of the KwaZulu-Natal coast, between St Lucia and Port Shepstone. Eni and Sasol are considering the possibility of conducting an exploration drilling programme in Block ER236 (12/3/236) to assess the commercial viability of the hydrocarbon reservoir for future development.

Eni is considering drilling up to six deep water wells within Block ER236, up to four wells (two exploration and two appraisal wells) in the northern area of interest and up to two wells (one exploration and one appraisal) in the southern area of interest, to establish the quantity and potential flow rate of any hydrocarbon present. The northern area of interest is located, at its closest point, 62 km from shore in water depths ranging between 1,500 m and 2,100 m whilst the southern area of interest is located, at its closest point, 65 km from shore, in water depths ranging between 2,600 m and 3,000 m. Due to water depth in the area of interest, it is anticipated that exploratory drilling will be conducted using a deep water drillship. The potential impacts of the drilling programme that relate specifically to the fishing industry have been identified as the exclusion from fishing ground and the impact on fishing operations, stock spawning and recruitment resulting from unplanned hydrocarbon emissions.

A 500 m safety zone would be enforced around the drilling unit for the duration of drilling operations, resulting in a temporary (short-term) exclusion from fishing ground. Following installation of a wellhead, a permanent restriction on the setting of demersal fishing gear, trawling and anchoring would be enforced to a distance of 500 m around each wellhead, due to the physical obstruction presented by the wellhead. 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 project site. Only the pelagic longline sector is likely to be excluded from fishing areas as these vessels operate within much of the area covered by both the northern and southern areas of interest for well-drilling. Due to the nature of the gear used by the fishery however, the impact is only likely to occur whilst the drilling unit is on site (short-term) and not on abandonment of the wellhead. The magnitude of the impact on the sector is considered to be medium and of overall minor significance due to the low sensitivity of the pelagic fishery. Although a number of other fisheries sectors operate off the KwaZulu-Natal coastline, due to the distance of the proposed drilling operation offshore, none of these is expected to be affected by the exclusion zone around the drilling unit or wellhead.

There is a lack of definitive evidence regarding the effects of drilling operations on marine fishes but behavioural effects can result from an increase in noise above ambient levels which in turn could affect catch rates in the affected area. The main source of noise from the proposed drilling programme includes a continuous low frequency noise produced by the drilling unit, and supply vessels. The noise characteristics and level of various vessels used in the drilling programme will vary between 130 and 182 dB re 1μPa at 1 m. There has been no sound modelling provided for this particular drilling operation; however, the results of an noise modelling assessment for a similar project indicated that noise resulting from drilling would attenuate to ambient levels at a distance of 3 km from the drilling location. Based on the proximity of the affected area to commercial fishing grounds, it is unlikely that a significant change in catch rate would be experienced by any sector as a result of elevated noise levels.

Oil spill modelling was performed in a separate study (ERM, 2018) to simulate three different types of spill scenarios, the results of which were used to assess the potential impact of each of these on the fishing industry. The three scenarios included: a diesel spill associated with a vessel collision happening either during the drilling of wells or the operation phase (Scenario 1); a wellhead blowout releasing crude oil from the reservoir (Scenario 2); and a release of low toxicity oil-based muds (NADF) due to the accidental disconnection of the riser occurring during the drilling phase (Scenario 3). Scenario 2 was divided into two separate cases to examine different blowout situations to simulate different ways in which the release may be terminated. In Scenario 2a, the spill ended after 7 days when the hole collapsed upon itself. In Scenario 2b, a capping stack is installed on the 20th day of the release. The scenarios were evaluated assuming the release occurred at three possible locations where exploration and appraisal wells can possibly be drilled (two locations in the northern part and one location in southern part of ER236 block). In line with international standards and in order to present a conservative analysis, no cleanup or response efforts were assumed. In reality this would not be the case and Eni would implement measures to protect shorelines or prevent the spill trajectory from freely moving, therefore, these modelled results show the absolute worst case results.

Based on the current assessment, the effects of exclusion from fishing ground are likely to result in an impact of moderate significance on one fishery sector. Mitigation would not reduce this effect but the following communications strategy is considered essential. Prior to the commencement of drilling activities the South African Tuna Association should be informed of the navigational co-ordinates of the proposed drilling location, 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. Other key stakeholders should be notified prior to commencement and on completion of drilling once the drilling unit and support vessels are off location. These include; the South African Navy Hydrographic Office (HydroSAN), South African Maritime Safety Association (SAMSA), Ports Authority, Ezemvelo KZN Wildlife and the Department of Agriculture, Forestry and Fisheries Vessel Monitoring, Control and Surveillance Unit in Cape Town (Vessel Monitoring System Unit).

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ACRONYMS AND ABBREVIATIONS

CapMarine	Capricorn Marine Environmental (Pty) Ltd
CPUE	Catch Per Unit Effort
DAFF	Department of Agriculture, Forestry and Fisheries
DMR	Department of Mineral Resources
EAP	Environmental Assessment Process
EIA	Environmental Impact Assessment
Eni	Eni South Africa BV
ER	Exploration Right
ERM	Environmental Resources Management
FLO	Fisheries Liaison Officer
GRT	Gross Registered Tonnage
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
ORI	Oceanographic Research Institute
Pisces	Pisces Environmental Consulting (Pty) Ltd
S&EIR	Scoping and Environmental Impact Reporting
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
Sasol	Sasol Limited
SATLA	South African Tuna Longline Association
SSFP	Small Scale Fisheries Sector Policy
t	Tonnes
TAC	Total Allowable Catch
TAE	Total Allowable Effort
ToR	Terms of Reference
VMS	Vessel Monitoring System

1 INTRODUCTION

1.1 PROJECT BACKGROUND

Eni South Africa BV (Eni), and Sasol Africa Limited (Sasol) hold an Exploration Right (ER236), offshore of the KwaZulu-Natal coast, between St Lucia and Port Shepstone. Eni and Sasol are considering the possibility of conducting an exploration drilling programme in Block ER236 (12/3/236) to assess the commercial viability of the hydrocarbon reservoir for future development.

Eni is considering drilling up to six deep water wells within Block ER236, up to four wells (two exploration and two appraisal wells) in the northern area of interest and up to two wells (one exploration and one appraisal) in the southern area of interest, to establish the quantity and potential flow rate of any hydrocarbon present. Well testing may be conducted on the appraisal wells if they present potential commercial quantities of hydrocarbon.

The northern area of interest is located, at its closest point, approximately 62 km from shore, in water depths ranging between 1,500 m and 2,100 m and covers an area of 1,717.50 km^2. The southern area of interest is located, at its closest point, approximately 65 km from shore, in water depths ranging between 2,600 m and 3,000 m and covers an area of 2,905 km^2 (see Figure 1-1). The expected drilling depth would be between approximately 3,800 m and 4,100 m from sea level in the northern area, while around 5,450 m for the southern area.

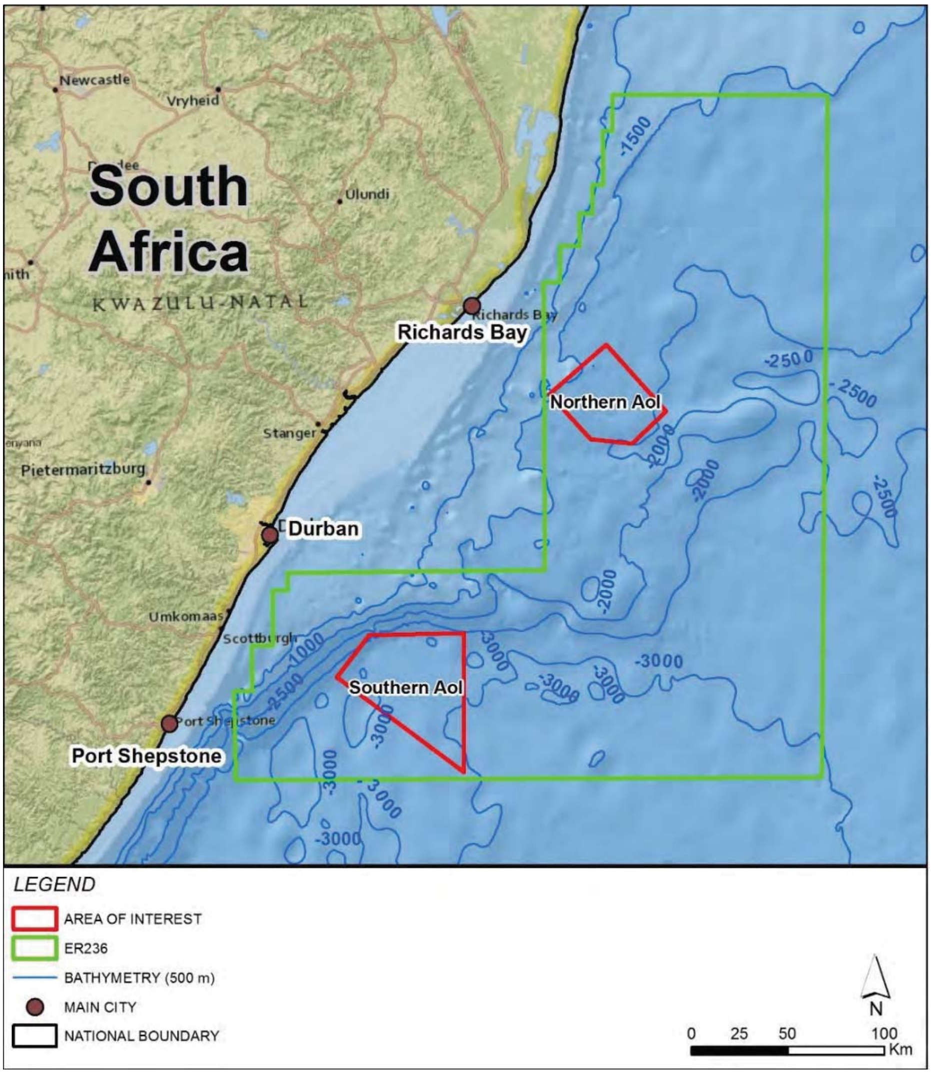


Figure 1-1: Locality map of Block ER236 and the proposed areas of interest for well-drilling, located off the East Coast of South Africa.

The specific number of wells and their locations will be based on a number of factors, including further analysis of seismic data, the geological target (the hydrocarbon bearing geology into which the well is to be drilled), and the presence of any seafloor obstacles. In addition, the success (if valuable hydrocarbon is discovered) of the first well in each area will determine whether or not subsequent wells are drilled.

The time sequence of these possible additional wells will be dependent on the results of the first exploration well, and will not occur immediately after the drilling of the initial well.

The co-ordinates of the Block ER236 and the drilling areas of interest are provided in Table 1-1 and Table 1-2 respectively.

Table 1-1: Coordinates of Block ER236 (WGS84).

Point	Latitude	Longitude
A	27°48'30"S	32°52'00"E
B	27°48'30"S	34°00'00"E
C	31°00'00"S	34°00'00"E
D	31°00'00"S	30°49'00"E
E	30°35'00"S	30°49'00"E
F	30°35'00"S	30°55'00"E
G	30°22'24"S	30°55'00"E
H	30°22'24"S	31°02'00"E
I	30°07'00"S	31°02'00"E
L	30°02'00"S	32°30'00"E
M	28°41'18"S	32°30'00"E
N	28°41'18"S	32°35'20"E
O	28°31'04"S	32°35'20"E
P	28°31'04"S	32°41'30"E
Q	28°21'59"S	32°41'30"E
R	28°21'59"S	32°45'40"E
S	28°13'51"S	32°45'40"E
T	28°13'51"S	32°49'00"E
U	27°58'47"S	32°49'00"E
V	27°58'47"S	32°52'00"E

Table 1-2 Coordinates of the Northern Drilling Area of Interest (WGS84)

Point	Latitude	Longitude
A	29° 12' 33"S	32° 31' 46"E
B	28° 58' 47"S	32° 49' 33"E
C	29° 17' 29"S	33° 08' 59"E
D	29° 26' 35"S	32° 58' 12"E
E	29° 25' 22"S	32° 44' 46"E

Table 1-3 Coordinates of the Southern Drilling Area of Interest (WGS84)

Point	Latitude	Longitude
A	30° 19' 40"E	32° 03' 49"E
B	30° 58' 36"E	32° 03' 26"E
C	30° 31' 35"E	31° 22' 26"E
D	30° 19' 50"E	31° 33' 08"E

The earliest that drilling is expected to take place is in the third quarter of 2019. The drilling of one well is estimated to take approximately 71 days to complete. The time sequence of any additional wells will be dependent on the results of the first exploration well.

The drillship will be mobilised from either West or East Africa and will enter South African waters either at the Namibian or Mozambican border, as such at the worst case mobilisation will take in the order of 5 days.

The drilling of the wells would be undertaken by a deep-water drillship held in position by dynamic positioning thrusters. The drillship would be supported by at least three vessels, which would facilitate equipment, material and waste transfer between the drillship and onshore logistics base. The supply vessels would call into port regularly during the drilling campaign.

Eni, in its role of operator of ER236, has appointed Environmental Resources Management (ERM) as the independent Environmental Assessment Practitioner (EAP) for the Environmental Impact Assessment (EIA) process. The EIA will set out the anticipated impacts arising from the Project and propose measures on how these might be managed. The EIA report will inform an environmental authorisation decision to be taken by the Department of Mineral Resources (DMR). As part of the EIA process, Capricorn Marine Environmental (Pty) Ltd ('CapMarine') has been appointed to undertake an assessment of the impact of the proposed project on commercial fishing operations.

1.2 Terms of Reference

The Terms of Reference (ToR) for the current report are to provide an overview of fisheries spatial and temporal catch and effort data and to produce a baseline description of the current commercial fisheries operating within the vicinity of the proposed Project area. Following this, to provide an assessment of the potential impacts of the Project on the existing fisheries and to identify mitigation measures. The specific ToR for the Fisheries Specialist Study are as follows:

- A description of the existing baseline fisheries characteristics within Block ER 236 and the area of interest for well-drilling (distribution of fish stocks and commercial, subsistence and recreational fishing activities).
- An introduction presenting a brief background to the study and an appreciation of the requirements stated in the specific terms of reference for the study.
- Details of the approach to the study where activities performed and methods used are presented.
- The specific identified sensitivity of fishing sectors related to the proposed activity.
- Map/s superimposing the proposed area of interest for well-drilling on the spatial distribution of effort expended by each fishing sector.
- Calculation of proportion of fishing ground that coincides with the proposed affected area.
- Assessment of potential impacts on fisheries using prescribed impact rating methodology.
- A description of any assumptions made and any uncertainties or gaps in knowledge.
- Recommendation of mitigation measures, where appropriate.

1.3 Assessment Approach

This study has adopted a 'desktop' approach. The description of the baseline environment in the study area is therefore based on a review and collation of existing information. The information for the identification of potential impacts was primarily drawn from the marine fauna specialist report for this project (Pisces Environmental Services (Pty) Ltd) as well as literature reviews by Carroll et al. (2017) and Cochrane and Wilkinson (unpublished, 2015).

2 PROJECT DESCRIPTION

2.1 MAIN PROJECT COMPONENTS

This section describes the main project components, which include:

- Deep Water Drillship;
- Exclusion Zone;
- Shore base (refer to scoping report, ERM);
- Supply and stand-by vessels;
- Personnel (refer to scoping report, ERM);
- Crew transfer; and
- Infrastructure and services (refer to scoping report, ERM).

2.1.1 DEEP WATER DRILLSHIP

Various types of drilling vessels are used worldwide in offshore drilling operations, with the type of unit typically dependent on water depths in which it needs to operate. Alternative drilling vessels types are discussed further in Section 2.8.2. Due to water depth in the area of interest, it is anticipated that exploratory drilling will be conducted using a deep water drillship. The deep water drill ship (Figure 2-1) will be kept in position using a dynamic positioning system (DPS) which allows for minimal subsea disturbance due to its ability to operate without moorings. A significant benefit to using a drill ship is the ease of mobility as it is a self-propelled vessel with the flexibility to move from location to location without the need of transport vessels. An example of deep water drillship specifications is presented in Table 2-1 below.

Figure 2-1: Example of a typical drillship (source: Shutterstock, 2017).

Table 2-1: Example drillship specifications.

Parameter	Example Drillship
Principal Dimensions / Operating Parameters	
Length	228 m
Breadth	42 m
Depth	19 m
Operational draft	12 m
Transit draft	13 m
Maximum water depth	3,658 m
Maximum drilling depth	10,660 m
Moonpool	25.6 m x 10.26 m
Available Accommodation	200 People on Board (POB)
Storage Capacities	
Active mud	2,000 bbl
Reserve mud	10,000 bbl
Brine water	3,000 bbl
Base oil	3,000 bbl
Bulk mud/cement	34,500 bbl
Drill water	18,000 bbl
Fuel oil	50 000 bbl
Machinery / Equipment / Fittings	
Main generator sets	6 x diesel generators, 9, 900 HP each

Source: Eni, 2015 and Saipem, 2017[1]

2.1.2 Exclusion Zone

During the drilling operations there will be a temporary 500 m safety zone around the drillship, which will be enforced by a standby vessel. The safety zone would be described in a Notice to Mariners as a navigational warning.

The purpose of the safety zone is to prevent a vessel collision with the drillship during operations. Under the Marine Traffic Act, 1981 (No. 2 of 1981), an "exploration platform" or "exploration vessel" used in prospecting for or mining of any substance falls under the definition of an "offshore installation" and as such it is protected by a 500 m safety zone.

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Section II, Rule 18), a drillship that is engaged in underwater operations 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. Vessels engaged in fishing are required to, so far as possible, keep out of the way of the well drilling operation.

2.1.3 Supply and Standby Vessels

For the duration of the drilling operation, the drillship will be supported by platform supply vessels (PSVs), which are general purpose vessels designed to carry a variety of equipment and cargo. These vessels will supply the drillship three to four times a week with drilling muds, cement and equipment such as casing, drill pipe and tubing. They will also remove waste that must be appropriately disposed of on land. The number of firm PSVs has not yet been defined (it is anticipated that there will be two or three).

[1] http://www.saipem.com/SAIPEM_en_IT/scheda/Vessels/Saipem+12000.page

A standby vessel (or a PSV in dual mode – supply and standby) would also be available to support the drilling operations during an emergency, including oil containment/recovery and rescue and to supply any specialised equipment necessary in case of an emergency.

The standby vessel would also be used to patrol the area to ensure that other vessels adhere to the 500 m exclusion zone around the drillship.

2.1.4 Crew Transfers

Transportation of personnel to and from the drillship would most likely be provided by helicopter operations from Richards Bay or Durban. The drillship would accommodate around 200 personnel. Crews would generally work in 12 hour shifts in 2 to 4 week cycles. Crew changes would be staggered, and in combination with ad hoc personnel requirements. Thus helicopter operations to and from the drillship would occur on an almost daily basis. The helicopter crew would generally work in 10 hour shifts in 2 to 4 week cycles and in accordance with Eni's Aviation Manual.

2.2 Project Activities

Project activities associated with drilling include the following phases:

- Mobilisation of the supply vessels to Richards Bay or Durban, operation of the shore-based facilities for handling support services needed by the drillship;
- Drilling of a well;
- Well execution (side track, logging, completion) options;
- Optional well testing;
- Well abandonment; and
- Demobilisation of the drillship, vessel and local logistics base.

All activities will be conducted in conformity with recognised industry international best practice.

2.2.1 Mobilisation Phase

Vessel Mobilisation and Site Preparation

The drilling locations will be identified prior to mobilisation of the drillship based on the results of the analysis of seismic data. The drilling locations will be within the identified Area of Interest.

During mobilisation, the drillship will arrive directly on location from previous country of intervention (probably from West Africa or North/East Africa). Support vessels could sail directly in convoy with the drillship to site or from the Richards Bay or Durban mooring area.

The drillship will be equipped with navigation equipment for accurate station keeping above the well location (dynamic positioning – using thrusters).

Once in position, the drillship will carry out its pre-drilling activities comprising seabed survey; remote operated vehicle (ROV) dive; positioning; beacon placement and dynamic positioning (DP) trials.

Should any obstacles/sensitivities be identified at the drilling location, the well will be relocated to a nearby location where no obstacles/sensitivities are located.

These activities will be followed up with safety checks, drills, communication tests and drilling of the pilot hole. This will take approximately nine days to complete.

2.2.2 DRILLING PHASE

Well Drilling

After the mobilisation, the first process is the drilling phase. The strategy for the first exploration planned well is not yet defined and, therefore, could be in the northern drilling area of interest consisting of drilling a main hole approximately 62 km south east of Richards Bay, in water depths ranging between 1,500 m and 2,100 m or in the southern drilling area where the exploration well is approximately 145 km east north-east of Port Shepstone, in a water depth of around 3,000 m. The drilling activity proposed is a vertical well to a total depth of approximately 3,800 m and 4,100 m below the seafloor for the wells located in the northern area, while 5,450 m for the well located in the southern area, in order to evaluate and confirm the commercial viability of the reservoir. The expected hydrocarbon for this well is oil.

A standard well design and program for subsea well has been described below, however this will be updated after the completion of seismic interpretation and stratigraphy evaluation by the geologists and petroleum engineers. The well path will be defined accordingly.

During the drilling phase, different drilling bits sizes are used to drill a series of telescoping holes, from the seabed to the total depth of the planned well. The first hole, the outer, is the biggest and called the top hole, while the next inner holes are progressively smaller and smaller as the well depth increases. This continues until the final hole, which is the smallest, reaches the reservoir level (refer to Figure 2-2 and Table 2-2).

The drill bit is connected to surface by a string of hollow tubulars referred to as the drill string. On the rig floor, drill pipes are one by one attached to the top of the string as the drill bit advances into the borehole. The action of drilling (creating a hole in the rocks stratigraphy) is obtained by applying weight and rotation to the bit.

The topdrive, installed in the drillship's derrick, advances the drill string into the well, and provides the rotation and weight on bit required to drill. To give additional torque, sometimes a downhole motor is installed at the bottom of the string, whose rotor is connected to the bit. A sophisticated telemetry system is connected to the string and it transmits to surface the drilling parameters (direction, pressure, rotation, weight etc.) to guarantee a full control and safety during the drilling phase.

Once each hole section has been drilled, casing (steel tubulars) is run into the well and cemented in place to secure/seal the hole interval just drilled and to allow for the drilling of the next (smaller) hole section. A wellhead is connected to the surface casing, to have a connection and anchoring point for the following casing head sections and the marine riser.

The cement operation consists in pumping cement down the drill string to the bottom. The cement flows, out the bottom of the casing shoe and back up into the annular space around the casing, the space between the cased hole and open hole.

Offshore drilling operations typically use Portland cements, defined as pulverised clinkers consisting of hydrated calcium silicates and usually containing one or more forms of calcium sulphate. The raw materials used are lime, silica, alumina and ferric oxide. The cement slurry used is specially designed for the exact well conditions encountered.

Additives can be used to adjust various properties in order to achieve the desired results. There are over 150 cementing additives available. The amount (concentrations) of these additives generally make up only a small portion (<10%) of the overall amount of cement used for a typical well. Usually, there are three main additives used: retarders, fluid loss control agents and friction reducers. These additives are polymers generally made of organic material and are considered non-toxic.

When the cementing job is completed, a mechanical and sealing test is performed. Casing plus cement is a tested barrier that facilitates the drilling of the next section, allowing to reach the target final depth in the safest way.

Table 2-2: Preliminary well design.

Section	Hole Size (inches)	Casing size (inches)	Drilling interval (m) [length –m-]	Effective drilling duration per phase (days)
1	Jetted (alternative 42")	36"	Jetted	2
2	24"	20"	600 m	8
3	16"	13" 3/8	600 m	10
4	12"1/4	9" 5/8	700 m	12
5	8" 1/2	Open hole or 7" liner	700 m	13
Total	-	-	2,630 m	45 **

Source: Eni; 2018

**45 days is the estimated time for the effective drilling phase. 71 days is the estimated overall time for a single well campaign without well testing but including mob/demob, drilling phase, casing runs, cement jobs, logs, BOP run and retrieve.

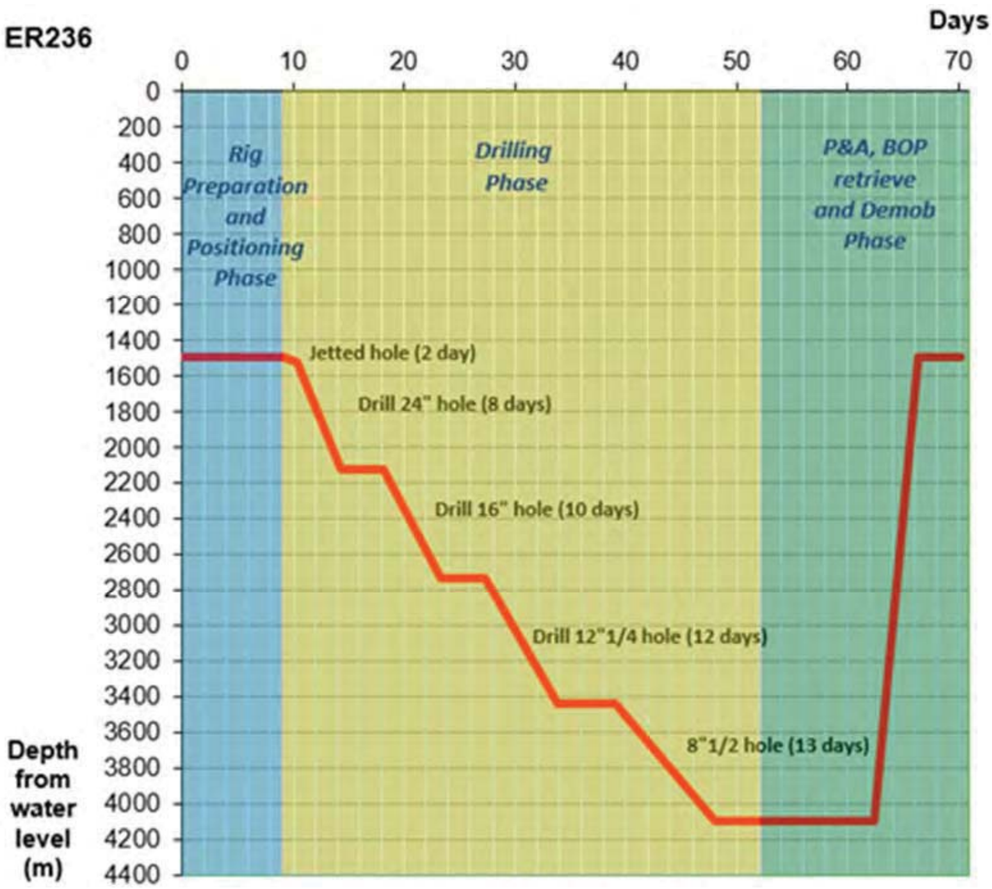


Figure 2-2: **Preliminary well construction phases vs drilling time schedule (Source: ENI).**

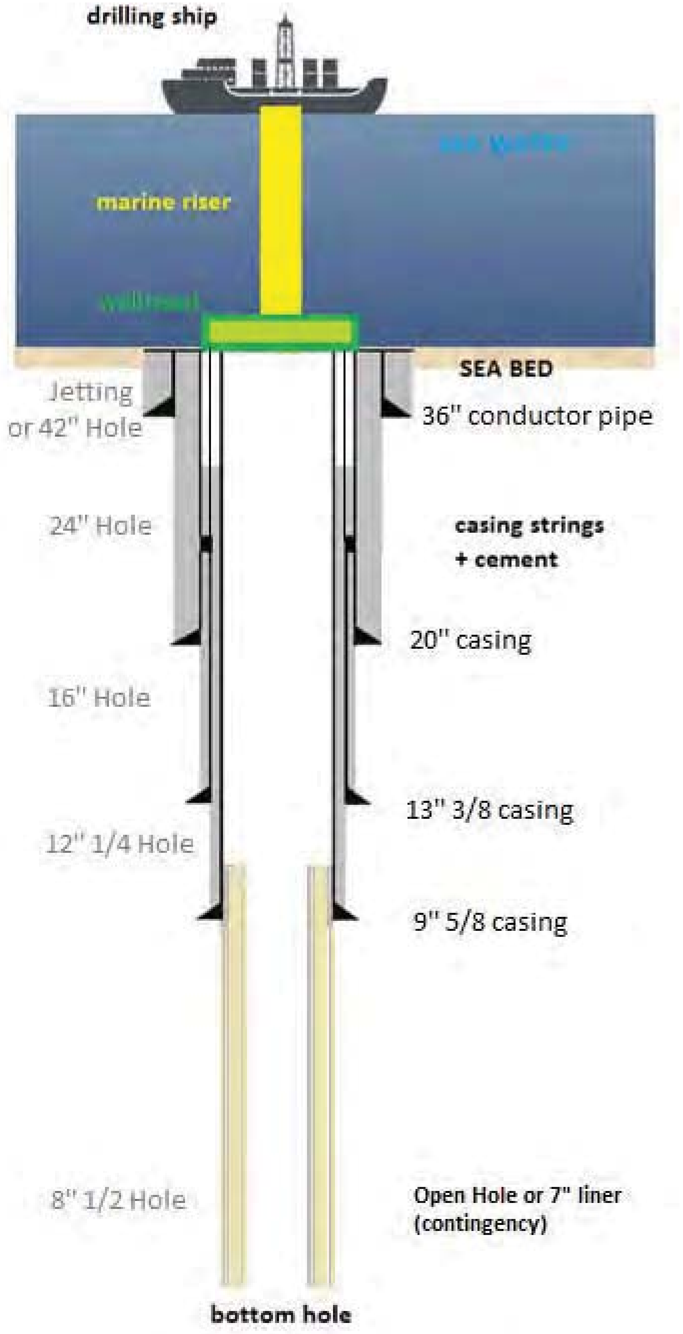


Figure 2-3: Subsea well schematic at the end of the drilling phase (Source, ENI).

Mud System and Cuttings Discharge

Drilling is carried out using seawater, sweeps and drilling mud. Muds can be water based mud (WBM), also called water base fluid (WBF), or non-aqueous drilling fluid (NADF).

Sea water is used during the first sections drilled riserless, the top hole drilling without riser installed. In conjunction with seawater, high viscous pills and sweeps could be used for the top-hole sections cleaning.

Water-Based Muds (WBM) consist of mixtures of clays, natural and synthetic organic polymers, mineral weighting agents, and other additives dissolved or suspended in freshwater, saltwater or brine (OGP, 2016). These muds are used subsequent to the installation of the riser. The main components of a WBM used on a typical well, their functions and description of their ecotoxicity are provided in Table 2-3 below.

Table 2-3: Main components of water-based muds.

Material	Use	Ecotoxicity
Aluminium stearate	Defoamer	Non-toxic, insoluble
Barite	Weighting agent	Non-toxic, insoluble, non-biodegradable
Bentonite	Viscosifer	Non-toxic, insoluble, non-biodegradable
Calcium carbonate	Bridging, loss of circulation	Non-toxic, insoluble
Caustic soda	pH and alkalinity control	Soluble, corrosive
Cellulose based polymers	Fluid loss control	Insoluble, non-toxic
Citric acid	pH control	Soluble, low toxicity, irritant
Diesel oil pill (< 0.1 % mud volume)	Stuck pipe spotting fluid	Slightly soluble, 96 hr LC_{50} >0.1-1000 ppm
Gilsonite (asphalt based)	Lubricant, fluid loss reducer	Low toxicity, slightly soluble
Gluteraldehyde (0.01% mud vol)	Bactericide (biocide)	Noted for its toxic properties, irritant
Lime	Carbonate and CO_2 control	Slightly soluble, non-toxic, irritant
Organic synthetic polymer blends	Filtrate reducing agent	Non-toxic, 96 hr LC_{50} >500 ppm
Palm oil ester	Lubricant, stuck pipe pills	Slightly soluble, biodegradable
Potassium chloride	Shale / clay inhibitor	Soluble, non-toxic
Soda ash	Alkalinity, calcium reducer	Soluble, non-toxic
Sodium bicarbonate	Alkalinity, calcium reducer	Soluble, non-toxic
Xanthan gum	Viscosity, rheology	Soluble, non-toxic

Source: OIGP 2016, Neff 2005, Boehm et al. 2001

Non-Aqueous Drilling Fluids (NADF): Deep water drilling concepts are technically challenging and require high performance drilling fluids with capabilities exceeding those available from WBM, in particular in terms of prevention of formation of hydrates and preservation of wellbore stability. As a result, non-aqueous drilling fluids (NADF), for which the continuous phase is primarily a non-water soluble base fluid, have also been used extensively by the petroleum industry. Low toxicity mineral oil based fluids, highly refined mineral oils and synthetic fluids (esters, paraffin's and olefins) are generally used as base fluids. The main components of NADF are provided in Table 2-4.

Table 2-4: Main components of non-aqueous drilling fluid.

Material	Description
Base oil	Non-aqueous drilling fluids use base fluids with significantly reduced aromatics and extremely low polynuclear aromatic compounds. New systems using vegetable oil, polyglycols or esters have been and continue to be used.
Brine phase	$CaCl_2$, NaCl, KCl.
Gelling products	Modified clays reacted with organic amines.
Alkaline chemicals	Lime e.g. $Ca(OH)_2$.
Fluid loss control	Chemicals derived from lignites reacted with long chain or quaternary amines.
Emulsifers	Fatty acids and derivatives, rosin acids and derivatives, dicarboxylic acids, polyamines.

Source: Adapted from OGP, 2003

An IOGP Group 3 non aqueous base fluid (NABF) with low to negligible aromatic content will be used for this project[2]. These fluids are characterised by PAH contents less than 0.001% and total aromatic contents less than 0.5%. Group III includes synthetic based fluids which are produced by chemical reactions of relatively pure compounds and can include synthetic hydrocarbons (olefins, paraffins, and esters). Base fluids derived from highly processed mineral oils using special refining and/ or separation

2 Based on classification by the International Oil and Gas Producers (IOGP).

processes (paraffins, enhanced mineral oil based fluid (EMBF), etc) are also included. In some cases, fluids are blended to attain particular drilling performance conditions (OGP, 2003).

A combination of seawater, WBMs and NADFs will be used for drilling activities in the drilling area of interest. The mud program will be defined based on final well design and expected rheology.

The main functions of drilling fluids (also referred to as drilling muds) include the following:

- Removal of drilled rock cuttings from the bottom of the well and from the well bore and transportation of these cuttings to the surface;
- Control of formation pressures and prevention of formation fluids entering the well bore (ie ‘primary well control’);
- Transmission of hydraulic horsepower to the drill bit;
- Provision of hydrostatic pressure as well as chemical stability to the rock to maintain the integrity of the hole and prevent hole collapse;
- Corrosion control of the metal components of the drilling tools;
- Lubrication and cooling of the drill bit.

The physical and chemical properties of the drilling fluid are constantly monitored and adjusted to suit varying down-hole conditions. These conditions are, in part, due to the variation in formation pressure within the well bore at different depths. In particular, fluid density (or mud weight) is adjusted via weighting materials such as barite.

For deep water well construction, after drilling the first casing interval, a drilling riser, ie a hollow tube known as the ’marine riser‘ is run between the drillship and the wellhead at seabed, so that drilling fluid can be pumped through the drill pipe, out through the drill bit and circulated back up to surface through the marine riser. The marine riser allows cuttings to be brought back up to the rig to be collected and properly disposed.

Prior to the installation of the riser, meaning during the drilling of top hole intervals drilled riserless, sea water, high viscous pills and sweeps, cuttings and excess cement are returned directly to the seabed (quantities of discharges are included in Section 3.6.2).

Once the riser is installed the drilling fluid is circulated into the well bore through the centre of the drill pipe and the mixture of mud and cuttings is then returned to the rig via the annulus to a solids control system (Figure 3.5), which is designed so that drilling mud can be processed to remove drill cuttings (small rock fragments, sand and silt) and subsequently re-circulated back down-hole.

The WBMs will be processed onboard and reused and recycled if possible. The spent WBMs will either be stored onboard and shipped to shore for disposal or discharged overboard in accordance with Eni’s Waste Management Guidelines, local regulation and international recommendations.

The NADF muds will be recovered, reused and, when spent, stored onboard and shipped to shore for disposal. The NADF drill cuttings will be routed through a cuttings dryer (centrifuge type equipment) to remove residual liquids for reuse. The NADF retained on the drill cuttings will be discharged overboard following treatment in accordance with international recommendations and Eni’s Waste Management Guidelines. Base fluid retained on cuttings will not exceed limits detailed in Section 3.7.2. Solids removal efficiency for each hole section will be monitored to ensure solids control and fluids recovery equipment is operating as designed.

The amount of drilling waste discharge estimated for one well is quantified in Table 2-5 below.

Table 2-5: Typical well design and estimated discharges.

Section	Hole Size (inches)	Casing size (inches)	Proposed Mud Type	Volume of cuttings (m^3)	Volume of mud to be disposed of (m^3)
1	42”	36”	Sea water and sweeps	100	200 (seabed)
2	24”	20”	Sea water and sweeps	300	700 (seabed)
3	16”	13” 3/8	WBM/NADF	120	Discharged/recovered
4	12” 1/4	9” 5/8	WBM/NADF	70	Discharged/recovered
5	8” ½	Open hole or 7”	WBM/NADF	30	Discharged/recovered
Total	**-**	**-**	**-**	**620**	**900**

Source: ENI, 2018

Note: WBM are discharged overboard, while NADF will be recovered

2.2.3 WELL EXECUTION OPTIONS

Well Logging

Continuous testing is carried out on the drill cuttings transferred to the surface. These tests are used to determine and obtain information on the presence of hydrocarbons, formation types being drilled and formation pressures. Further information is obtained on the physical properties of the rock formations by means of open and cased hole logging using sensors introduced down-hole on a wireline cable, or by means of sensors located in the drill collar (measurement while drilling). A logging plan will be developed and implemented in accordance with standard industry best practices.

In the case of exploration wells, once a full log of the reservoir section has been undertaken, the well will be permanently plugged and abandoned.

Well Completion

Well completion and well testing operations will not be conducted during exploration wells (first wells) drilling but, if hydrocarbon is discovered, may be performed after drilling of the appraisal wells.

The completion phase of an oil or gas well takes place after the reservoir formation has been drilled and the production casing cemented. Preliminary completion operations are usually required to clean and condition a wellbore from mud, in order to prepare the well for the following operations.

At the beginning of the completion operations, the wellbore is displaced with a completion brine, necessary to balance the downhole pressure and, at the same time, to complete the removal of mud and solids from the well in order to minimise any potential damage to the formation.

A specific tubular string, the completion string, is then run in hole. This string can be secondary named well testing or completion strings, if used during well testing or in the case of preparation for further production respectively.

This string allows subsea safety, guaranteeing full control of hydrocarbon flow during the testing or production phase.

Subsequently the weighted completion fluid that maintains sufficient pressure and prevents formation fluids from migrating into the hole, is displaced out of the well-bore in order to start the next phase, if required, the well testing phase.

Well Testing

As stated previously, well testing may be conducted on the appraisal wells if they present potential commercial quantities of hydrocarbon.

A well test is a temporary completion of a well to acquire dynamic rate through time, pressure, and fluid property data.

The well test often indicates how the well will perform when it is subjected to various flow conditions. An analysis is usually performed on the data to determine reservoir parameters and characteristics including pressure, volume, and temperature.

Current testing practices are carried out using modern testing equipment and high resolution pressure data acquisition system, getting the reservoir evaluation objectives depends on the behavior of the formation fluid properties, well completion, and flow assurance situations are only known when testing is carried out.

The well test objectives are to:

1. Determine key technical factors of the reservoir (eg size, permeability and fluid characteristics) and values for use in future drilling.
2. Obtain representative data including reservoir pressure, production rates and sample(s).

While testing, hydrocarbons are sent to a flare boom with a burner to ensure as complete destruction of fluids (including hydrocarbons) as possible. Flaring may be initiated using LNG or similar fuel to ignite the mixture. To ensure that burning can be done downwind of the drillship, more than one flare boom can be used, or the ships positioning may be adjusted. Water misters may be used to mitigate heat exposure on the rig.

The flow periods and rates will be limited to the minimum necessary to obtain the required reservoir information during the well test. It is anticipated that a maximum well test time for this project will be approximately 20 days.

Downhole sampling, if required, normally consists of recovering reservoir fluids via wireline or through specific tools added directly to the temporary test string. Wireline testing involves running instruments into the borehole on a cable to measure formation pressures and obtain fluid samples. Formation fluids are brought to the surface where the composition can then be analysed.

The following key well testing preventative measures will be implemented during the well testing program:

- Monitor flare performance to maximise efficiency of flaring operation;
- Ensure sufficient compressed air provided to oil burner for efficient flaring;
- Flare equipment appropriately inspected, certified and function tested prior to operations;
- Flare equipment appropriately maintained and monitored throughout well testing operations;
- The equipment is designed and built to appropriate codes and standards and certified;
- The appropriate emergency stop mechanisms are in place to halt testing in case of emergency.

Well Control and Blowout Prevention

Health, safety and environmental protection are prioritised throughout the drilling process. In particular, there is a specific focus and attention during preparation and operations to avoid any potential accidental events, with related hydrocarbon release or uncontrolled flow from downhole to seabed or at surface (rig floor).

In fact well control during well operations is a routine function, with each well designed and executed to minimise risk of developing a well control incident.

Down-hole conditions, such as shallow gas and high-pressure zones can cause control problems as a sudden variation in well pressure. A well kick can occur if there is an influx of formation fluids with sufficient pressure to displace the well fluids.

The primary well control against a well kick is provided by the maintenance of a sufficient hydrostatic head of weighted drilling mud/completion brine in the well bore to balance the pressures exerted by fluids in the formation being drilled.

Secondary well control is provided by the installation of mechanical device, such as the float collar in the drilling string and the blowout preventer (BOP) at seabed, installed on top of the wellhead after the running and setting of the surface casing. The BOP effectively closes and seals the annulus if there is a sudden influx of formation fluids into the well bore, by the use of a series of hydraulically/electrically actuated rams. In addition, this device allows the formation fluids to be safely vented or pumped at the surface with the well closed, thereby enabling other methods to be applied to restore a sufficient hydrostatic head of mud on the well bore, for example pumping a higher density volume of mud, the so called ‘kill mud’. The capacity and pressure rating of equipment, safety device and the BOP rating exceed the predicted reservoir pressures.

The well control philosophy and procedure, constantly updated by the Eni drilling department, includes the identification and assessment of all well blowout risks.

2.2.4 WELL ABANDONMENT

Once drilling is completed, the well will be plugged and abandoned. This will involve setting cement plugs inside the wellbore and testing them for integrity. The BOP will then be retrieved at surface and the wellhead will be left on the seabed.

2.2.5 DEMOBILISATION

On completion of drilling, the drillship and support vessels will leave the well location. A final ROV survey will be performed at seabed.

2.3 PLANNED EMISSIONS AND DISCHARGES, WASTE MANAGEMENT

This section presents the main sources of emissions to air, discharges to sea and waste that would result from the planned drilling activities and associated operations.

The principle of Eni for waste management is to follow the following golden rules; in the order of priority: reduce, reuse, recycle, recover, treat, dispose.

All vessels would have equipment, systems and protocols in place for prevention of pollution by oil, sewage and garbage in accordance with MARPOL 73/78.

A project specific Waste Management Plan (covering all wastes generated offshore and onshore) would be developed in accordance with MARPOL requirements, South African regulations and Eni’s waste management guidelines.

Waste disposal sites and waste management facilities would be identified, verified and approved prior to commencement of drilling.

2.3.1 DISCHARGES TO SEA

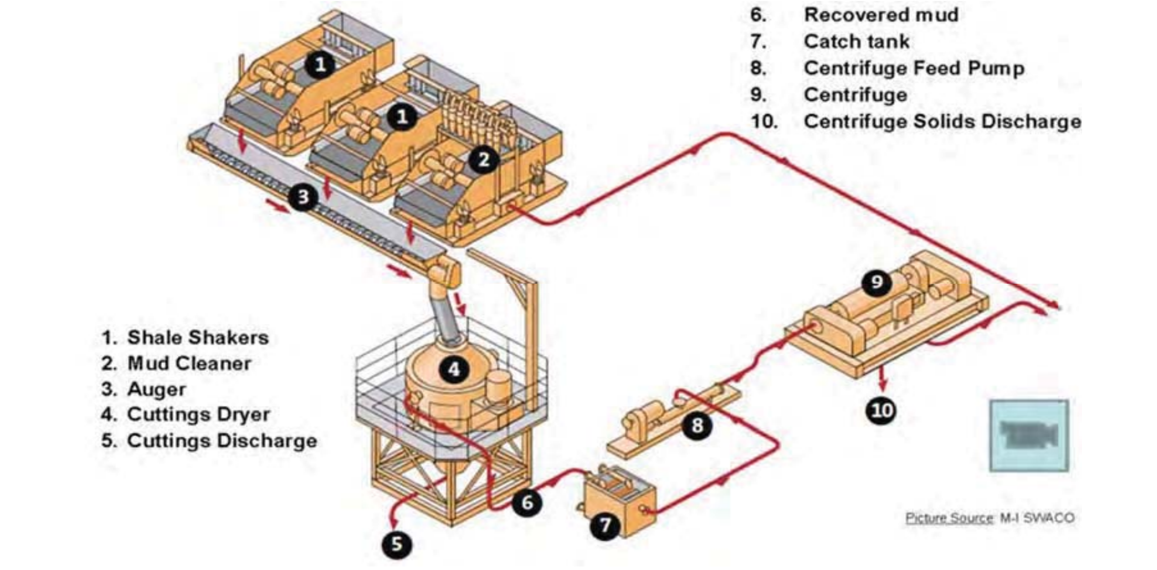
Drill Cuttings and Mud Disposal

During the drilling of the well, drill cuttings are produced as the rock is broken down in small rock particles by the drill bit advancing through the subsurface. The amount of drill cuttings that will be discharged during the drilling of the planned well are described in Table 2-6.

For deep water drilling, sea water with high viscous pills and sweeps are used for drilling the fiserless tophole sections of the well, while WBMs and/or NADFs are used for the subsequent sections (with riser installed on top of wellhead and BOP). During the riserless drilling stage (tophole section drilling), fluid and cuttings are discharged directly on the seabed in immediate proximity of the well. Following installation of the riser (at the end of tophole section) excess seawater stored in tanks will be discharged overboard.

During WBM/ NADF drilling, drilling muds are circulated in a closed loop system which recycles the drilling muds and removes the drill cuttings. The returns from downhole (muds and cuttings) are routed to the shakers which will physically separate the drill cuttings from the drilling muds (Figure 2-4).

Figure 2-4: Typical Solids Control/Fluid Recovery System (Source: MI-Swaco, 2016).



If there is spent WBM remaining, they will either be stored onboard and shipped to shore for disposal or will be discharged overboard. If the WBM cuttings are discharged overboard they will be discharged under the following circumstances and limitations:

- Discharge of cuttings via a caisson in >15 m depth;
- Discharge of cuttings only in water >30 m depth;
- Hg: max 1 mg/kg dry weight in stock barite;
- Cd: max 3 mg/kg dry weight in stock barite;
- Maximum chloride concentration must be less than four times the ambient concentration of fresh or brackish receiving water; and
- Ship-to-shore otherwise.

The NADF muds will be recovered, reused and when spent will be stored onboard and shipped to shore for disposal. The NADF drill cuttings will be routed through a vertical cuttings dryer (centrifuge type equipment) to remove residual liquids for reuse. The NADF retained on the drill cuttings will be discharged overboard under the following circumstances and limitations:

- Discharge of cuttings via a caisson in >15 m depth;
- Discharge of cuttings only in water >30 m depth;
- Organic Phase Drilling Fluid concentration: maximum residual non aqueous phase drilling fluid (NAF) 5% (C16-C18 internal olefins) or 9.4% (C12-C14 ester or C8 esters) on wet cuttings;
- Hg: max 1 mg/kg dry weight in stock barite;
- Cd: max 3 mg/kg dry weight in stock barite; and
- Ship-to-shore otherwise.

Table 2-6: Cuttings discharge quantities per well.

Waste Type	Est. Discharge (m^3)	Comments
High viscous pills and sweeps discharged at the sea floor while drilling the riserless hole intervals	400	Drill 42" and 24" hole intervals with sea water and 100 bbls viscous gel sweeps every 30 m. 2 sweeps at TD
Surplus whole WBM left at the end of well operations	220	Discharge to sea
WBM slops generated during operations such as tank cleaning or operating	150	Tank cleaning prior to displacement to NADF
WBM sludges generated during operations such as tank cleaning or cementing	100	Tank cleaning

Cement

During the initial cementing operation (top hole section), the required cement volume will be pumped into the annular space between the casing and the borehole wall. An excess of cement, necessary to guarantee sufficient presence of cement through the overall annulus, will emerge out of the top of the well. Doing this, the conductor pipe and surface casing are cemented all the way to the seafloor.

After the riser has been installed, for the next phases cement jobs, the excess of cement could be returned via the riser to the drilling vessel and treated using the solids control system. Unused cement slurry that has already been mixed is discharged overboard to avoid plugging the lines and tanks.

Bilge Water

All deck drainage from work spaces (bilge water) will be collected and piped into a sump tank on board the project vessels to ensure MARPOL 1973/78 Annex I compliance. The fluid will be monitored and any oily water would be processed through a suitable separation and treatment system prior to discharge overboard at a maximum of 15 ppm oil in water.

Sewage

Sewage discharge from the project vessels would meet the requirements of MARPOL 73/78 Annex IV. MARPOL 73/78 Annex IV requires that sewage discharged from vessels be disinfected, comminuted and that the effluent must not produce visible floating solids in, nor cause discoloration of the surrounding water. The treatment system must provide primary settling, chlorination and dechlorination. The treated effluent is then discharged into the sea.

Galley Wastes

The disposal into the sea of galley waste is permitted, in terms of MARPOL 73/78 Annex V, when the vessel is located more than 3 nautical miles (approximately 5.5 km) from land and the food waste has been ground or comminuted to particle sizes smaller than 25 mm.

Detergents

Detergents used for washing exposed marine deck spaces would be managed as bilge water. The toxicity of detergents varies greatly depending on their composition. Water-based or biodegradable detergents are preferred for use due to their low toxicity.

In certain cases of specific area cleaning, eg marine deck with no contamination of pollutants, using no toxic detergent, direct overboard discharge may be considered.

2.3.2 LAND DISPOSAL

A number of types of wastes generated during the drilling activities would not be discharged at sea but would be transported to shore for disposal. These wastes would be recycled or re-used if possible or disposed at an appropriate licensed municipal landfill facility or at an alternative approved site.

Where practicable, the following waste types will be recycled or reused onshore:

- Garbage (eg paper, plastic, wood and glass) including wastes from accommodation and workshops etc;
- Scrap metal and other material;
- Drums and containers containing residues (eg lubricating oil) that may have environmental effects;
- Used oil, including lubricating and gear oil; solvents; hydro-carbon based detergents, possible drilling fluids and machine oil;
- Drilling fluid, including LTSBM and cuttings, brine from drilling and completion activities.

The following wastes will be disposed of by a licenced waste contractor at licenced waste facilities:

- Drums and containers containing residues (eg lubricating oil) that may have environmental effects;
- Hazardous wastes (eg radioactive materials, neon tubes and batteries);
- Medical waste from treatment of personnel onboard the vessel; and
- Filters and filter media from machinery;

At the end of operations, the overboard discharge of hazardous chemicals, bulk cement or any other chemical is not permitted by Eni. The preferred solution for unused chemicals is to return them to the supplier for reuse in other projects. Should this not be possible these could be stored in a dedicated warehouse for future use by Eni or managed as per the above mentioned Eni waste management hierarchy.

2.3.3 NOISE EMISSIONS

The main sources of noise from the proposed drilling programme include noise produced by the drillship and supply vessels. The noise characteristics and level of various vessels used in the drilling programme will vary between 130 and 182 dB re 1µPa at 1 m (Simmonds et al, 2003; Richardson et al, 1995). The particular activity being conducted by the vessels changes the noise characteristics, for example, if it is at idle, holding position using bow thrusters, or accelerating.

2.4 UNPLANNED EMISSIONS AND DISCHARGES

This section presents the main sources of emissions that would result from the unplanned/ accidental events during the drilling activities and associated operations.

2.4.1 HYDROCARBONS AND CHEMICAL SPILLS

Two of the main types of accidental events that could occur while drilling wells that could result in a discharge of hydrocarbons or chemicals to the marine environment are loss of well containment and single-event/batch spills.

Loss of well containment is a continuous release which could last for a measurable period of time, while a single-event spill is an instantaneous or limited duration occurrence. Eni is committed to minimising the release of hydrocarbons and hazardous chemical discharge into the marine environment and avoiding unplanned spills.

In case of accidental events, Eni minimises any adverse effects to the environment and plans to accomplish this goal by:

i) Incorporating oil and chemical spill prevention into the drilling plans;

ii) Ensuring that the necessary contingency planning has taken place to respond effectively in the event of an incident.

Eni will develop and implement an Oil and Chemical Spill Response Plan in the event of an accidental release of oil offshore.

In addition, precautions are taken to ensure that all chemicals and petroleum products stored and transferred onshore and offshore are done so in a manner to minimise the potential for a spill and environmental damage in the event of an accidental release.

2.5 PROJECT ALTERNATIVES

2.5.1 SITE LOCALITY ALTERNATIVE

Drilling Location

Eni is the operator and holds an Exploration Right for ER236. Both 2D and 3D seismic surveys have been undertaken over ER236 and possible areas of interest identified. Based on the interpretation of the seismic information, Eni have identified two areas of interest covering a limited area of ER236, in which they are considering undertaking exploration drilling activities in order to determine the presence and viability of the reserve. The northern area of interest (1,840 km^2) is located approximately 62 km offshore of Richards Bay, and the southern area (2,905 km^2) approximately 145 km offshore of Port Shepstone. Although the well locations are still to be finalised based on a number of factors, including further analysis of the seismic data, the geological target and seafloor obstacles, the EIA considers that the wells could be drilled within the area of interest.

Onshore Logistics Base

An onshore logistics base will either be located in the Port of Richards Bay or the Port of Durban, the decision between these locations will be dependent on discussions with Transnet and the availability of sufficient space to accommodate the logistics base. The EIA will assess the impacts from a logistics base in either Richards Bay or Durban.

2.5.2 TECHNOLOGY ALTERNATIVE

Drilling Vessel Alternatives

There is a range of drilling vessels available to conduct the drilling of an offshore well. For deep water areas these are restricted to two options, drillships or semi-submersible rigs. Figure 2-5 shows the options available and the associated operation depths.

As discussed in Section 2.4.1, a drillship is commonly kept in position using a DPS which allows for minimal subsea disturbance due to its ability to operate without moorings. A significant benefit to using a drillship is the ease of mobility as it is a self-propelled vessel with the flexibility to move from well to well or location to location without the need of transport vessels. This option does however require greater energy use (and therefore emissions) and the DPS produces greater underwater sound during operation.

A semi-submersible drill rig has to be towed to a site and is either moored to the seabed using a series of anchors which may extend up to 1 km from the rig or may use dynamic positioning to stay in position. These rigs have a partially submerged structure below the water line. Water is used as a ballast control to maintain flotation and stability.

This option will cause greater disturbance to the seabed due to the presence of the moorings, but requires less energy use and produces less underwater sound.

Both drilling units are self-contained units with derrick and drilling equipment, an internal access to the water surface called moonpool, a helicopter pad, fire and rescue equipment and crew quarters. The operations and discharges are similar. Each drilling unit would also require between one to three supply vessels, it is likely that a semi-submersible drill rig would require more support vessels (or more trips by the support vessel to the base) than a drillship, as a drillship has more onboard storage capacity. A drillship is also significantly more mobile than a semisubmersible.

Eni's preferred drilling vessel is a drillship due to its availability, flexibility and ease of mobility.

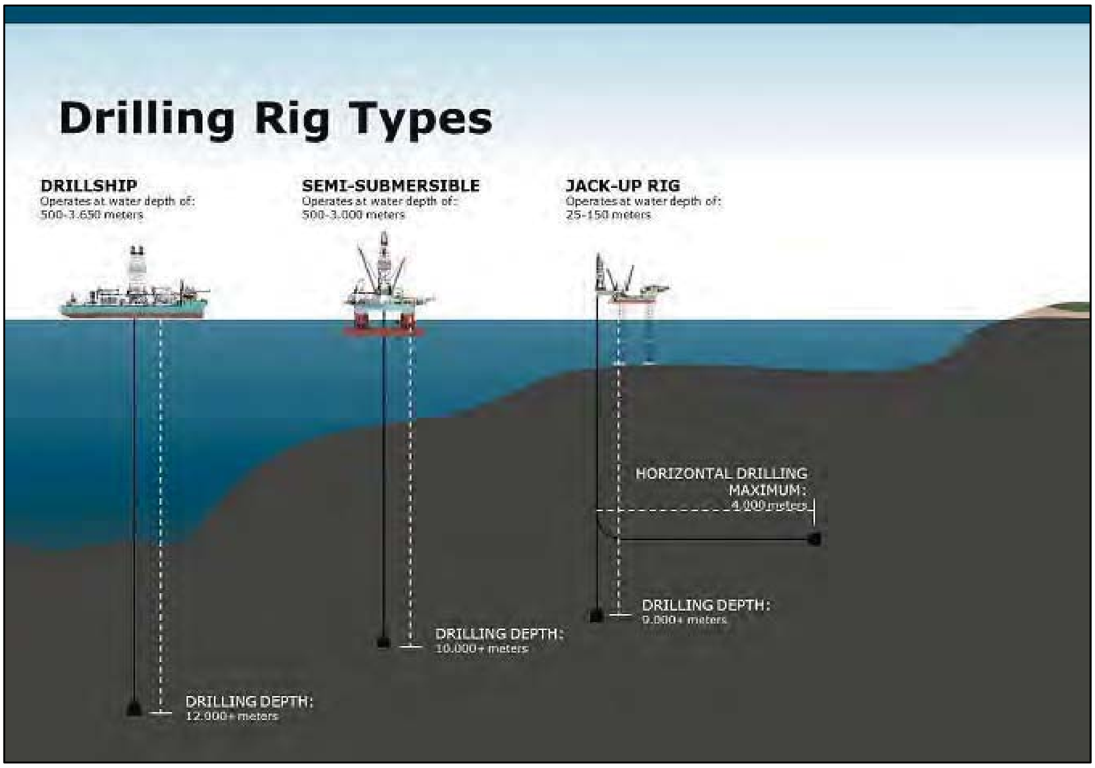


Figure 2-5: Drilling vessel alternatives (Source: http://www.maerskdrilling.com/en/about-us/the-drilling-industry).

Drilling Fluids

Various factors govern the best combination of drilling chemicals used to produce the required drilling mud needed to lubricate the drill bit, maintain well pressure control, and carry cuttings to the surface.

According to the IOGP classifications, the three types of NADF that could be used for offshore drilling can be defined as follows:

- Group I NADF (high aromatic content) - These base fluids were used during initial days of oil and gas exploration and include diesel and conventional mineral oil based fluids. They are refined from crude oil and are a non-specific collection of hydrocarbon compounds including paraffins, olefins and aromatic and polycyclic aromatic hydrocarbons (PAHs). Group 1 NADFs are defined by having PAH levels greater than 0.35%.
- Group II NADF (medium aromatic content) - These fluids are sometimes referred to as Low Toxicity Mineral Oil Based Fluids (LTMBF) and were developed to address the rising concern over the potential toxicity of diesel-based fluids. They are also developed from refining crude oil but the distillation process is controlled such that the total aromatic hydrocarbon concentration is less than Group I NADFs (0.5 – 5%) and the PAH content is less than 0.35% but greater than 0.001%.
- Group III NADF (low to negligible aromatic content) - These fluids are characterised by PAH contents less than 0.001% and total aromatic contents less than 0.5%. They include synthetic based fluids (SBF) which are produced by chemical reactions of relatively pure compounds and can include synthetic hydrocarbons (olefins, paraffins and esters). Using special refining and/or separation processes, base fluids of Group III can also be derived from highly processed mineral oils (paraffins, enhanced mineral oil based fluid (EMBF)). PAH content is less than 0.001%.

A combination of WBDFs and NADFs will be used to drill the proposed exploration well. It is anticipated that an IOGP Group III non aqueous base fluid (NABF) with low to negligible aromatic content will be used for this project.

Drill Cuttings Disposal Method

The solids control system applies different methods to remove solids (drill cuttings - particles of stone, clay, shale and sand) from the drilling fluid and to recover drilling fluid so that it can be reused. During riserless drilling, using sea water and high viscous sweeps and pills, cuttings are disposed of directly at the seabed. Once the riser has been installed on top of the wellhead and cuttings can be returned to the rig, there is no standard practice for the treatment and disposal of drill cuttings that is applied worldwide.

As per OGP (2003) there are three alternatives for the discharge of drill cuttings, namely:

- Offshore treatment and discharge to sea - where cuttings are discharged overboard from the drilling vessel or platform after undergoing treatment by solids control equipment and fluid contaminant reduction system;
- Re-injection - where drill cuttings are ground to fine particle sizes and disposed of, along with entrained drilling fluids, by injection into permeable subterranean formations; and
- Onshore disposal and treatment - where cuttings and the associated drilling fluids are collected and transported for treatment (eg thermal desorption, land farming) if necessary and final disposal by techniques such as land filling, land spreading, injection, or re-use.'

Re-injection is not an option in this location and is generally not possible during exploration drilling and as such the two potentially disposal options discussed below are discharge to sea and onshore disposal.

Offshore Treatment and Discharge to Sea

This option involves discharging the drilling cuttings, after specific treatment, to the marine environment.

Drill cuttings would be treated to remove drilling fluid for reuse and reduce oil content to less than 5 percent of wet cuttings weight (as low as possible) using a suitable combination of shakers, a centrifuge and/or a cuttings dryer.

Other possible additional systems could include a washing system and a thermo-mechanical treatment unit.

The cuttings containing residual fluid are then mixed with sea water and discharged to the sea through a pipe known as a chute (or caisson). The end of the chute is typically located approximately 15 m below the water surface. Unlike the other disposal options, no temporary storage for cuttings is required.

In South Africa, offshore discharge is the accepted method of disposal, if cuttings have been treated and contamination concentrations are below the maximum allowable thresholds.

The expected dispersion (fall and spatial extent of the deposition) of discharged cuttings will be predicted in the "drilling discharge modelling - drill cuttings dispersion model" study during the next phase of the EIA.

Offshore pre-treatment and Onshore Disposal

As per OGP (2003), this option would involve the processing of cuttings onboard the drilling vessel, followed by storage and transportation to shore for disposal.

Consequently, there are some aspects of onshore disposal that must be considered when evaluating the viability of this option, advantages and disadvantages of:

- Marine transport (skip and ship, which is common to all potential onshore disposal options);
- Onshore disposal facility option;
- Additional movements of skips on board of vessel with increased risk for workers during lifting operations; and
- Limited availability on deck space on board for equipment and reduced chemicals and fluids storage capacity; more difficult to allocate materials to guarantee stability of boat.

The potential onshore disposal options include:

- Landfill disposal: Depending on the level of treatment and residual oil content in percentage of dry cuttings, the cuttings would more than likely need to be disposed of at a hazardous landfill site.
- Land-farming: This involves spreading fully treated cuttings followed by mechanical tilling with the addition of nutrients, water and or oxygen as necessary to stimulate biodegradation by naturally occurring oil-degrading bacteria, material is applied several times at the same location. Depending upon the location of the land-farm, a liner, over liner, and/or sprinkler system may be required.
- Re-use (eg road construction). Treated cuttings may be used for construction or other alternative uses. If necessary or optimal, cuttings could be further treated prior to re-use, eg with thermal-mechanical treatment or bio-remediation.

Although the onshore disposal option has the benefit that it does not leave an accumulation of cuttings on the seafloor, it has several disadvantages (eg additional pressure on existing landfill sites and potential impacts on vegetation and groundwater) and involves a substantial amount of additional equipment, transportation, and facilities.

The additional transportation requirements to transfer the cuttings to shore increases environmental and safety risks associated with shipping and handling of materials.

Considering the aspects previously discussed, the dynamic nature of the marine environment in the area of interest and in order to limit the footprint for onshore land farming and waste facilities in the area, Eni's preferred option is to offshore treat and discharge cuttings in accordance with the previously defined limitations.

2.5.3 DESIGN OR LAYOUT ALTERNATIVES

Eni proposes to drill:

- Up to four wells within the northern area of interest: up to two exploration wells and up to two appraisal wells;
- Up to two wells within the southern area of interest: one exploration well and one appraisal well.

The number of wells to be drilled will be determined by the success of the first wells. The EIA Report will assess the drilling of one well within each area of interest as the drilling of each of the six wells will not occur immediately after the drilling of the initial well. The initial drilling activities are currently proposed in 2019, the time of year has not as yet been confirmed.

2.5.4 NO-GO OPTION

The No-Go alternative will be considered in the EIA in accordance with the requirements of the EIA Regulations, 2014 (as amended). The No Go alternative entails no change to the status quo, in other words the proposed exploration drilling activities will not be conducted in ER236.

The option not to proceed with exploration or appraisal drilling would leave the areas of the potential drilling sites in their current environmental state, with the oil/gas potential remaining unknown.

While exploration or appraisal drilling does not automatically lead to the development of oil/gas production, it is an essential stage in the process, which might lead to the drilling of production wells and thereafter significant employment opportunities in this sector, if commercial reserves can be exploited. The 'do nothing' or 'no-go' option forgoes these possible advantages.

3 RECEIVING ENVIRONMENT AND BASELINE ASSESSMENT

3.1 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 Department of Agriculture, Forestry and Fisheries (DAFF). 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 3-1 lists these along with ports and regions of operation, catch landings and number of active vessels and rights holders (2016). Figure 3-1 gives an indication of the proportional volume of catch and economic value of each of these sectors for 2016. Primary fisheries in terms of economic value and overall tonnage of landings are the demersal (bottom) trawl and long-line fisheries targeting the Cape hakes (*Merluccius paradoxus* and *M. capensis*) and the pelagic-directed purse-seine fishery targeting pilchard (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus*) and red-eye round herring (*Etrumeus whitheadii*). Highly migratory tuna and tuna-like species are caught on the high seas and seasonally within the South African waters by the pelagic long-line and pole fisheries. Targeted species include albacore (*Thunnus alalunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*) and swordfish (*Xiphias gladius*). The traditional line fishery targets a large assemblage of species close to shore including snoek (*Thyrsites atun*), Cape bream (*Pachymetopon blochii)*, geelbek (*Atractoscion aequidens)*, kob (*Argyrosomus japonicus)*, yellowtail (*Seriola lalandi)* and other reef fish. Crustacean fisheries comprise a trap and hoop net fishery targeting West Coast rock lobster (*Jasus lalandii*), a line trap fishery targeting the South Coast rock lobster (*Palinurus gilchristi*) and a trawl fishery based solely on the East Coast targeting penaeid prawns, langoustines (*Metanephrops andamanicus* and *Nephropsis stewarti*), deep-water rock lobster (*Palinurus delagoae*) and red crab (*Chaceon macphersoni*). Other fisheries include a mid-water trawl fishery targeting horse mackerel (*Trachurus trachurus capensis*) predominantly on the Agulhas Bank, South Coast and a hand-jig fishery targeting chokka squid (*Loligo vulgaris reynaudii*) exclusively on the South Coast. In addition to commercial sectors, recreational fishing occurs along the coastline comprising shore angling and small, open boats generally less than 10 m in length. The commercial and recreational fisheries are reported to catch over 250 marine species, although fewer than 5% of these are actively targeted by commercial fisheries, which comprise 90% of the landed catch.

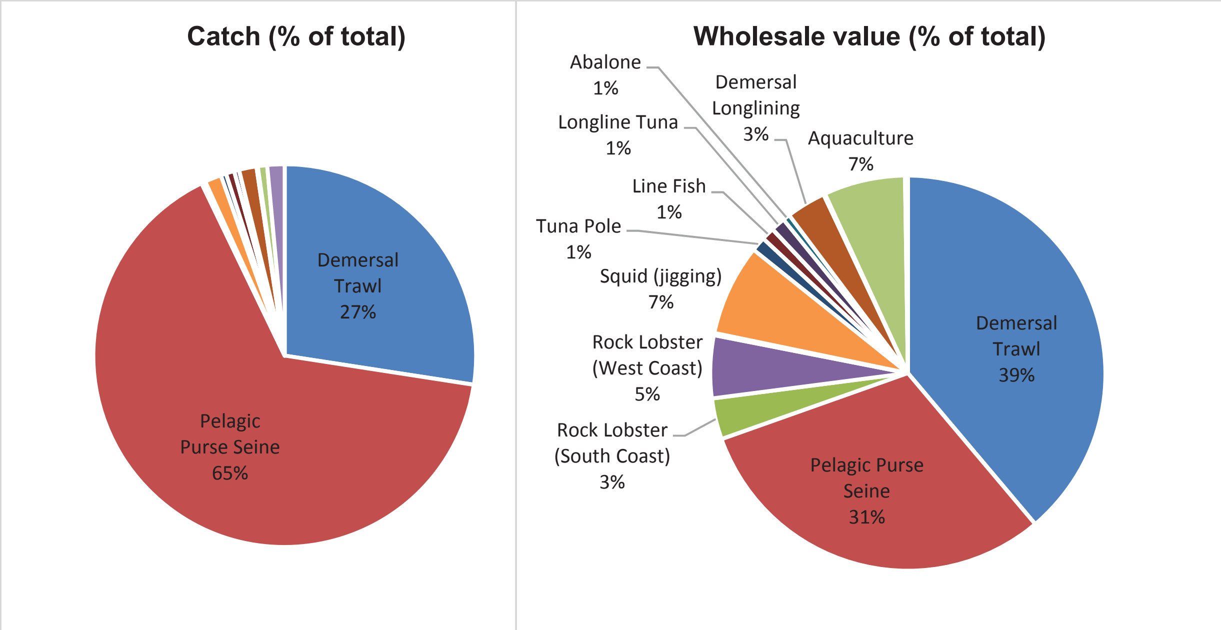


Figure 3-1: Pie chart showing percentage of landings by weight (left) and wholesale value (right) of each commercial fishery sector as a contribution to the total landings and value for all commercial fisheries sectors combined (2016). Source: DAFF, 2016.

Most commercial fish landings must take place at designated fishing harbours. For the larger industrial vessels targeting hake, only the major ports of Saldanha Bay, Cape Town, Mossel Bay and Port Elizabeth are used. On the West Coast, St. Helena Bay and Saldanha Bay are the main landing sites for the small pelagic fleets. These ports also have significant infrastructure for the processing of anchovy into fishmeal as well as canning of sardine. Smaller fishing harbours on the West / South-West Coast include Port Nolloth, Hondeklip 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, ranging in size from small villages to towns (DAFF, 2016). Small-scale fisheries commonly use boats but occur mainly close to the shore. Kwa-Zulu Natal, in particular, has a large number of participant in recreational fisheries supported by the diversity of marine and estuarine organisms in the province.The recreational sectors that are active off the KZN coastline comprise shore-based, estuarine and boat-based line fisheries as well as spearfishing. Net fisheries for recreational purposes include cast, drag and hoop net techniques.

Table 3-1: South African offshore commercial fishing sectors, landings, number of rights holders, wholesale catch value and target species (Source: DAFF 2016).

Sector	Areas of Operation	Main Ports in Priority	No. of Rights Holders (Vessels)	Landed Catch (tons)	Wholesale Value (R'000)	Target Species
Small pelagic purse-seine	West, South Coast	St Helena Bay, Saldanha, Hout Bay, Gansbaai, Mossel Bay	111 (101)	399 612	3210924	Anchovy (*Engraulis encrasicolus*), sardine (*Sardinops sagax*), Redeye (*Etrumeus whiteheadi*)
Demersal trawl (offshore)	West, South Coast	Cape Town, Saldanha, Mossel Bay, Port Elizabeth	50 (45)	151 456	3927000	Deepwater hake (*Merluccius paradoxus*), shallow-water hake (*Merluccius capensis*)
Demersal trawl (inshore)	South Coast	Cape Town, Saldanha, Mossel Bay	18 (31)	6 956	131793	East coast sole (*Austroglossus pectoralis*), shallow-water hake (*Merluccius capensis*), juvenile horse mackerel (mackerel (*Trachurus capensis*)
Mid-water trawl	West, South Coast	Cape Town, Port Elizabeth	34 (6)	9 674		Adult horse mackerel (*Trachurus capensis*)
Demersal longline	West, South Coast	Cape Town, Saldanha, Mossel Bay, Port Elizabeth, Gansbaai	146 (64)	9 027	338600	Shallow-water hake (*Merluccius capensis*)
Large pelagic longline	West, South, East Coast	Cape Town, Durban, Richards Bay, Port Elizabeth	30 (31)	7 492	123367	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	170 (128)	2 809	124009	Albacore tuna (*T. alalunga*)
Traditional line fish	West, South, East Coast	All ports, harbours and beaches around the coast	422 (450)	6 445	109763	Snoek (*Thyrsites atun*), Cape bream (*Pachymetopon blochii*), geelbek (*Atractoscion aequidens*), kob (*Argyrosomus japonicus*), yellowtail (*Seriola lalandi*), Sparidae, Serranidae, Carangidae, Scombridae, Sciaenidae
South coast rock lobster	South Coast	Cape Town, Port Elizabeth	13 (12)	735	351196	*Palinurus gilchristi*
West coast rock lobster	West Coast	Hout Bay, Kalk Bay, St Helena	240 (105)	1 033	537516	*Jasus lalandii*
KwaZulu-Natal prawn trawl	East Coast	Durban, Richards Bay	6 (5)	181	17859	Tiger prawn (*Panaeus monodon*), white prawn (*Fenneropenaeus indicus*), brown prawn (*Metapenaeus monoceros*), pink prawn (*Haliporoides triarthrus*)
Squid jig	South Coast	Port Elizabeth, Port St Francis	92 (138)	8 500	781908	Squid/chokka (*Loligo vulgaris reynaudii*)
Gillnet	West Coast	False Bay to Port Nolloth	162 (N/a)	634	10433	Mullet / harders (*Liza richardsonii*)
Beach seine	West, South, East Coast	N/a	28 (N/a)	1 600		Mullet / harders (*Liza richardsonii*)
Oysters	South, East Coast	N/a	146 pickers	42	3300	Cape rock oyster (*Striostrea margaritaceae*)
Seaweeds	West, South, East	N/a	14 (N/a)	6 172	23566	Beach-cast seaweeds (kelp, *Gelidium* spp and *Gracilaria* spp
Abalone	West Coast	N/a	N/a (N/a)	86	59500	*Haliotis midae*

3.2 Spawning and Recruitment of Fish Stocks

The South African coastline is dominated by seasonally variable and sometimes strong currents, and most species have evolved 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 Benguela and Agulhas ecosystems (Refer to Figures 3-2 a,b). Adults spawn on the central Agulhas Bank in spring (September to November). Spawn products drift 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. Figure 3-2 c shows the spatial inshore distribution of anchovy recruits based on the results of the 2017 survey undertaken by DAFF. Juveniles shoal and 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 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 Bank (located inshore of Block ER236), as well as the many estuaries along the KZN coastline, serve as important nursery areas for many of these species.

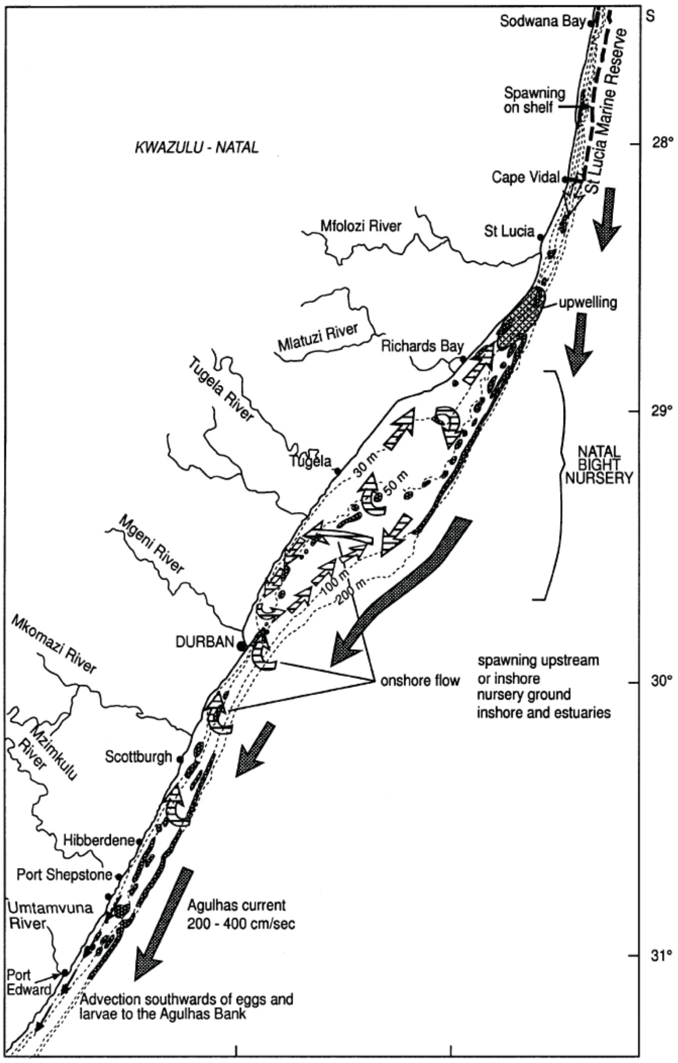


Figure 3-2 a): Details of the Natal Bight nursery area (after Hutchings et al., 2002).

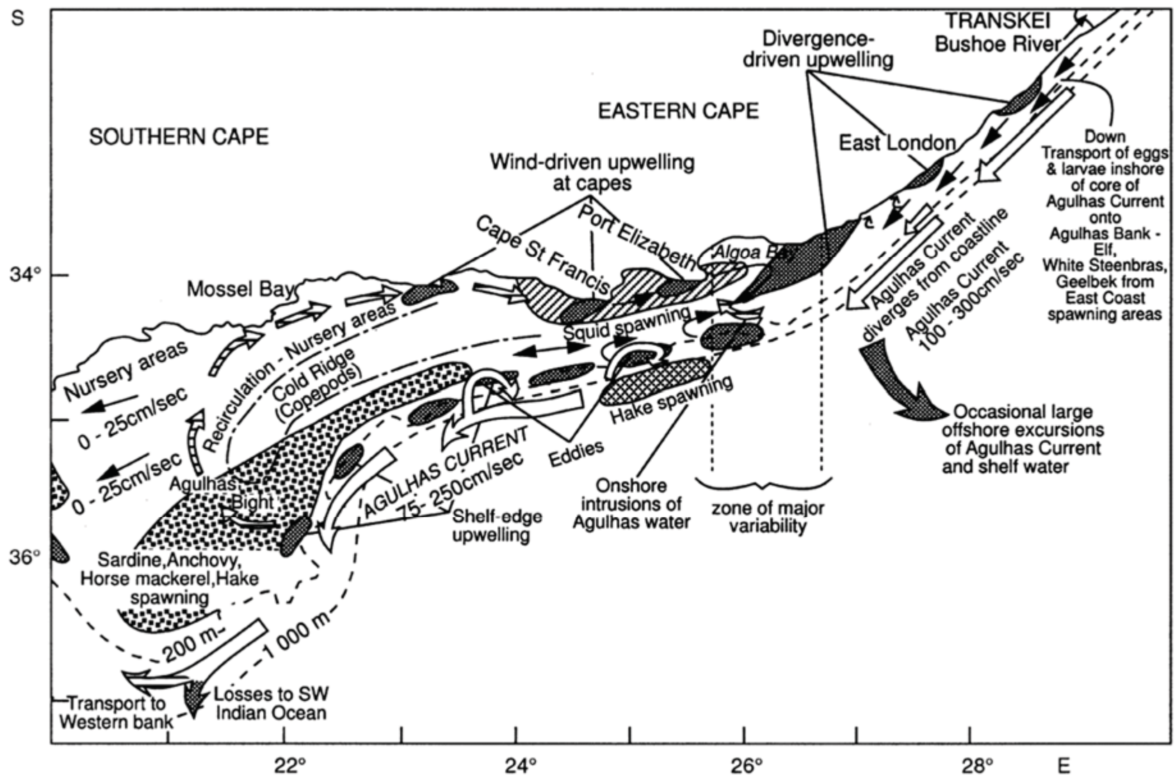


Figure 3-3 b): **Generalised figure showing the central-eastern Agulhas Bank nursery and spawning grounds for primary commercial species (after Hutchings et al., 2002).**

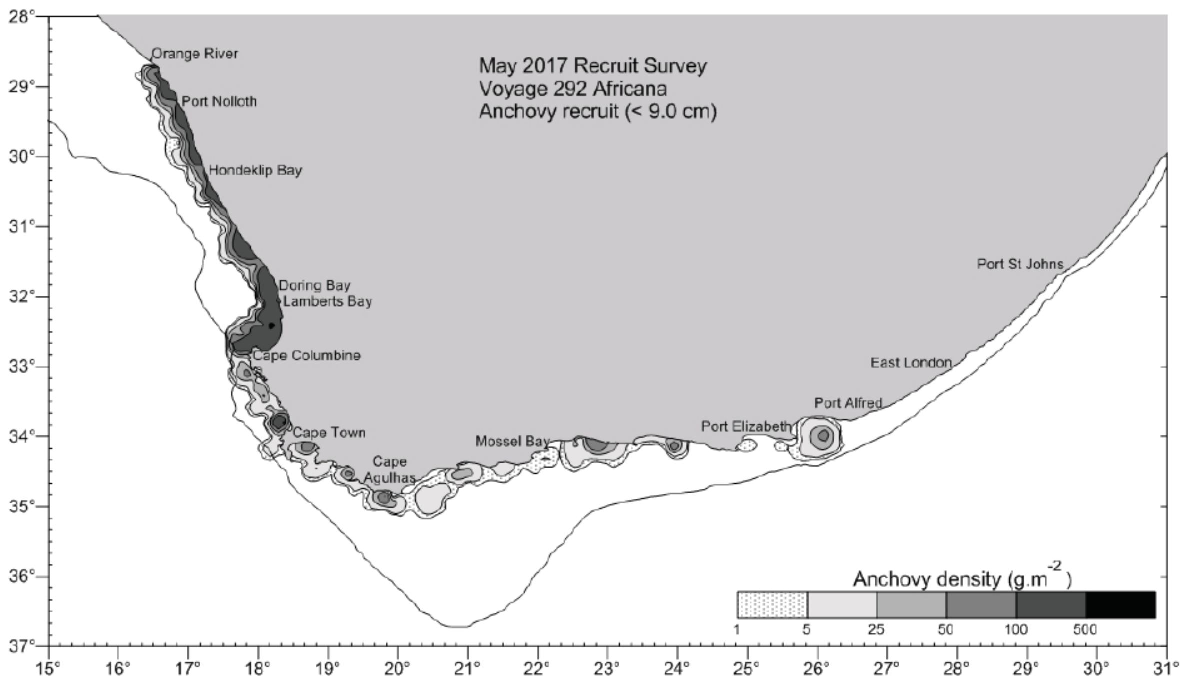


Figure 3-4 c): **Distribution and relative abundance of anchovy recruits (length < 9.0 cm). Source: DAFF**

3.3 DESCRIPTION OF COMMERCIAL FISHING SECTORS AND FISHERIES RESEARCH SURVEYS

3.3.1 DEMERSAL TRAWL

The primary fisheries in terms of highest economic value are the demersal (bottom) trawl and long-line 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 and inshore fleet, which differ primarily in terms of vessel capacity and the areas in which they operate. Approximately 45 offshore vessels operate from most major harbours on both the West and South Coasts. The wholesale value of catch landed by the inshore and offshore demersal trawl sectors, combined, during 2016 was R4.059 Billion, or 39% of the total value of all fisheries combined. Landings during 2016 amounted to 168,085 tons.

Trawlers target fish at a water depth range of 300 m to 1 000 m and fishing grounds extend in an almost continuous band along the shelf edge from the Namibian maritime border in the north to Port Elizabeth in the East. The inshore fleet comprises approximately 30 vessels which operate off the South Coast from the harbours of Mossel Bay and Port Elizabeth. Inshore grounds are located on the Agulhas Bank and extend eastward towards the Great Kei River. Sole is targeted at a water depth range of between 50 m and 80 m, while hake is targeted at depths of between 100 m and 160 m. Figure 3-3 shows the Exploration Right area and the areas of interest for well-drilling in relation to the spatial extent of demersal trawling grounds.

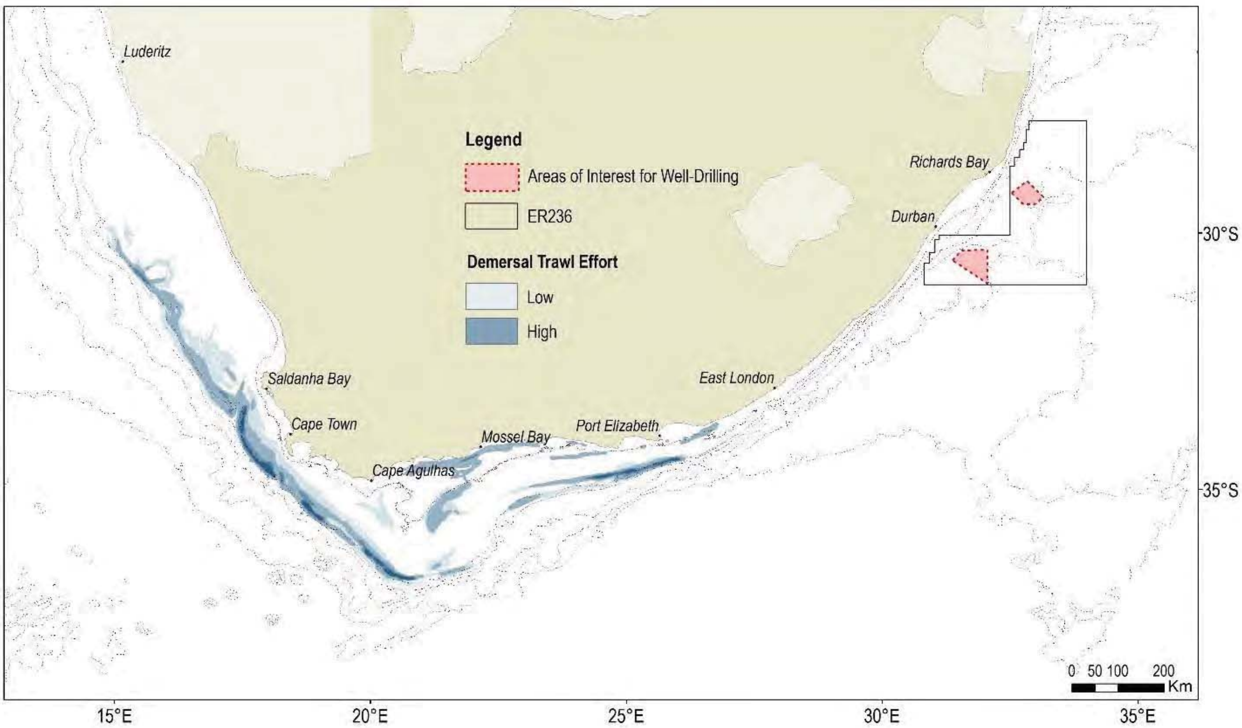


Figure 3-5: Spatial distribution of fishing effort expended by the inshore and offshore trawl sectors targeting demersal fish species (primarily hake) in relation to ER236 and the proposed areas of interest for well-drilling.

3.3.2 MID-WATER TRAWL

Adult horse mackerel (*Trachurus trachurus capensis*) is targeted by mid-water trawl, which 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. The fishery operates predominantly on the Agulhas Bank, where shoals are found in commercial abundance. The spatial extent of mid-water trawl activity is relatively limited when compared to that of demersal trawling. Until recently, fishing was restricted by permit condition to the area eastward of 20°E where fishing grounds are condensed into three areas. 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, DAFF has permitted experimental fishing to take place westward of 20°E in response to sustained low catch rates recorded off the South and East Coasts. Figure 3-4 shows the Exploration Right area and the areas of interest for well-drilling in relation to the spatial extent of grounds fished by mid-water trawlers.

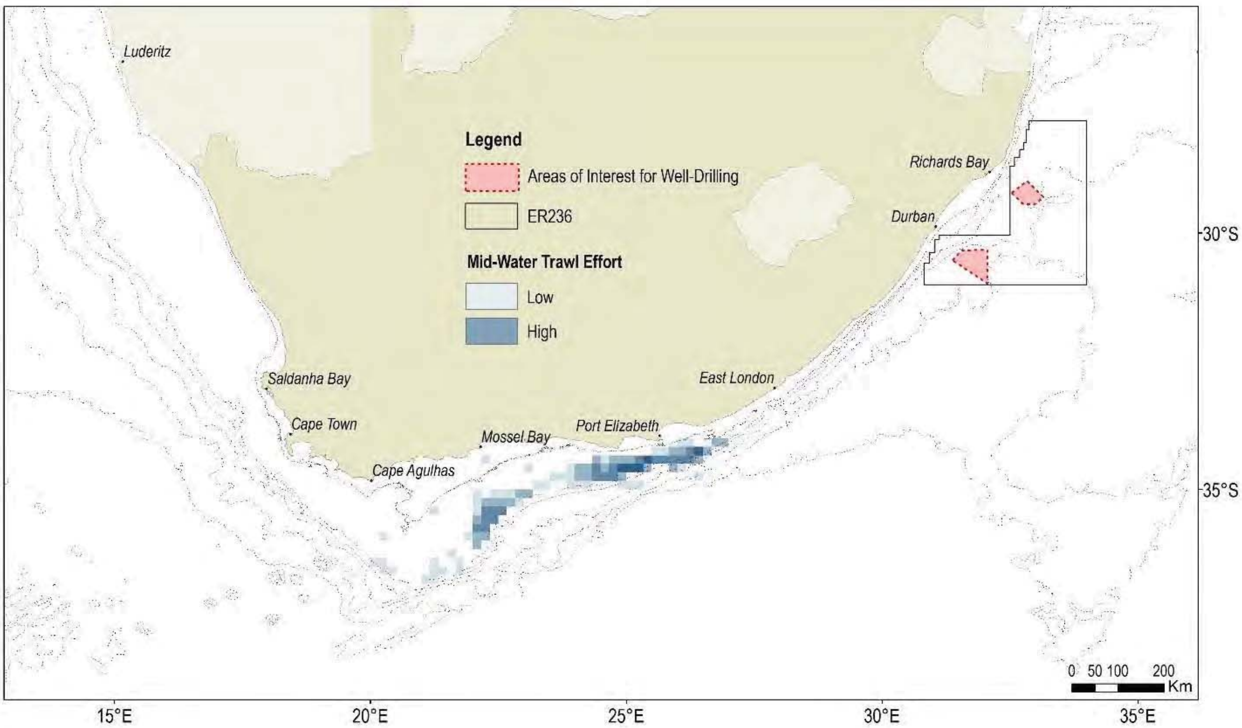


Figure 3-6: Spatial distribution of fishing effort expended by mid-water trawl sector in relation to ER236 and the proposed areas of interest for well-drilling.

3.3.3 DEMERSAL LONG-LINE

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. The wholesale value of catch landed by the sector during 2016 was R338.6 Million, or 3% of the total value of all fisheries combined, with a total landed catch of 9027 tons.

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. Off the West Coast, vessels target fish along the shelf break from Port Nolloth (15°E, 29°S) to the Agulhas Bank (21°E, 37°S). Lines are set parallel to bathymetric contours and to a maximum depth of 1 000 m, in places.

Figure 3-5 shows the spatial extent of demersal long-line grounds in relation to the Exploration Right area and the areas of interest for well-drilling.

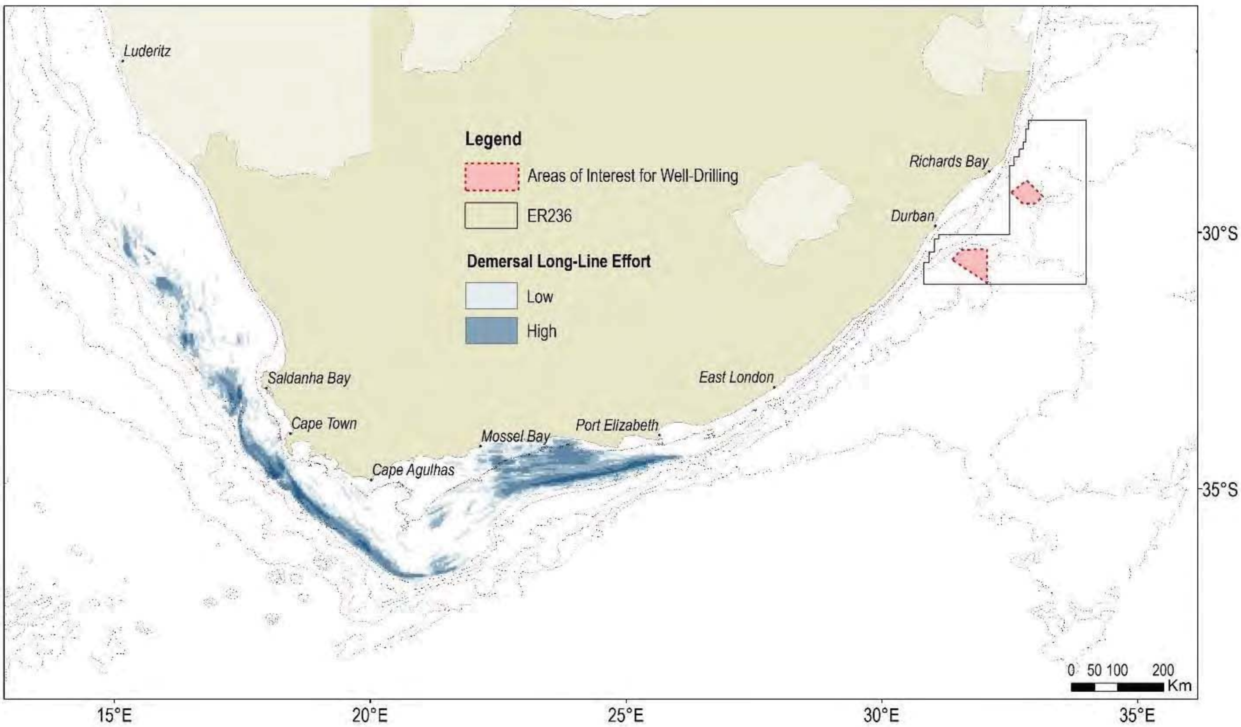


Figure 3-7: Spatial distribution of fishing effort expended by the long-line sector targeting demersal fish species (primarily hake) in relation to ER236 and the proposed areas of interest for well-drilling.

3.3.4 SMALL PELAGIC PURSE-SEINE

The pelagic-directed purse-seine fishery targeting pilchard (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus*) and red-eye round herring (*Etrumeus whitheadii*) 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 2016 was R3.211 Billion, or 31% of the total value of all fisheries combined. Landings during 2016 amounted to 400,681 tons.

The abundance and distribution of small pelagic species fluctuates considerably in accordance with the upwelling ecosystem in which they exist. Fish are targeted in inshore waters, primarily along the West and South Coasts of the Western Cape and the Eastern Cape coast, up to a maximum offshore distance of about 100 km. The majority of the fleet of 101 vessels operate from St Helena Bay, Laaiplek, Saldanha Bay and Hout Bay with fewer vessels operating on the South Coast from the harbours of Gansbaai, Mossel Bay and Port Elizabeth. Ports of deployment correspond to the location of canning factories and fish reduction plants along the coast. Figure 3-6 shows the spatial extent of fishing grounds in relation to the Exploration Right area and the areas of interest for well-drilling.

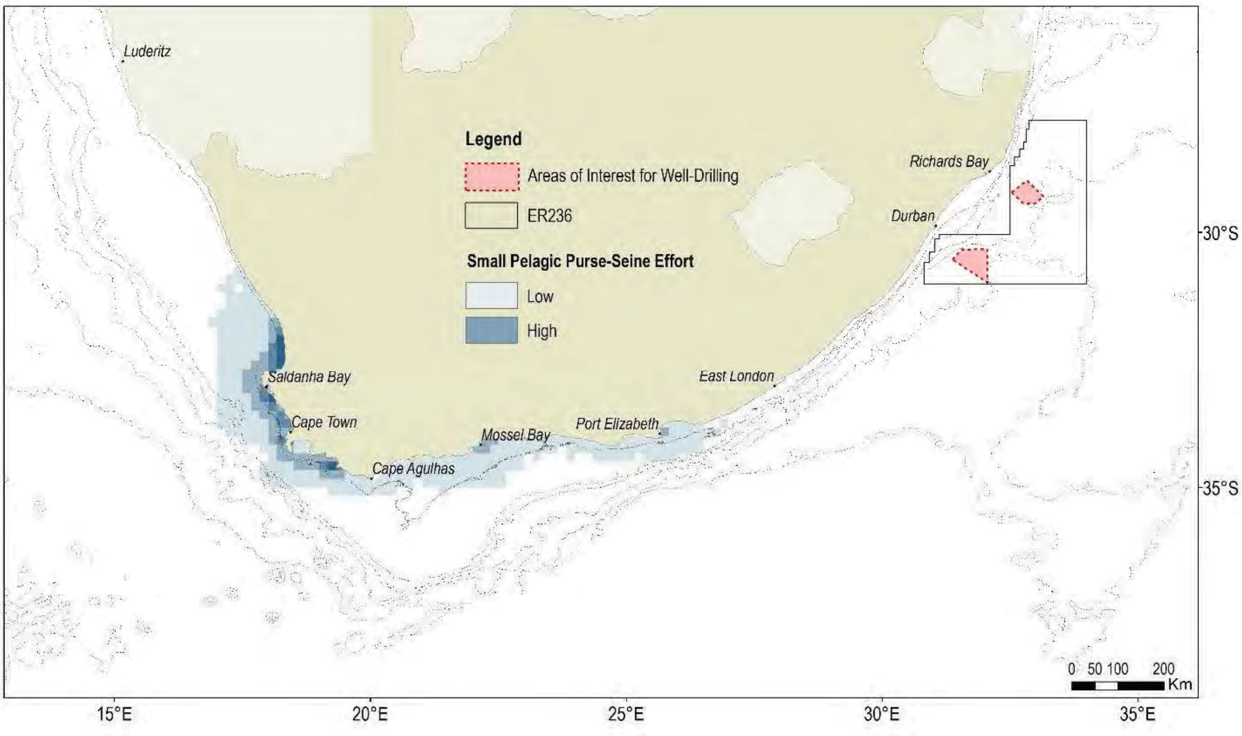


Figure 3-8: Spatial distribution of fishing effort expended by the purse-seine sector targeting small pelagic fish species in relation to ER236 and the proposed areas of interest for well-drilling.

3.3.5 Large Pelagic Long-Line

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 long-line 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 2016 was R123.4 Million, or 1.2% of the total value of all fisheries combined, with landings of 2450 tons.

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 small fleet of local long-liners although the fishery is still undertaken primarily with Japanese vessels fishing in joint ventures with South African companies. There are currently 30 commercial large pelagic fishing rights issued and 21 vessels active in the fishery.

The fishery operates extensively within the South African EEZ, primarily along the continental shelf break and further offshore. As indicated in Figure 3-7, the Exploration Right area coincides with the spatial distribution of pelagic long-line fishing effort. The impact of the proposed project activities on the sector will be assessed further in section 4.

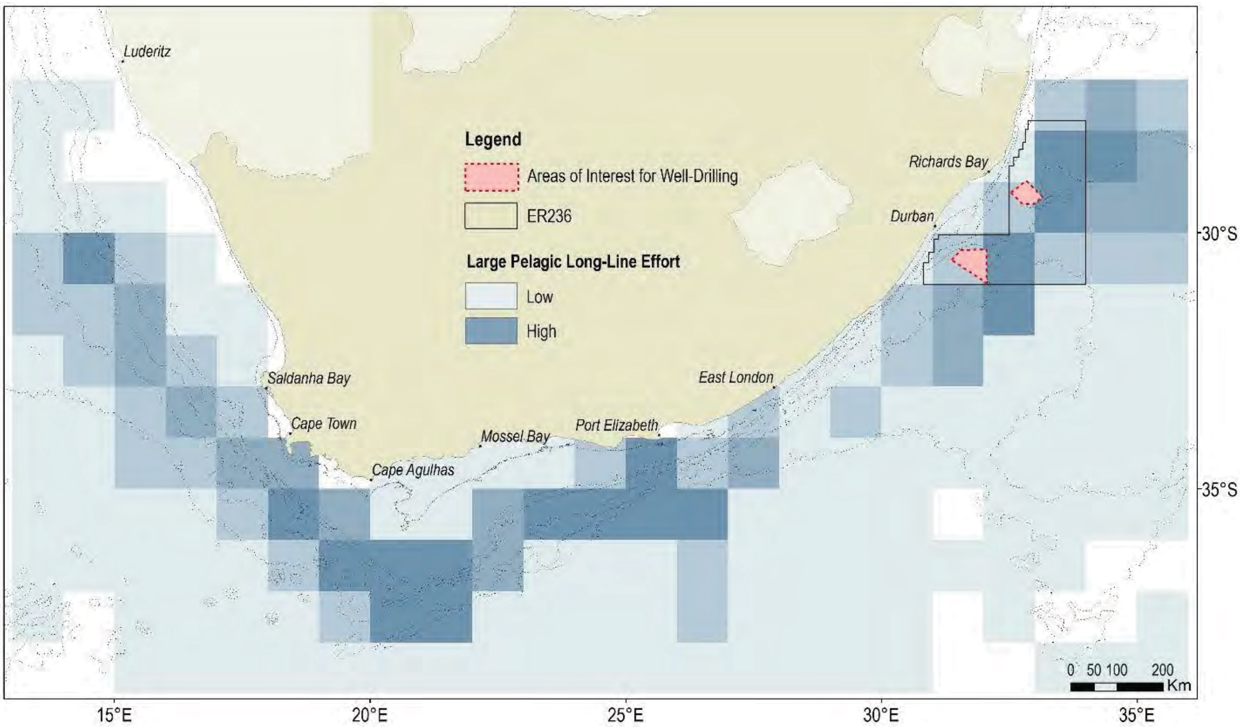


Figure 3-9: Spatial distribution of national fishing effort expended by the long-line sector targeting large pelagic species in relation to ER236 and the proposed areas of interest for well-drilling.

The fishery operates year-round with a relative increase in effort during winter and spring (see Figure 3-8). 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). During the period 2000 to 2014, the sector landed an average catch of 4 527 tons and set 3.55 million hooks per year. Catch by species and number of active vessels for each year from 2005 to 2014 are given in Table 3-2. Total catch and effort figures reported by the fishery for the years 2000 to 2014 are shown in Figure 3-9.

Table 3-2: Total catch (t) and number of active domestic and foreign-flagged vessels targeting large pelagic species for the period 2005-2014 (Source: DAFF, 2016).

Year	Bigeye tuna	Yellowfin tuna	Albacore	Southern bluefin tuna	Swordfish	Shortfin mako shark	Blue shark	Number of active vessels	
								Domestic	Foreign-flagged
2005	1077.2	1603.0	188.6	27.1	408.1	700.1	224.6	13	12
2006	137.6	337.3	122.9	9.5	323.1	457.1	120.7	19	0
2007	676.7	1086.0	220.2	48.2	445.2	594.3	258.5	22	12
2008	640.3	630.3	340.0	43.4	397.5	471.0	282.9	15	13
2009	765.0	1096.0	309.1	30.0	377.5	511.3	285.9	19	9
2010	940.1	1262.4	164.6	34.2	527.7	590.5	311.6	19	9
2011	906.8	1181.7	338.7	48.6	584.4	645.2	541.6	16	15
2012	822.0	606.7	244.6	78.8	445.3	313.8	332.6	16	11
2013	881.8	1090.7	291.1	50.9	471.0	481.5	349.0	15	9
2014	543.8	485.8	113.8	31.2	223.1	609.6	573.4	16	4

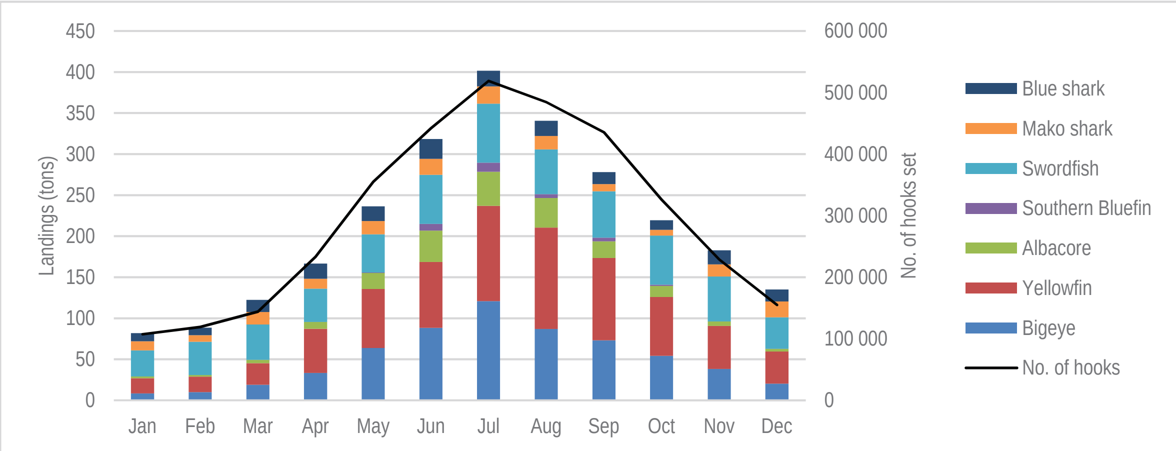


Figure 3-10: Monthly variation of catch and effort recorded by the large pelagic long-line sector (average figures for the period 2000 – 2014).

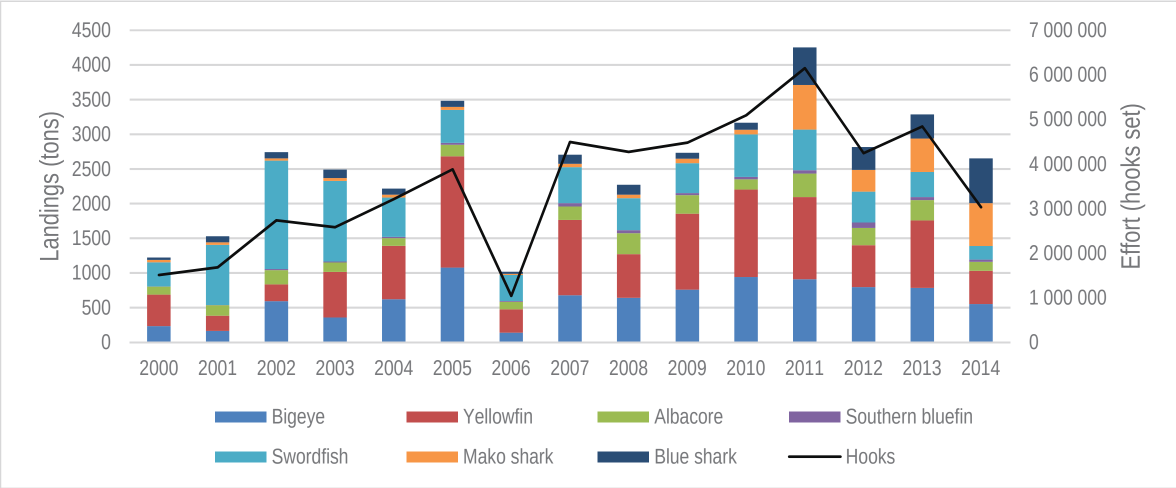


Figure 3-11: **Inter-annual variation of catch landed and effort expended by the large pelagic longline sector (2000 - 2014).**

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 (see Figure 3-10). 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. 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.

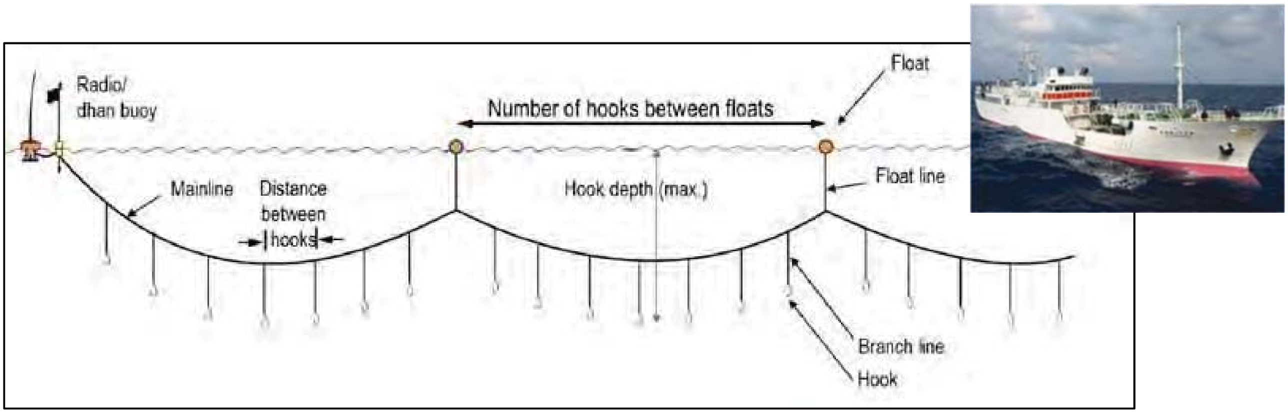


Figure 3-12: **Schematic diagram showing typical configuration of long-line gear targeting pelagic species (left), and photograph of typical high seas long-line vessel (upper right).**

3.3.6 TUNA POLE

Poling for tuna is predominantly based on the southern Atlantic longfin tuna stock also referred to as albacore (*T. alalunga*). Other catch species include yellowfin tuna, bigeye tuna, skipjack tuna (*Katsuwonus pelamis*), snoek and yellowtail. Landings for 2016 amounted to 2806 tons, with a wholesale value of R124 Million, or 1.2% of the total value of all fisheries combined. The average weight of albacore landed over the period 2003 to 2014 was 3 371 tons per year with albacore comprising between 72% and 91% of the total catch landed by the fishery during this period. Although there is a trend of gradually decreasing effort since 2003, catches have been sustained.

The South African fleet is comprised of approximately 128 vessels based at the ports of Cape Town, Hout Bay and Saldanha Bay. Fishing occurs along the entire West Coast, along the shelf break and beyond the 200 m isobaths. Favoured fishing areas are situated north of Cape Columbine and between 60 km and 120 km offshore from Saldanha Bay (see Figure 3-11).

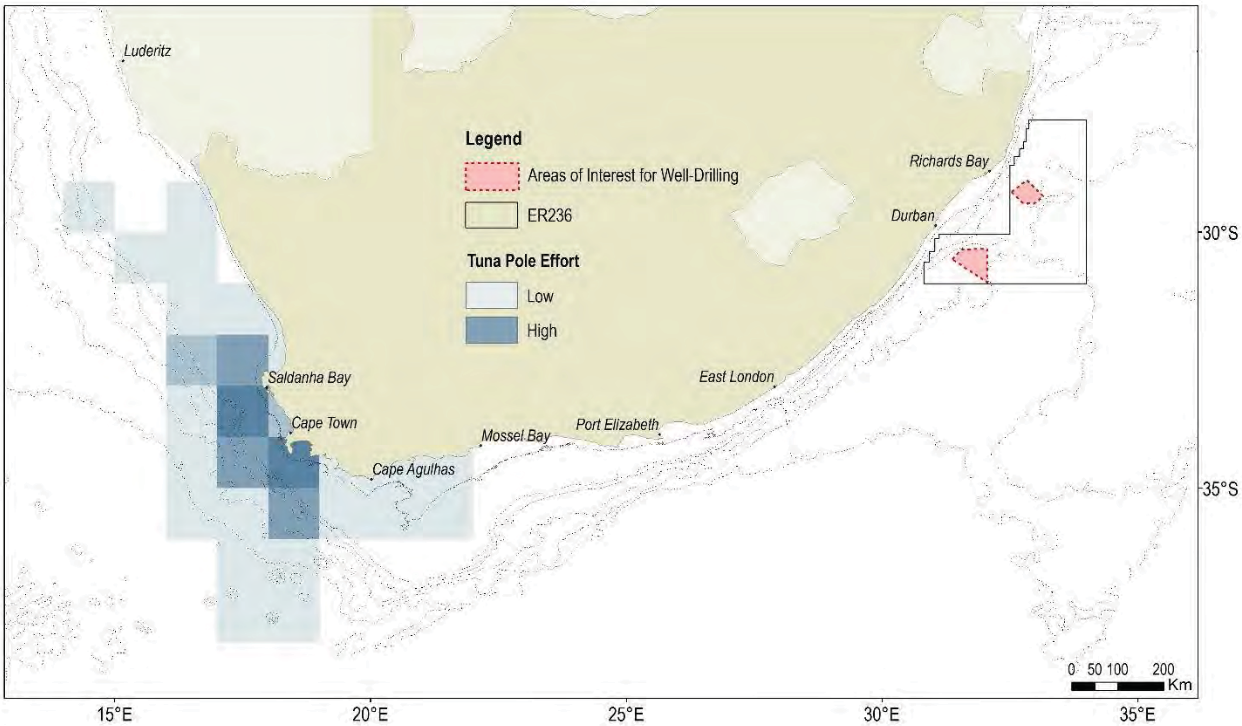


Figure 3-13: Spatial distribution of fishing effort expended by the tuna pole sector targeting primarily longfin tuna in relation to ER236 and the proposed areas of interest for well-drilling.

The fishery is seasonal with vessels active predominantly between November and May and peak catches recorded from November to January. Effort fluctuates according to the availability of fish in the area, but once a shoal of tuna is located a number of vessels will move into the area and target a single shoal which may remain in the area for days at a time. As such the fishery is dependent on window periods of favourable conditions relating to catch availability.

3.3.7 TRADITIONAL LINE-FISH

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 2016, the wholesale value of catch was reported as R109.8 million. Table 3-2 lists the catch of important linefish species for the years 2000 to 2016.

Table 3-3: Annual catch of linefish species (t) from 2000 to 2016 (DAFF, 2016).

	snoek	yellowtail	kob	carpenter	slinger	hottentot seabream	geelbek	santer	Total catch
2000	6543	320	547	441	186	234	894	76	
2001	6839	327	416	285	139	109	395	69	
2002	3837	242	392	231	101	79	315	48	
2003	4532	329	272	177	88	106	513	48	
2004	7278	883	360	228	184	254	672	87	
2005	4787	739	324	184	169	168	580	84	
2006	3529	310	400	159	192	87	419	79	
2007	2765	478	421	265	157	128	448	84	11841
2008	5223	313	358	226	194	120	403	82	
2009	6322	330	442	282	186	184	495	66	14109
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

The traditional line fishery is a boat-based activity and has since December 2000 consisted of 3450 crew operating from about 450 commercial vessels. The number of rights holders in 2017 is 425 with 2550 allowable crew (rights are valid until 31 December 2020). The crew use hand line or rod-and-reel to target approximately 200 species of marine fish along the full 3000 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 16000 tons for the traditional commercial line fishery. Almost all of the traditional line fish catch is consumed locally. The fishery is widespread along the country's shoreline from Port Nolloth on the West Coast to Cape Vidal on the East Coast (see Figure 3-12). Effort is managed geographically with the spatial effort of the fishery divided into three zones. Zone A extends from Port Nolloth to Cape Infanta, Zone B extends from Cape Infanta to Port St Johns and Zone C covers the KwaZulu-Natal region. Table 3-3 lists the annual Total Allowable Effort (TAE) and activated effort per linefish management zone from 2006 to 2012. 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. Fishing vessels of between 4.5m and 11m in length generally range up to a maximum offshore distance of about 70 km, although fishing at this outer limit is sporadic. The spatial distribution of line-fishing effort coincides with inshore areas of ER236 and the impact of the proposed project activities on the sector will be assessed further in section 4.

Table 3-4: Annual Total Allowable Effort (TAE) and activated effort per linefish management zone from 2006 to 2012 (DAFF, 2016).

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 (Sikombe River to Ponto da Ouro)	
Allocation	455 (3182)		301 (2136)		103 (692)		51 (354)	
Year	Allocated	Activated	Allocated	Activated	Allocated	Activated	Allocated	Activated
2006	455	385	301	258	103	78	51	49
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

In 2016, approximately 250 skiboat launches (for the purpose of commercial fishing) took place from registered launch sites along the KZN coastline (Mann et al. 2016). An economic survey of the KZN commercial linefishery was conducted by Dunlop in 2010. Based on the estimated total catch of 785 t and the wholesale (first point of sale) value of linefish at that time (i.e. ~R30/kg), the total value of the catch was approximately R23 million. However, costs associated with commercial fishing are extremely high. The estimated costs of labour (crew), fuel, bait, tackle, equipment, vessel and vehicle maintenance, insurance, safety gear, permitting and levies etc. are such that profits by the owner/rights holder are often marginal (Mann *et al.* 2001, Sauer *et al.* 2003 in ORI, 2014).

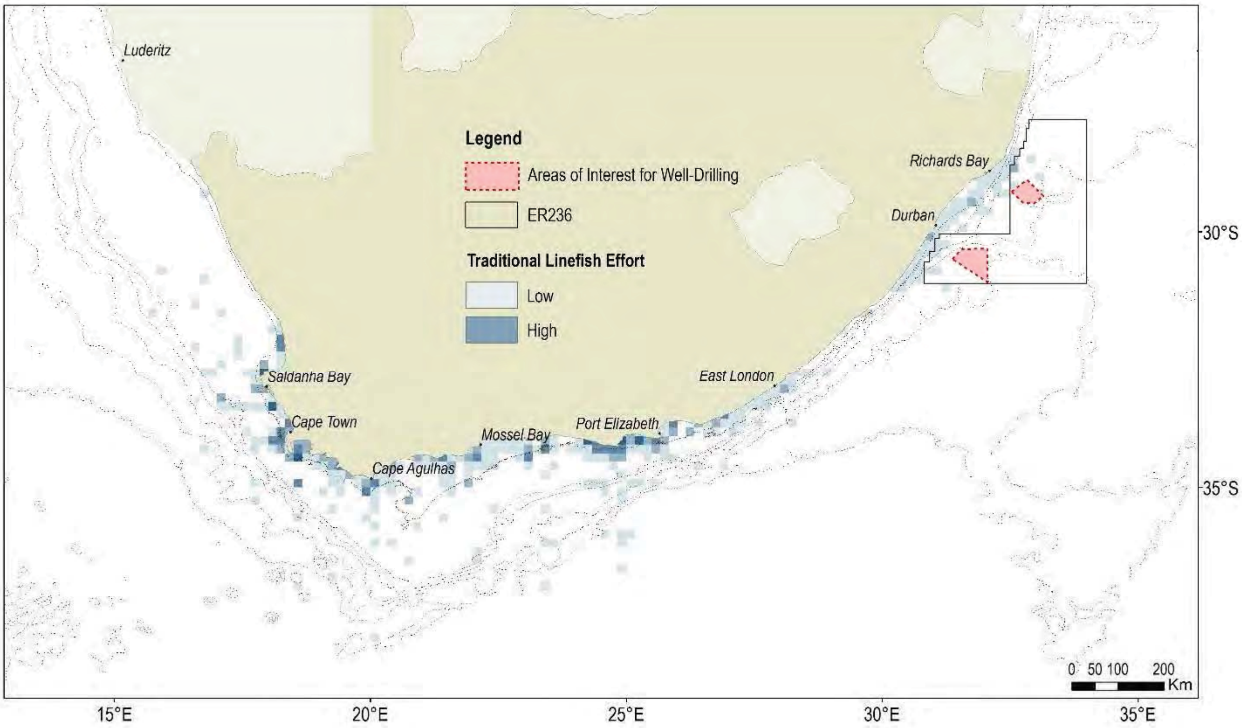


Figure 3-14: Spatial distribution of fishing effort expended by traditional line-fish sector in relation to ER236 and the proposed areas of interest for well-drilling.

3.3.8 WEST COAST ROCK LOBSTER TRAP

West Coast rock lobster (*J. lalandii*) is a slow-growing, long-lived species which occurs inside the 200 m depth contour along the entire West Coast to East London on the East Coast. The resource is targeted for commercial purposes along the West Coast by the offshore and the near-shore fisheries, both of which are directed inshore of the 100 m isobath. The offshore sector operates in a water depth range of 30 m to 100 m whilst the inshore fishery is restricted to waters shallower than 30 m in depth (thus within the 10 km coastal buffer) due to the type of gear used. Fishing grounds are divided for management purposes into areas stretching from the Orange River mouth to east of Cape Hangklip in the South-Eastern Cape. Figure 3-13 shows the Exploration Right area and the proposed areas of interest for well-drilling in relation to the spatial extent of fishing grounds for this sector.

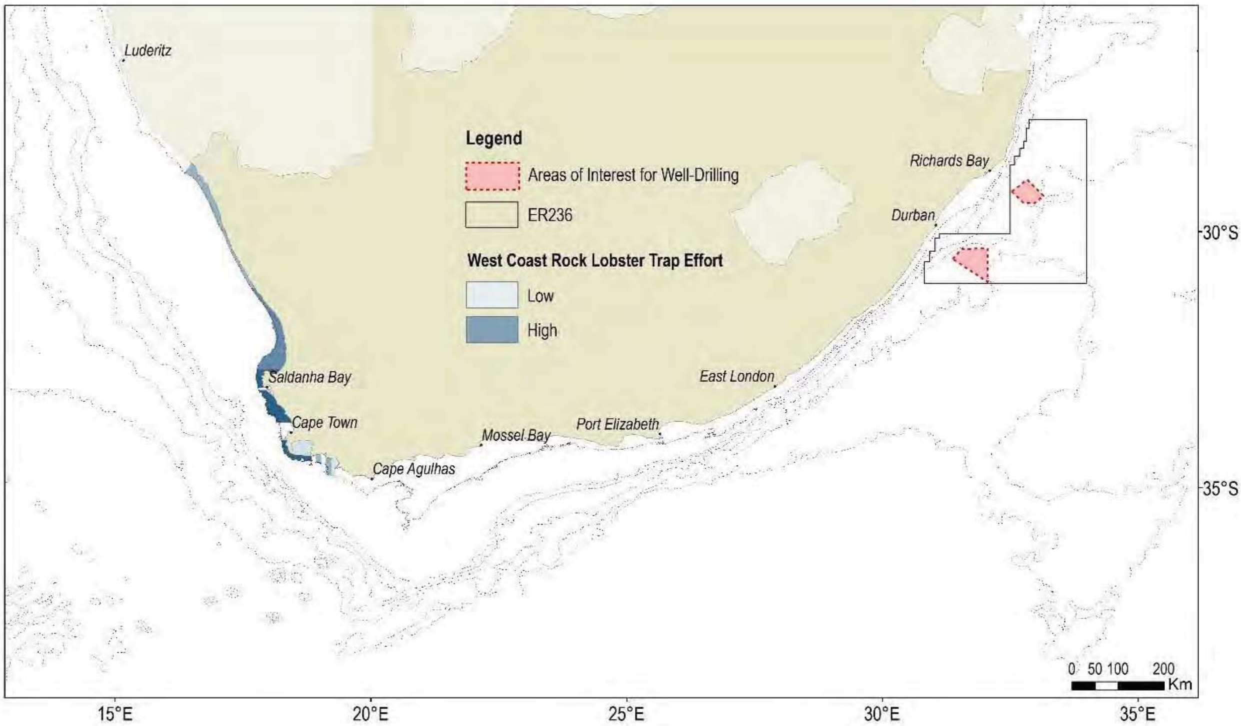


Figure 3-15: Spatial distribution of fishing effort expended by trap fishery targeting west coast rock lobster. Fishing grounds are shown in relation to ER236 and the proposed areas of interest for well-drilling.

3.3.9 SOUTH COAST ROCK LOBSTER

The South Coast rock lobster fishery is a deep-water long-line 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 will set between ten lines 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 will be 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 will remain at sea for up to 40 days per trip, while those retaining live catch will remain at sea between seven and 10 days before discharging at port. The fishery operates year-round with comparatively low activity during

October. There are currently seven vessels operating within the fishery which landed a total lobster tail weight of 345 t in 2015/6.

South Coast Rock Lobster (*Palinurus gilchristi*) occurs on the continental shelf of the South Coast between depths of 50 m and 200 m. 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. The fishery is restricted from operating far offshore by the Agulhas Current, but would be expected to operate within the proposed survey area west of East London and inshore of the 200 m bathymetric contour. Figure 3-14 shows grounds fished in relation to the Exploration Right area and areas of interest for well-drilling.

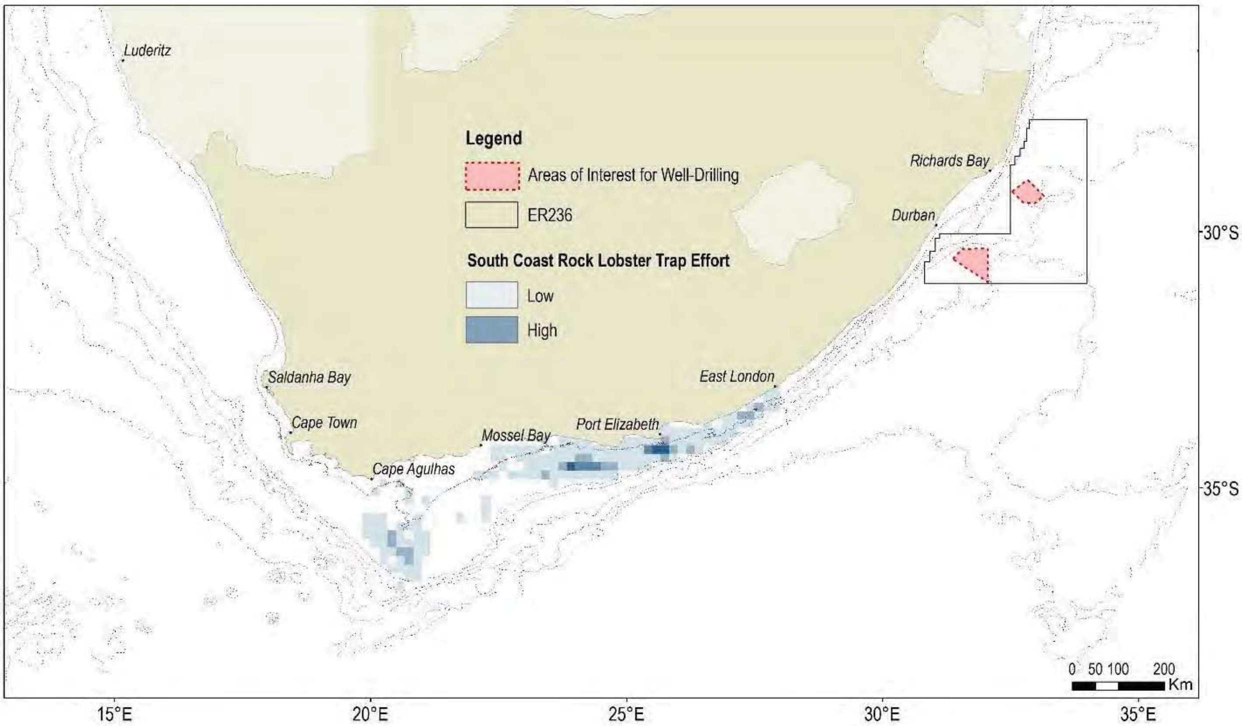


Figure 3-16: Spatial distribution of fishing effort expended by trap fishery targeting south coast rock lobster in relation to ER236 and the proposed areas of interest for well-drilling.

3.3.10 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). Figure 3-15 shows the distribution of fishing effort in relation to the Exploration Right area and the areas of interest for well-drilling.

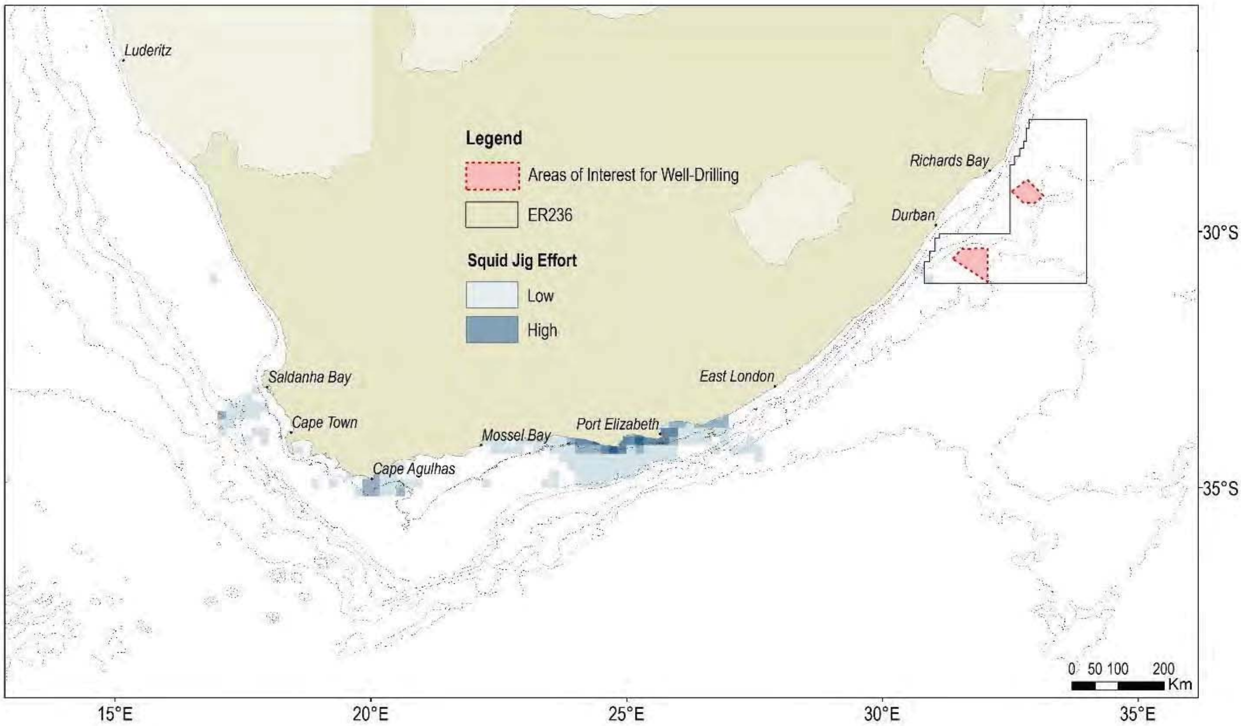


Figure 3-17: Spatial distribution of effort expended by the squid jig fishery in relation to ER236 and the proposed areas of interest for well-drilling.

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, DAFF).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 Port Elizabeth harbours.

The squid fishery is managed in terms of the Total Allowable Effort (TAE) allowed within the fishery. The TAE is based on the number of crew permitted to harvest squid across the fishery (2 422) and the maximum number of man days fishing during the season (270 000). Skippers record how many of their crew fish and for how many hours each day. Fishing rights were issued to 121 companies for the period 2006 to 2013 with the number of vessels and crew active within the fishery listed as 136 and 2 422 respectively. There are two closed seasons totaling slightly more than 4 months; i) a permanent closed period of 5 weeks between October and November to allow for summer spawning; and ii) an additional 3 months in winter to prevent the man-days from exceeding the maximum.

During the enforced annual five-week closure between October and November, DAFF undertakes a survey on spawning aggregations in the bay areas. During 2016 this closure was in effect from 19 October to 23 November. An additional industry-imposed 3-month closed season was introduced in 2014. The timing of closure is typically during March, April and May or April, May and June – but the decision is made during the Industry's annual general meeting held in October each year. The period of this closure coincides with a drop-off in adult spawning activity and a reduction in catches.

The fishery is seasonal, with most effort conducted between November and March. Typically annual catches range from 4 000 – 11 000 t. A maximum landed catch of 12 000 t was recorded in 2003/4 with a leveling-off thereafter to 9 000 t between 2005 and 2008. From 2009 catches gradually declined from 10 000 t to 6 000 t recorded in 2012. During 2013 catches dropped below 3 000 t and this was attributed to anomalous environmental cues. The industry exports all of the catch to Europe at a value of approximately R80 per kg and depending on the season, the industry is valued anywhere between R320 and R880 million.

3.3.11 CRUSTACEAN TRAWL

South Africa's crustacean trawl fishery operates exclusively within the province of KwaZulu-Natal (KZN). Also referred to as the KwaZulu-Natal prawn trawl sector, the fishery comprises two components; a shallow-water (5-40 m) fishery on the Thukela Bank and at St Lucia in an area of roughly 500 km^2, and a deep-water fishery (100-600 km) between Cape Vidal in the north and Amanzimtoti in the south. In combination, the shallow- and deep-water fisheries operate over an area of approximately 1700 km^2 along the edge of the continental shelf. The inshore and offshore sectors differ not only according to the fishing grounds in which they operate but also according to their targeted species and gear types.

The inshore fishery is based on white prawns (*Fennereopenaeus indicus*), tiger prawns (*Penaeus monodon*) and brown prawns (*Metapenaeus monoceros*) which occur on the shallow water mud banks along the north east coast of KZN. There are few areas within the habitat distribution of penaeid prawns that are suitable for trawling due to the steep slope of the continental shelf on the East Coast. The shelf widens between Durban and Richards Bay to form the Tugela Bank – a muddy/sandy area relatively sheltered from the fast-flowing Agulhas current. The inshore fishery operates on the Tugela Bank in water depths of up to 50 m and within 10 nautical miles of the shore. There is a seasonal closure of the Tugela Bank grounds in order to minimize high bycatch levels, therefore trawlers operate only within these inshore grounds during the period March to August. During summer months activity shifts northwards towards St Lucia, where the fishery targets bamboo prawns (*Penaeus japonicus*) in addition to the previously-mentioned species. The prawn species on which the inshore fishery is based are fast-growing and are dependent on estuarine environments during the early phase of their life cycle. As juveniles they recruit onto the mud banks where they mature and reproduce. The catch composition within the fishery typically comprises 20% prawn species, while approximately 10% of the remainder of the catch is also retained for its commercial value and includes crab, octopus, squid, cuttlefish and linefish. The remainder of the catch is discarded.

The deep-water fishery operates between water depths of 100 m and 600 m from Amanzimtoti in the south to Cape Vidal in the north, covering approximately 1 700 km^2 along the edge of the continental shelf. The boundary between the delimitation of offshore and inshore fisheries is about seven nautical miles from the shore. Offshore trawling takes place year-round. Targeted species include pink (*Haliporoides triarthus*) and red prawns, langoustines (*Metanephrops andamanicus* and *Nephropsis stewarti*), red crab (*Chaceon macphersoni*) and deep-water rock lobster (*Palinurus delagoae*). Catches are packed and frozen at sea and landed at the ports of Richards Bay or Durban.

The fishery is managed using a Total Applied Effort (TAE) strategy, which limits the number of vessels permitted to fish on the inshore and offshore grounds. Currently there are five vessels operating within the inshore grounds and two vessels restricted to working in the offshore grounds. The fleet comprises steel-hulled vessels ranging in length from 25 – 40 m and up to a Gross Registered Tonnage (GRT) of 280 tons. All are equipped with GPS, echosounders, radar and VHF/SSB radio. Most vessels are single otter trawlers, deploying nets from the stern or side at a speed of two to three knots. Trawl net sizes range from 25 m to 72 m footrope length, with a minimum mesh size of 60 mm. The duration of a typical trawl is four hours. Trip lengths range from three to four weeks and vessels may carry a crew of up to 20. Table 3-4 below lists the catch by species group of the prawn trawl fishery from 2000 to 2016.

Table 3-5: Annual catch of the KZN prawn trawl fishery (t) (DAFF, 2016).

		Total catch (t)						
		Inshore fishery	Offshore fishery				Both fisheries	
Year	TAE (no. of permits)	Shallow-water (all prawns)	Deep-water (all prawns)	Langoustine	Red crab	Rock lobster	Landed by-catch	Total catch
2000		107	142	76	53	10	34	422
2001		63	103	80	54	8	4	313
2002		93	102	56	28	9	10	298
2003		29	162	60	40	5	91	387
2004		40	116	42	24	4	82	308
2005		33	140	42	31	4	88	339
2006		21.3	123	49	31	4.7	47	276
2007	7	17.6	79.2	53.2	24.1	5.3	46.9	226.3
2008	7	9.2	104.6	31.4	17.0	4.7	34.9	201.8
2009	7	7.7	196.7	59.8	20.9	9.7	53.4	267.8
2010	7	7.3	172	51.2	23.2	22	69.4	345.1
2011	7	9.6	150.1	79.2	19.7	22.7	63.2	344.5
2012	7	7.6	153.4	81.6	21.6	18.5	71.4	354.1
2013	7	1.7	103.3	61.5	12.0	8.1	34.4	221.0
2014	7	0.3	149.6	56.2	11.5	4.9	25.2	247.7
2015		0	118.0	72.8	55.9	6.3	48.1	301.1
2016		0	115.0	32.5	42.5	4.3		

Figure 3-16 indicates the location of fishing grounds in relation to the Exploration Right area and the areas of interest for well-drilling. As there is a potential overlap with the Exploration Right area, the impact of the proposed project activities on the sector will be assessed further in section 4

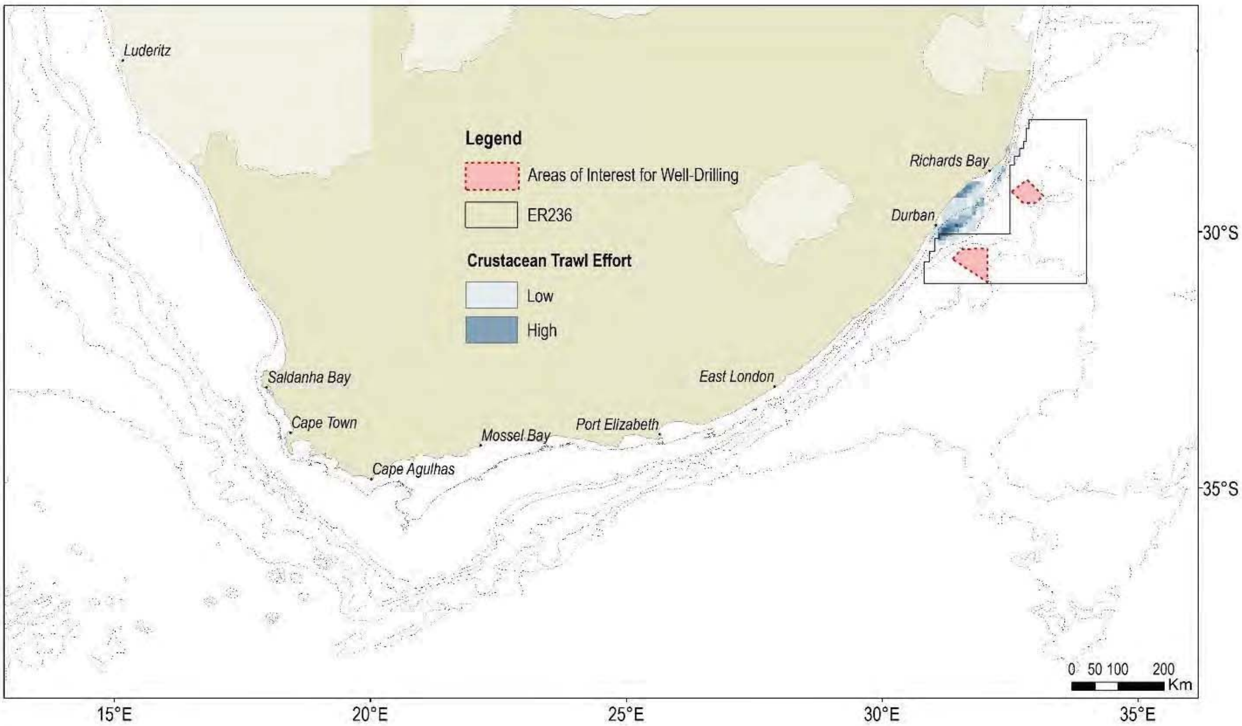


Figure 3-18: Spatial distribution of effort expended by the crustacean trawl fishery in relation to ER236 and the proposed areas of interest for well-drilling.

3.3.12 NETFISH (BEACH-SEINE AND GILL NET) FISHERIES

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 (*Liza 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.

The fishery is managed on a TAE basis with a fixed number of operators in each of 15 defined areas. The number of Rights Holders for 2014 was listed as 28 and 162 for beach-seine and gill-net, respectively (DAFF, 2014). Permits are issued solely for the capture of haarders, 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. 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.

KZN Sardine beach-seine fishery

The KwaZulu Natal Sardine Beach Seine Fishery is an opportunistic fishery operation targeting migrating sardines stranded in the shallow waters of the KwaZulu Natal beaches. These fish are a spill off from the spawning grounds in the Agulhas bank and the south east coast around Algoa bay. They follow inshore cooler counter currents in massive numbers and migrate east and northwards along the former Transkei coast into KwaZulu Natal, affectionately called the Natal Sardine Run**.** The sardine schools in these runs can be as big as 15km long, 40 metres deep and three kilometres wide. The sardine run, will draw predator fish, like sharks, dolphins and seals. It also attracts a number of tourist, fishermen and women and the general local public.

As the fish migrate northwards along the KwaZulu Natal Coast, they tend to beach, more often than not in the areas between Port Shepstone and Durban. The sardine run is seasonal occurring during the winter months. Whilst the run is expected annually, it does not always arrive annually. When it does arrive its duration and size varies. Some runs are longer with more fish whilst others are shorter with fewer fish and sometimes its duration may be longer with less fish.

The KZN Sardine Beach Seine Fishery relies exclusively on the Sardine Run. The unpredictable variables of the run make operations within the fishery very challenging. Despite the challenges, associated with making viable catches there are times when the catches average landings estimated at 500 tons with a value of approximately two million rand.

The Total Applied Effort (TAE) is set at 35 operators. There are currently 25 operators operating the KwaZulu Natal seashore. These operators are not restricted to any area or beach, allowing them to follow the sardine run to maximise the catch when possible. Understandably, operators participating in this seasonal fishery work in other fisheries or industries when the fishery is dormant. These operators alternatively participate in the traditional line fish industry either as crew or commercial right holders.

Mixed shoaling fish beach-seine fishery

The mixed fish beach-seine fishery is a relic of the large fishery which commenced in Durban in the mid-1800s. The only active right-holder is based at Vetch's Pier in Durban. The operator uses a "banana" boat to row out on flat calm, days to set the net. Nets are sometimes set if a shoal of fish is spotted, but often nets are set blindly. A long rope attached to one end of the net is anchored on the beach, and the boat rows out streaming the line behind it; the net is deployed in a semi-circle and is then retrieved by hand onto the beach. Catches are placed into crates and are either sold immediately on the beach to buyers or members of the public, or are taken away for sale at the local fish market.

Of the three available rights only two have been taken up and only one is in regular use. The operator has a crew of around 6 people who assist in deploying and/or retrieving the net. Members of the public frequently help in retrieving the nets Annual catches are extremely variable owing to the unpredictability of fish shoals occurring within a catchable distance from the shore.

Available reported landings are irregular and it is doubtful whether they reflect actual catches; 2012 landings were around 8 t and 5 200 individual fish/squid (catches are inconsistently reported as weight and/or numbers and it is not possible to determine totals accurately). Because the abundance of edible fishes is low, this fishery is largely a fishery for bait which is supplied to recreational shore fishermen or to fishing shops. Catches are generally small and a wide diversity of species occurs; most retained catches consist of mullet (Mugilidae), scad-like fishes (*Trachurus*, *Decapterus*, *Atule, Rastrelliger*), squid (*Uroteuthis duvaucelii*) and sardines in season. Occasionally, larger edible species such as queen mackerel (*Scomberomorus plurilineatus),* kingfish (*Caranx* spp), garrick (*Lichia amia*) and stumpnose (*Rhabdosargus* spp) are caught. Large shoals of small, unwanted and/or sublegal-sized fishes such as soapies (*Secutor* spp), and shad (*Pomatomus saltatrix*) are frequently caught and discarded; elasmobranchs (mainly stingrays [*Dasyatis* spp.]) are also discarded (Beckley and Fennessy 1996; ORI unpubl. data).

Netting occurs only in the Vetch's Bight in Durban, when the sea is calm, and generally after a south-westerly wind. Netting is almost entirely confined to early mornings; generally only 1-3 net pulls are conducted on days when fishing takes place. Currently, effort estimates can only be derived from the available reported landings which, as indicated earlier, are erratic. When regular monitoring occurred from July 1993 to June 1994, 270 nets were set on 146 days (Beckley and Fennessy 1996). Effort appears to have declined markedly since then: in 2010, 2011 and 2012, fishing was reported on 12, 23 and 89 days respectively (DAFF unpubl. data). Edible fishes and bait are either purchased by members of the public directly from the netters, or they are sold to the local market. No formal estimates of value are available; based on the available reported 2012 catches and assuming a catch value of around R10 per kg and R10 per squid, a landed value of around R100 000 can be estimated.

Netting may only take place between Mgeni River and North Pier and only one net may be used at a time. The net may not exceed 130m in length and 8m in depth. Nets may not be set with motorised boats or retrieved by motorised means.

KZN Experimental Purse-Seine

The exploratory KZN purse-seine fishery for redeye sardine *Etrumeus wongratanai* (previously *E. teres*) *and E. whiteheadi* intends to use a small pelagic seine net deployed from a skiboat, targeting redeyes for bait.

There is one permit holder. The redeye population (both species) which occurs to the east of Port Alfred up to KZN during the sardine run season (May to August) is small, with an annual biomass (total weight) estimate of around 41 000 t (Coetzee *et al.* 2010), most of which does not appear to enter KZN waters (Coetzee *et al.* [2010] estimate about 2%). Most of the population during these months appears to be west coast redeye (Coetzee *et al.* 2010); the availability and seasonality of east coast redeye for the rest of the year is not known. However, due to the apparent abundance of redeye and the low effort exerted, it is likely that this species is under-exploited in KZN waters. A maximum of 100 t of redeye may be caught per year. Fishing operations shall cease during the sardine run (defined as occurring from the time the first shoals are netted south of Durban until the shoals have moved too far north of Durban for the beachseine operators to fish).

Commercial Drag Net Fishery

The commercial drag net fishery is confined to Richards Bay harbour/estuary; it targets bait organisms (mainly mullet and prawns *Penaeus* spp) by means of a small frame net towed behind a small motorized skiboat. The fishery has not been in operation for the past four years (due to an error in the permit conditions limiting the fishery to between North Pier and Umgeni River in Durban) and no recent catch data are available (Stim Stamatis, Adcan Marine, pers. comm.). From the 1970s to 1990 annual prawn catches fluctuated between 2 and 25 t (Forbes & Demetriades 2005). In the 1990s, 42 fish species were recorded, dominated by mullet, glassnoses (*Thryssa* spp) and perch (*Acanthopagrus berda*) (Forbes & Demetriades 2005). The fishery has not been in operation for the past four years but even when it was in operation, effort was irregular. From the 1970s to 1990 effort varied between 100-300 boat days per year (Forbes & Demetriades 2005).

3.3.13 OYSTER

This small commercial fishery operates on intertidal and shallow subtidal rocky reefs between the Thukela River mouth in the north and the Mzimkhulu River mouth in the south, excluding the area between the Umgeni and Isipingo Rivers (de Bruyn 2006, Steyn *et al.* 2010). Shore-based collectors pry oysters off rocks and sell the oysters locally. The Cape rock oyster (*Striostrea margaritacea*) is targeted by the fishery, constituting 95% of the catch (WIOFish 2013). The Natal rock oyster (*Saccostrea cuccullata*) is also occasionally collected (5% of the catch; WIOFish 2013).

A total of 23 oyster pickers were granted permits in 2005 to harvest on the KZN north coast and another 8 oyster pickers received permits to harvest on the KZN south coast. These permits were valid until 2008, extended until 2010 and thereafter annual exemptions were given to permit holders until 2013.

Total catch in 2010 was at least 131 455 oysters or almost 2 tons (marketable quality as well as small and damaged oysters). Very few catch returns have been submitted since 2010 and there are no recent estimates of total catches for this fishery (ICS 2013).

Oyster pickers reported a total of 778 outings in 2010, but catch data is missing for three months. Assuming that fishing effort stayed the same throughout the year, a minimum of 1 037 outings was conducted in 2010. No recent estimates of fishing effort are available as very few catch returns have been submitted since 2010 (ICS 2013).

Most oyster pickers sell to middlemen who in turn sell to local restaurants. However, some of the catch is sold directly to the public on the beach. Oyster pickers sell oysters for R2, the total catch in 2010 thus amounted to R197 000 (ICS 2013). The fishery is managed using total applied effort (TAE) based on the catch returns received (South Africa 2013). The number of pickers is limited based on the TAE and a daily bag limit of 190 oysters applies in KZN (South Africa 2013). A rotational harvesting system is implemented in KZN, whereby the north and south coast are each divided into four zones (South Africa 2013). Harvesting is limited to only one zone on the north coast and one zone on the south coast for a period of one year, affording each zone a fallow period of three years (South Africa 2013). The change over to a new zone occurs on the 1st of November of every year, which is the start of the peak oyster breeding season in KZN and thus, promotes the recovery of the exploited oyster beds (Schleyer 1988).

Other inshore invertebrates

A sand prawn (*Callichirus kraussi*) fishery has operated at Kosi Bay for several decades and catches are sold to tourists (Beckley *et al.* 1999). This fishery was technically described in the 1990s as a small-scale commercial fishery. Local men and boys use prawn pumps to collect sand prawns to sell as bait. This fishery takes place exclusively in the shallow sandy margins of lakes Makawulani and Mpugwini at Kosi Bay in the iSimangaliso Wetland Park (WIOFish 2013). Sand prawns are also pumped in the Durban Harbour and are openly sold as bait near Wilsons Wharf. However, the Durban fishery is illegal and these ‘small-scale commercial’ fishers are not licensed (ICS 2013).

3.3.14 EXPLORATORY REDEYE JIG

An experimental fishery for redeye was commenced in 2014. Participants with experimental permits use small surf-launched paddleskis or inflatable boats and rod and line with small lures to catch redeye sardines (*Etrumeus* spp) which are then sold to fishing shops for re-sale as bait. There are currently three exploratory permit holders but also numerous illegal participants (Pradervand & Fennessy 2009). Almost all of the fishing takes place in the region of Scottsburgh, KZN. Data reported for 2013-2014 shows that trips ranged between 0.75 and 7 hours in duration. A total of 118 trips (totalling 375.2 hours at an average duration of 3.2 hours) were reported in 2013, and 94 trips (totalling 334.7 hours at an average duration of 3.5 hours) were reported in 2014 (DAFF, 2016). Total catches of 14 175 (843.5 kg) and 22 597 (1 138.2 kg) of East Coast redeye were made in 2013 and 2014, respectively. CPUE values ranged between 24-55 fish.h^{-1} and 1.2-3.0 kg.h^{-1} in 2013 and between 10-147 fish.hr^{-1} and 0.9-8.8 kg.h^{-1} in 2014. A total catch of 37 000 fish (~2 t) was taken in 2013 and 2014 (to mid-August). Catch patterns indicate that this is predominantly winter fishery.

Investment in recreational paddleskis, boats and equipment varies enormously, from a few thousand Rands to over R200 000 per vessel (Mann et al 2012, Dunlop & Mann 2013).

EKZNW and DAFF are the responsible management authorities. Exploratory permit holders may not catch more than 5 t (paddleski) or 100 t (inflatable boat) per year. Catch returns must be completed and sent to DAFF. Fishers voluntarily measure and weigh 50 fish per week and retain samples for DAFF. Recreational fishing permit holders are not allowed to sell their catch.

3.3.15 FISHERIES RESEARCH SURVEYS

Swept-area trawl surveys of demersal fish resources are carried out twice a year by DAFF in order to assess stock abundance. Results from these surveys are used to set the annual TACs for demersal fisheries. First started in 1985, the West Coast survey extends from Cape Agulhas (20°E) to the Namibian maritime boarder and takes place over the duration of approximately one month during January. The survey of the Southeast coast (20°E – 27°E longitude) takes place in April/May. Following a stratified, random design, bottom trawls are conducted to assess the biomass, abundance and distribution of hake, horse mackerel, squid and other demersal trawl species on the shelf and upper slope of the South African coast. Trawl positions are randomly selected to cover specific depth strata that range from the coast to the 1 000 m isobath. Figure 3-18 shows the distribution of research trawls undertaken in relation to the Exploration Right area and proposed areas of interest for well-drilling.

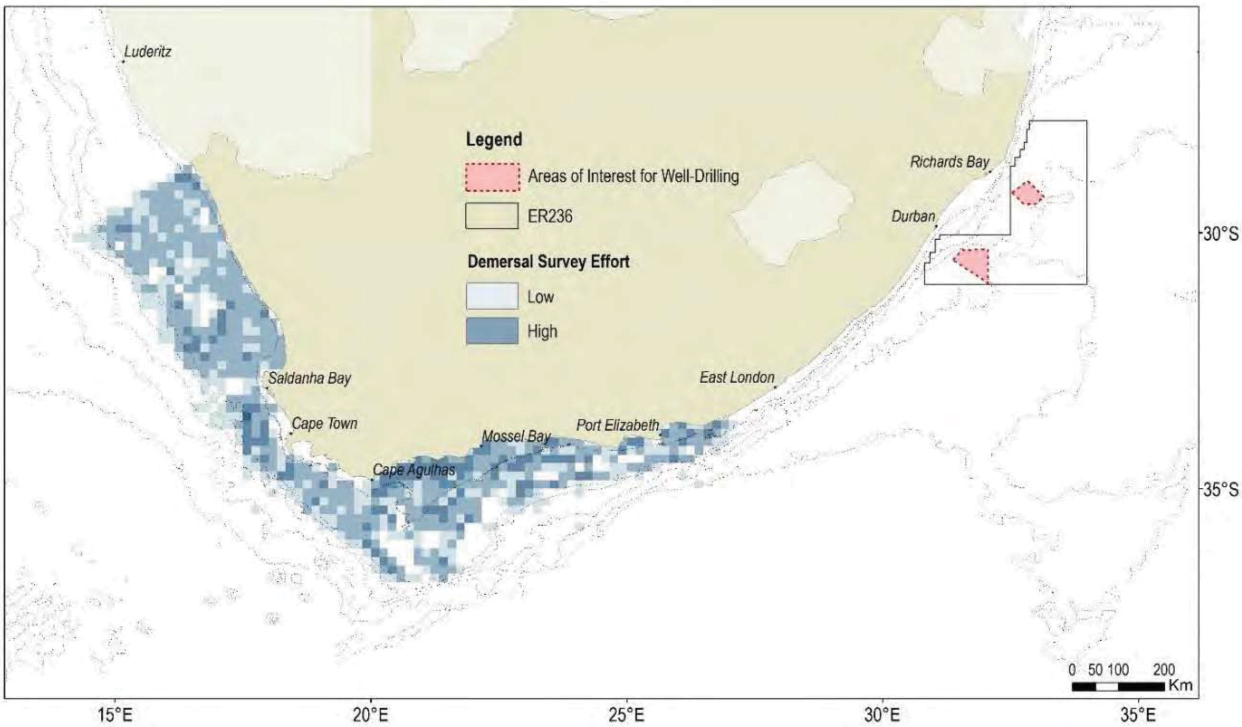


Figure 3-19: Spatial distribution of trawling effort expended during research surveys undertaken by DAFF to ascertain biomass of demersal fish species. Fishing grounds are shown in relation to ER236 and the proposed areas of interest for well-drilling.

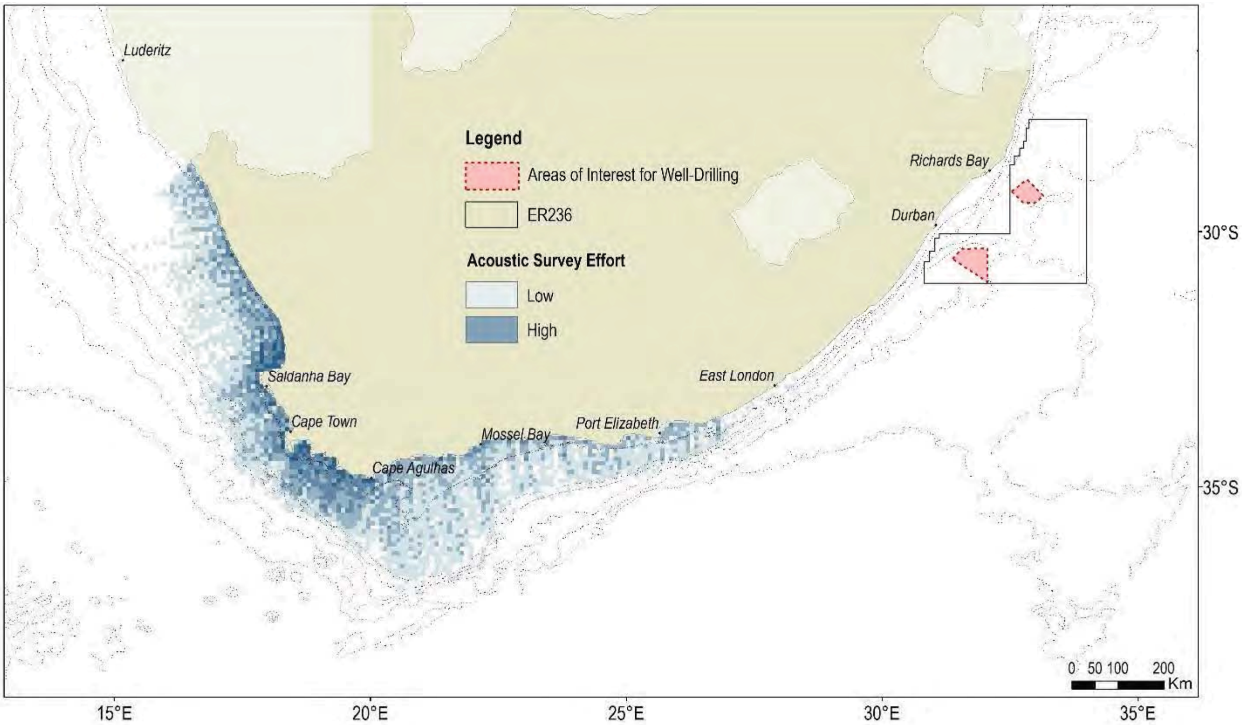


Figure 3-20: Spatial distribution sampling stations for acoustic surveys of the biomass of small pelagic species (1988 – 2013). The position of sampling stations are shown in relation to ER236 and the proposed areas of interest for well-drilling.

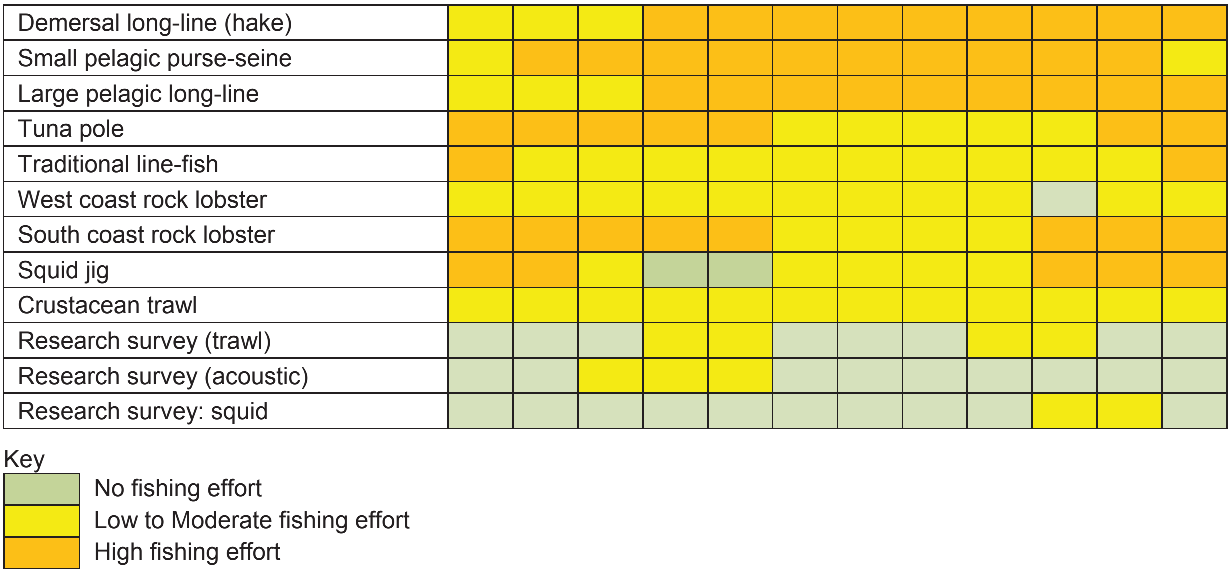
The biomass of small pelagic species is assessed bi-annually by an acoustic survey. The first of these surveys is timed to commence in mid-May and runs until mid-June while the second starts in mid-October and runs until mid-December. The timing of the demersal and acoustic surveys is not flexible, due 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 (see Figure 3-19). 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 DAFF survey vessel progresses systematically from the Northern border Southwards, around Cape Agulhas and on towards the east.

3.3.16 Summary Table of Seasonality of Catches for Commercial Fishing Sectors

The seasonality of each of the main commercial (and research) fishing sectors that operate off the West Coast of South Africa is indicated in Table 3-5, which presents relative intensity of fishing effort on a month-by-month basis.

Table 3-6: Summary table showing seasonal variation in fishing effort expended by each of the main commercial fisheries sectors operating in South African waters.

	J	F	M	A	M	J	J	A	S	O	N	D
Demersal trawl												
Mid-water trawl												



3.4 Description of 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 fisheries have a few defining characteristics namely; simple technology, labour intensive methods, relatively low capital inputs and a wide range of organisational levels.

Small-scale fishers fish to meet food and basic livelihood needs (i.e. “subsistence fishers”), 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. The equipment used by small scale fishers includes rowing boats in some areas, motorized boats on the south and west coast and simple fishing gear including hands, feet, screw drivers, hand lines, prawn pumps, rods with reels, gaffs, hoop nets, gill nets, seine/trek nets and semi-permanently fixed kraal traps.

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.

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.

In terms of the Marine Living Resources Act, 1998 (No. 18 of 1998) as amended in 2014 (No. 5 of 2014) and by Regulations Relating to Small-Scale Fishing in terms of section 19 of the MLRA, 1998 (published 08 March 2016), communities wishing to be recognised as small-scale fishing were required to register their expression of interest with DAFF. The Department would thereafter conduct a verification procedure of each person considering themselves to be a srnall-scale fisher in each of the communities that have registered an expression of interest. The granting of a small-scale fishing right would be at the level of an individual, who has to be a member of a co-operative, comprising a fishing community of at least 20 small-scale fishers. An estimated 30 000 rights would be allocated.

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 his or her livelihood from traditional fishing operations. More than 270 communities have registered the Expressions of Interest (EOI's) with the Department, representing an estimated 20,000 fishers in South Africa (DAFF media release, February 2016).

The small scale fishery rights cover the nearshore area (defined in section 19 of the MLRA as being within close proximity of shoreline). These in reality are unlikely to extend beyond 3 nm from the coast - and therefore would not directly coincide with the proposed drilling areas. However, the potential impact of upset conditions (e.g. an unplanned release of hydrocarbons) will be assessed further in section 4.

3.4.1 Kosi Bay Traditional Trap

Traditional traps are used in the Kosi lakes system extending from just inside the estuary mouth into the Makhawulani, Mpungwini and Nhlange lakes. These traps have been in operation in the Kosi Lakes for many generations. The traps are semi-permanent and are constructed by pushing branches into the sand approximately 50 cm apart in two parallel lines that extend from the banks mostly curving upstream. Fish movement is directed between the lines by packing brushwood in between the branches to form fences. At the end of the fences, there is a heart-shaped palisade which guides the fish into a basket with fish-proof walls and a non-return entrance which allows fish to enter the basket but not to exit it. The traps mostly target fish that move at night from the lakes to the ocean. They are caught in the baskets during the night and are speared and removed by the fishers in the morning. A 30 m wide channel is kept free of traps from the lakes to the ocean (Kyle 2013a). While this fishery was previously considered a subsistence fishery, it now operates as a small-scale commercial fishery (WIOFish 2013).

There are approximately 150 fishers active in the fishery (WIOFish 2013). In 2012 there were an estimated 64 392 fish caught in the traps weighing approximately 66 t (WIOFish 2013). Since 1981, catches have varied between 28 696 fish in 1986 to 100 448 fish in 2006 Kyle 2013a). Fishers obtained approximately R50 per kg for their catch in 2012 (WIOFish 2013). The total income from the catch would therefore be approximately R3.3 million.

3.4.2 Subsistence Linefishery

Subsistence fisheries refer to fisheries where poor, unemployed people harvest fish or other marine organisms in close proximity to where they live as a means to meet their basic needs of food security (Branch *et al*. 2002). However, categorisation of "true" subsistence linefishers is extremely difficult (Beckley *et al.* 2000). Generally these fishers' fish along the sea or estuary shore, they cannot afford vessels of any type, they use mostly old, second-hand or home-made rods and reels or hand-lines and they usually collect their own bait (such as mussels, red bait, mole crabs or sand prawns) as they often cannot afford to buy bait such as sardines. These fishers seldom catch enough fish to sell and most fish caught are used for personal or family consumption to supplement their diet. In rare occurrences where large catches are made, the surplus may be sold or bartered.

Clark *et al*. (2002) estimated that there were approximately 21 641 households along the KZN coast involved in subsistence fishing. However this is believed to be a substantial overestimate as Dunlop (2011), showed that “true” subsistence linefishers made up a relatively small percentage (3-6%) of the total number of shore fishers, which was estimated at approximately 65 000 in 2010 (Dunlop 2011) (i.e. the best estimate is between 2000-4000 subsistence linefishers). Approximately 2 500 people from 23 KZN communities participate in seven types of fisheries. Of these, marine and estuarine rod and line fishing (subsistence shore fishing) is the second most important (in terms of overall catch). In 2012, through established local fishing co-management structures, formal applications were received for fishing rights (exemption permits) for 938 subsistence linefishers from 12 recognised subsistence fishing communities including Kosi Bay, Mabibi, Mbila/Sodwana, Sokhulu, Nhlabane/Mbonambi, Port Durnford, Mpembeni, Amatikulu, Nonoti, Umgababa, Mfazazana/Mthwalume and Nzimakwe/Port Edward.

In terms of the annual amount of food harvested, it is estimated that the subsistence shore fishery harvests approximately 23 t of linefish in the marine and estuarine environments per annum (Mkhize 2010, Kyle 2013c, WIOFish 2013). Based on the estimates made by Dunlop (2011), the total subsistence linefish catch for the sea shore was in the region of 16 t per annum.

Due to the nature of the subsistence shore fishery and the fact that many participants are not formally permitted, total effort is extremely difficult to estimate. Based on the results from Dunlop (2011) best estimates for the marine subsistence shore linefishery would be between 24 000-48 000 fisher-days.year-1. Trends in fishing effort are not available for this fishery as a whole.

Limited information is available regarding the economic value of the subsistence linefishery. Reported value of the total annual catch ranges from R150 000 (Mkhize 2010) to R920 000 (based on figures cited in WIOFish 2013).

3.4.3 Illegal Gill and Seine Net

Illegal gill and seine-netting has been taking place in a number of KZN rivers, estuaries and freshwater impoundments since at least the early 1950s (Mann 1995, 2003, Kyle 1999, 2003). Monofilament gill-net is set along estuary margins, across estuary channels, into estuarine lakes or across river channels targeting a range of different fish species. The length of net can be between 10 and 1000 m and width from 2 to 4 m. Most netting was carried out on foot but more recently and particularly in larger estuaries such as Lake St Lucia, primitive home-made boats are used to set the nets. The seine-nets used in this fishery range from properly made nets with a weighted footrope, a buoyed float-line and a bag with a cod-end, to simple pieces of shade cloth that are dragged through the water. Seine-netting is an active method of fishing normally done by swimming the net out and pulling it into shore during the day with the main target being swimming prawns (Penaeidea). This should not be confused with the legal beach seine and drag net fisheries. Many of the people involved in these net fisheries are unemployed/poor rural people living in close proximity to estuarine systems. However, as it is an illegal fishery, much of the netting now being carried out is commercially motivated and well organised by poaching syndicates with fish buyers coming into rural areas with freezers in vehicles to purchase the fish and/or prawns which are then sold at nearby and distant markets. The main estuarine systems where illegal gill-netting is taking place include Kosi Bay, Lake St Lucia, Umfolozi/Msundusi, Lake Nhlabane, Richards Bay Harbour, Mhlatuze, Umlalazi, Amatikulu/Nyoni, Thukela, Zinkwazi, Umgeni and Durban Harbour (Beckley *et al.* 2000). Due to its illegal nature, estimates of total catch from this fishery are not available. During 2012 EKZNW anti-poaching patrols removed and destroyed a total of approximately 26 km of illegal gill and seine-nets from Lake St Lucia, as well as 56 boats. Many more kilometres of netting were removed from other estuaries.

Again due to the illegal nature of this fishery, determination of its economic value is impossible. Using maximum catch values from the experimental gill-net fisheries published in the literature (i.e. 39,5 t in Kosi Bay [Kyle 2003], 45 t in St Lucia [Mwanyama et al. 1999] and 5.2 t in Msundusi Estuary [Beckley *et al.* 2000]), the total value of the landed catch (first point of sale) at a ~R40/kg would be approximately R3.6 million. Similarly the value of prawns caught in the illegal seine-net fishery is also likely to be high.

3.4.4 ROCKY SHORE AND SANDY BEACH INVERTEBRATE FISHERY

Small-scale/subsistence fishers living along the KZN coast collect a variety of organisms including both mobile and sessile invertebrates living on intertidal rocks and sandy beaches. Harvesters living south of the iSimangaliso Wetland Park collect mostly mussels off the rocks and there is also some illegal collection of rock lobsters (*Panulirus* spp). There are approximately 300 fishers in the iSimangaliso Wetland Park but this may be an over-estimation as fishers may collect more than one type of target organism. Invertebrate collectors living along the remainder of the KZN coast number approximately 256 and the number of illegal lobster fishers is unknown.

Total catches (2011) for the various components of the small-scale invertebrate fishery as reported in WIOFish (2013) are mangrove crabs (8 043 kg), ghost crabs (200 kg), mole crabs (100 kg), mixed invertebrates (1700 kg) and mussels (9000 kg)

A total of 470 small-scale intertidal fisher exemption permits were applied for in 2013. The number has been steadily increasing since 2007. The increase can indicate either new entrants to the fishery or higher compliance by existing fishers of the interim fishery regulations. There is no information available on fishing effort (i.e. how often or for how long fishers harvest intertidal resources).

The total value of the catch (excluding the illegal lobster sales and the invertebrate collections south of the iSimangaliso Wetland Park for which there are no data) is approximately R445 000. Fishers have few costs except for the purchase of collection tools such as knives, scrapers, screwdrivers and hoes and, in some cases, transport to their fishing grounds. The real value of this fishery was that it often offered the ability for some of the poorest people in KZN to collect good quality food, especially in the time before substantial social grants.

3.5 DESCRIPTION OF RECREATIONAL FISHERIES

KZN has a large diversity of marine and estuarine organisms and the methods of harvesting them are equally diverse.The recreational sectors that are active off the KZN coastline comprise shore-based, estuarine and boat-based line fisheries as well as spearfishing. Net fisheries for recreational purposes include cast, drag and hoop net techniques. A description of each is presented below with information derived from the special publication on KZN's marine and estuarine fisheries produced by the Oceanographic Research Institute (2014), in conjunction with Ezemvelo KwaZulu-Natal Wildlife

(EKZNW)[3]. Information on recreational fisheries in KZN are recorded in the National Marine Linefish System – KZN Recreational Data and the KZN Boat Launch Site Monitoring System databases.

Overall, recreational fisheries account for the most fishers in the province. In terms of catches, the industrial fisheries contribute the most to the total catch for KZN but this is followed closely by the recreational fisheries and commercial fisheries (see Figure 3-17).

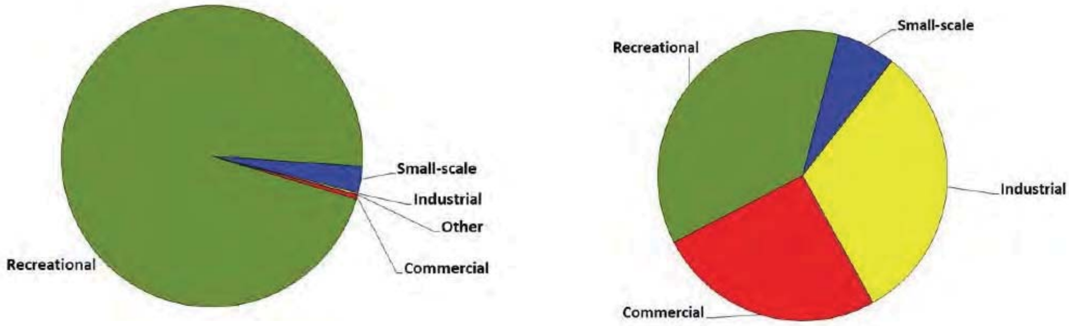


Figure 3-21: (Left) Proportion of fishers that contribute to overall participation in KwaZulu-Natal and (right) proportion of fisheries that contribute to total catch in KwaZulu-Natal (ORI, 2014).

3.5.1 Shore-Based Linefishery

Recreational shore-based fishing (angling), is a recreational activity that takes place from the shoreline, using a hook and line. The fishery is open access and widely distributed along the entire KZN coastline (Dunlop & Mann 2012). This makes it accessible to a wide variety of communities, ranging from subsistence fishers to recreational/social and competitive anglers (Dunlop & Mann 2012). Shore linefishing has a long-standing historical presence in the province, and easy access and relatively low gear and entry costs make recreational shore fishing the largest marine fishery in KZN in terms of the number of participants (Brouwer et al. 1997; McGrath et al. 1997; Dunlop 2011). In 2009/10, the total number of recreational shore anglers active in the fishery was estimated at between 41 283 and 68 087 anglers (Dunlop & Mann 2012). It was also estimated that between 8 463 and 13 958 shore anglers (20.5%) visit KZN annually from other provinces or countries (Dunlop & Mann 2012).

A wide variety of fish species are targeted, including shad (*Pomatomus saltatrix*), karanteen (*Sarpa salpa*) and blacktail (*Diplodus capensis*), with a limited amount of overlap in the species captured from the shore and in the offshore boat-based linefishery (Dunlop & Mann 2012). Catch per unit effort (CPUE) for the KZN shore fishery in 2009/10 was approximately 0.82 fish per angler-day or 0.32 kg per angler-day (Dunlop & Mann 2012). This amounts to approximately 263 t of fish per annum based on the estimates of total shore angling effort and CPUE (Dunlop & Mann 2012). Total shore angling effort was calculated to be 779 382 to 843 702 angler-days per annum in 2009/10 (Mann et al. 2008; Dunlop & Mann 2012). The most recent economic survey of the KZN shore fishery was conducted by Dunlop (2011) in 2009-10. Based on the estimated total catch of 263 t and the wholesale (first point of sale) value of linefish at that time (i.e. ~R30/kg), the total value of the catch was estimated at R7.9 million.

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[3] EKZNW is the provincial fisheries management authority and legal custodian of the natural environment that has been delegated the responsibility for managing the province's marine fisheries by the national Department of Agriculture, Forestry and Fisheries (DAFF).

3.5.2 ESTUARINE LINEFISHERY

Estuaries are highly productive and dynamic ecosystems providing an important nursery habitat for juvenile fish and feeding grounds for some adult species. Recreational estuarine fishing in KZN occurs in four major estuarine systems, namely Durban harbour (Guastella 1994, Pradervand et al. 2003), Richards Bay harbour (Everett & Fennessy 2007, Beckley et al. 2008), Lake St Lucia (Mann et al. 2002) and Kosi Bay (James et al. 2001). Anglers predominantly use light tackle to fish from the estuary shore and from small boats in water depths not exceeding 25 m in harbours and seldom exceeding 5 m in St Lucia and Kosi Bay.

Individual estimates of participation have been published for three of the four major estuarine systems in KZN. Participation in the Durban Harbour fishery was estimated by Pradervand et al. (2003) to be 6 442 anglers, while in Richards Bay, participation was estimated at 9 623 anglers (Everett & Fennessy 2007, Beckley et al. 2008). In St Lucia, Mann et al. (2002) estimated the participation at 15 307 anglers. Participation at Kosi Bay is likely to be far lower than that of St Lucia due to its remoteness (James et al. 2001). Angler participation in KZN's smaller estuarine systems is relatively low in comparison. The overall participation in the KZN recreational estuarine fishery as a whole is estimated to be 50 000 anglers (Lamberth & Turpie 2003).

Catch composition varies according to location but consists of spotted grunter, dusky kob (*Argyrosomus japonicas*), Natal stumpnose, mullet (Mugilidae), riverbream/perch (*Acanthopagrus vagus*) and a variety of other species. In 2012, EKZNW recorded an overall shore-based CPUE for the estuarine fishery of 0.06 $fish.angler^{-1}.hour^{-1}$ (Maggs et al. 2013). Total annual recreational catch retained in the four major systems is approximately 85 000 fish (~103 t) (James et al. 2001, Mann et al. 2002, Pradervand et al. 2003, Everett & Fennessy 2007, Beckley et al. 2008) and total recreational angling effort in the four major estuarine systems is approximately 850 000 angler hours per year (James et al. 2001, Mann et al. 2002, Pradervand et al. 2003, Everett & Fennessy 2007, Beckley et al. 2008). Fish may not be sold; however, based on the estimated total catch and the value of fresh fish of ~ R40/kg (2014, first point of sale), the landed catch is worth R4.1 million. Lamberth and Turpie (2003) estimated the overall economic contribution of the estuarine shore-based recreational sector in KZN at R84.5 million per year.

3.5.3 BOAT-BASED LINEFISHERY

The marine recreational boat-based fishery comprises various types of vessels from paddleskis (also known as fishing-skis) to large harbour-based vessels >10 m. However, the most common vessel used for recreational offshore fishing along the KZN coast is the skiboat. Skiboats are compact, trailer-able, beach-launched vessels 5-10 m long, usually powered by twin outboard engines and are more affordable, fuel efficient and cheaper to run than large, harbour- based vessels (Penney et al. 1999). These vessels can be launched at beach launch sites and harbours and give access to most offshore areas along the KZN coast (Dunlop & Mann 2013). Due to the recreational nature of the fishery, a large range of fishing gear is used depending on the target species. When bottom fishing for reef fish, sturdy fibreglass rods and Scarborough type reels are preferred, very similar to those used by commercial fishers. When targeting game fish (the most commonly targeted species), expensive graphite trolling rods fitted with multiplier reels will be used while trolling lures or live bait are used at varying depths depending on the species being targeted. A wide variety of pelagic and demersal reef fish species are caught (~78 species), including yellowfin tuna (*Thunnus albacares*), slinger (*Chrysoblephus puniceus*), dorado (*Coryphaena hippurus*), black musselcracker (*Cymatoceps nasutus*), eastern little tuna (*Euthynnus affinis*), blue emperor (*Lethrinus nebulosus*), chub mackerel (*Scomber japonicus*) and Englishman (*Chrysoblephus anglicus*) (Dunlop & Mann, 2013). There is considerable overlap in the species captured between the recreational, charter and commercial sectors of the offshore boat-based linefishery (Dunlop & Mann 2013).

The total number of recreational boat fishers participating in the KZN offshore boat-based linefishery was estimated at between 7 662 and 9 991 anglers in 2009/10, operating from an estimated 2 448 to 3 192 boats (Dunlop & Mann 2013). In addition, there are a minimum of 650 active participants in the paddleski fishery annually (Mann et al. (2012). CPUE during a 2009/10 survey was 8.58 fish per boat outing, or 15.0 kg per boat outing and the total annual catch was estimated at 457 t per annum (261 132 fish per annum) (Dunlop & Mann 2013).

During 2016 there were approximately 24 445 recreational boat launches undertaken for the purpose of recreational fishing along the KZN coast (Mann et al. 2016) with an additional estimated number of 6 685 paddleski launches made annually (Mann et al. 2012). In 2016, 72 290 fish were caught by recreational line and spearfishing combined during 2016 (Mann et al. 2016).

The most recent economic survey of the KZN recreational boat-based linefishery was conducted by Dunlop (2011). Based on the estimated total catch of 457 t and the wholesale (first point of sale) value of linefish at that time (i.e. ~R30/kg), the total value of the catch was approximately R13.7 million.

3.5.4 Cast Net Fishery

This recreational fishery is active in the shallow regions of estuaries, harbours and the intertidal zone of beaches (WIOFish 2013) with a quota system of cast net licences that are endorsed by EKZNW for use on specific estuaries. Fishermen operate from the shore, throwing a small circular net, weighted at the circumference, in such a way that the cast net spreads out on the water and sinks, entrapping fish.

In 2012, 1 233 annual cast net permits and an additional 113 temporary permits were issued in KZN (ICS 2013). The total fishing effort in KZN is unknown. A total of 182 cast netters were encountered on 102 EKZNW shore patrols conducted in 2012 (ICS 2013). The potential economic value of this fishery is unknown as there is no information on total catch.

3.5.5 Drag Net Fishery

This small recreational fishery is conducted in estuaries using a drag net to capture juveniles of several penaeid prawn species (WIOFish 2013). A vessel may not be used (Tomalin 1995). In 2012, a total of 169 drag net permits were issued, and an additional 155 permits purchased in the previous year were still valid in 2012 (ICS 2013).

There is no reliable catch information for this fishery, but total annual catch is estimated to be less than 100 kg (ORI, 2014). Catches made in this fishery may not be sold and are mainly used for bait.

3.5.6 Hoop Net Fishery

This recreational fishery targets small baitfish and squid in harbours and estuaries of KZN (Tomalin 1995). Animals are collected using a net that is attached to a hoop at the end of a pole. The fishery was suspended from 2005 to 2009, but in 2010, hoop net permits were again sold in KZN (ICS 2013).

Based on permit sales at KZN post offices, a total of 302 fishers bought 81 annual and 221 temporary hoop net permits in 2012. A further 77 hoop net permits sold in 2011 was also still valid in 2012 (ICS 2013). There is no information on fishing effort. The potential economic value of this fishery is unknown as there is no information on total catch.

3.5.7 INSHORE INVERTEBRATE FISHERY

Several marine and estuarine invertebrate species are collected by recreational harvesters in KZN estuaries, along sandy beaches, within the intertidal zone on rocky shores and on shallow inshore reefs. This fishery started in the early 1900's and the first permits for the recreational collection of east coast rock lobster, burrowing prawns and crab in KZN were sold in 1964 (Robertson 2003; Tomalin 1993).

East Coast rock lobster (*Panulirus homarus*) is collected on shallow inshore reefs mainly by free divers operating from the beach (>80% of collectors). A small number of rock lobsters caught in lobster traps, consisting of a flat circular base with no sides (<7% of collectors) (Tomalin 1995; Steyn & Schleyer 2014). Mussels (*Perna perna*), oysters (*Striostrea margaritacea* and *Saccostrea cuccullata*), octopuses (*Octopus vulgaris*), redbait (*Pyura stolonifera*), limpets (*Patella* spp.), rock crabs (*Grapsus* spp.) and ghost crabs are collected by hand from the intertidal and sandy beach zones. Sand and mud prawns (*Callichirus kraussi* and *Upobegia capensis*) are collected in estuaries and harbours using hand-held suction pumps.

Based on permit sales at KZN post offices, a total of 11 269 invertebrate collectors bought 14 143 annual and 449 temporary recreational invertebrate permits in 2012 (ICS 2013).

4 Impact Assessment

The following section assesses the potential impacts of the proposed well-drilling program on fishing sectors. Possible impacts are identified (Section 4.1) and the impact assessment methodology presented (Section 4.2). The data sources used to quantify fishing catch and effort (Section 4.3) and assumptions and limitations of the assessment (Section 4.4) are discussed. Assessment ratings for each of the identified impacts are provided in Section 4.5 – 4.6 Where possible, measures are suggested to reduce the overall significance of the impact on each sector (e.g. timing of the drilling operations to coincide with periods of low activity for seasonally active fisheries; timing of drilling operations to avoid peak spawning periods).

4.1 Description of Potential Impacts on Fisheries

The identification and assessment of impacts relating specifically to the fishing industry cover the four main activity phases of the proposed well-drilling project, namely:

- Mobilisation
- Drilling
- Operational
- Well Abandonment
- Demobilisation
- Unplanned Activities

4.1.1 Exclusion from Fishing Ground

Under the Marine Traffic Act, 1981 (No. 2 of 1981), a wellhead would fall under the definition of an "offshore installation" and as such it is protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter the safety zone. As such, fisheries could be affected by physical exclusion from fishing grounds. Whilst the drilling unit is in place, a contractor would typically request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond.

The table below summarises the project activities that have the potential to affect the fishing industry by exclusion from fishing ground.

Activity phase	Activity
Mobilisation	Transit of drilling unit to drill site
Drilling	Operation of drilling unit at the drill site
Well Abandonment	Abandonment of wellhead(s) on seafloor
Demobilisation	Transit of drilling unit from drill site.

Description of the source of impact

Proposed activities include the transit of the drilling unit to and from the drill site during the project mobilisation and demobilisation phases, the operation of the drilling unit at the drill site and the abandonment of wellhead(s) on the seafloor. These activities are further described below:

- **Operation of the drilling unit.** The exclusion of vessels from entering the 500 m safety zone around a drilling unit poses a direct impact to fishing operations in the form of loss of access to fishing grounds only if the fishing areas for each fishing sector identified overlap. The safety zones aim to ensure the safety both of navigation and of the drilling unit, avoiding or reducing the probability of accidents caused by the interaction of fishing boats and gears and the drilling unit.
- **Abandonment of wellhead(s) on seafloor.** On demobilization, exploration well(s) would be sealed with cement plugs, tested for integrity and abandoned. The wellhead, with a height of 3 m and a diameter of 1 m, would remain on the seafloor. An abandoned wellhead may pose an obstruction to any fishing activity directed towards the seabed (namely any demersal fishery).

Description of the environmental aspects

Planned events that are relevant to the fishing industry include the implementation of a 500 m safety area around the drill unit and abandoned wellhead, which could result in exclusion of vessels from accessing fishing grounds.

Description of the potential impact

The potential impact associated with these activities is loss of catch as a result of preclusion from fishing grounds around the drilling unit (during the operational phase) and the abandoned wellhead(s) (demobilisation phase). Whereas the impact of a safety zone around the drilling unit could potentially affect any fishery type, the presence of an abandoned wellhead could impact only those fisheries that direct fishing effort at the seabed (demersal). The 500 m safety zone surrounding each of the drill sites would result in an effective exclusion area of 0.785 km^2.

Sensitive receptors

The affected fisheries sectors (receptors) have been identified based on the overlap of fishing grounds with the area of interest for well drilling.

Project controls and industry objectives

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Section II, Rule 18), a drilling unit that is engaged in underwater operations is defined as a “vessel restricted in its ability to manoeuvre” which requires that power-driven and sailing vessels give way. Furthermore, under the Marine Traffic Act, 1981 (No. 2 of 1981), an “exploration platform” or “exploration vessel” used in prospecting for or mining of any substance falls under the definition of an “offshore installation” and as such it is protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter the safety zone. The safety zone would be issued as a navigational warning via the South African Navy Hydrographic Office (HydroSAN). Support vessels with appropriate radar and communications would be used during the drilling operation to warn vessels that are in danger of breaching the exclusion zone.

Performance objectives

The objective is to minimise interactions with the fishing industry and to achieve zero incidents.

4.1.2 UNPLANNED EMISSIONS AND DISCHARGES

Description of the source of impact

The table below summarises the project activities likely to affect the fishing industry though an unplanned loss of well containment.

Activity phase	Activity
Drilling and operational well testing	Loss of fuel from vessel accident
	Release of LTOBM due to accidental riser disconnect
	Loss of well control/ blow-out

These unplanned release into the environment of an accidental nature (outside of planned discharges and effluents) have been identified as the three hypothetical oil spill scenarios described below:

- Diesel spill in the event of a vessel collision during the drilling of a well.
- Release of non-aqueous drilling fluid (NADF) due to the accidental disconnection of the riser during drilling of a well.
- Deep blowout of crude oil during exploration.

A separate assessment was undertaken (ERM, 2018) to model the fate of hydrocarbons under three scenarios at each of two proposed drilling locations in the northern area and one location in the southern area of Block ER236. The results were used to inform the findings of the current assessment report (see section 4.5). Further information on the different oil spill scenarios that were considered are included below:

- Surface spill of marine diesel (795 m^3) at the well site due to a vessel collision, where the dominant weathering processes are evaporation and dispersion.
- Instantaneous release of LTOBMs (NADF) and contaminated cuttings (300 m^3 - 530 m^3) from the drillship following the accidental disconnection of the riser during drilling of the deeper well sections. LTOBMs comprise primarily alkanes, with aromatics comprising less than 0.01% of the oil by mass. The base oil comprises 60% by volume of the LTOBM, with the remaining 40% being solids (typically barium sulfate with other minerals and crystals such as calcium chloride, calcium hydroxide, silica, etc.). The muds comprise particles of <77 μm, with the largest representation by particles in the 12-28 μm size range. As with marine diesel, the dominant weathering processes are evaporation and dispersion.
- Blow-out of light to medium crude oil (750 m^3 – 1050 m^3 per day) at the seabed under a 7-day and 20-day blow-out scenario. The oil rises through the water column affected by different currents at the various vertical strata, where the oil either dissolves, volatilizes, degrades, or remains in the liquid state as a droplet until reaching the surface. On the water surface, a slick is formed. For crude oil the weathering processes over the short-term (hours to weeks) include evaporation, dispersion, dissolution, photo-oxidation, emulsification and spreading, whereas biodegration and sedimentation dominate the weathering processes over the medium- to long-term (weeks to years).

Description of the potential impact

There are several possible direct and secondary impacts of oil spills on fisheries:

- Exclusion of fisheries from areas that may be polluted or closed to fishing due to contamination of sea water by the oil or for example the chemicals used for cleaning oil spills.
- Oil contamination of mobile finfish species, in particular of juveniles in nursery areas could result in displacement of species from normal feeding and protective areas as well as possible physical contamination and/or physiological effects such as clogging of gills, both of which would lead to fish mortality;
- Oiling of sessile or sedentary species would result in physical clogging on individuals, disturbance and or removal of habitat for these species and gill clogging for filter feeding species such as mussels, all of which is likely to result in mortality;
- Oiling of passively drifting spawn products (eggs and larvae) would result in their contamination and mortality (the extent of mortality would depend on the nature and extent of the contaminants).
- Acute toxicological effects on aquatic organisms (i.e. from narcosis) of the dissolved aromatic hydrocarbons (DAHs) in marine diesel and NADFs.

The impacts of the biological effects of oil contamination on fish, spawn products and vulnerable supporting habitats has been assessed by Pisces Environmental Consulting (Pty) Ltd in a separate report. The current report assesses the potential impact of oil spills on fishing operations resulting from the exclusion of vessels from operating in affected areas.

Sensitive receptors

The spatial and temporal distribution of spawning areas as well as inshore nursery ground areas and fishing grounds will be assessed in relation to the various probabilities of different oiling scenarios. The spatial extent and distribution of the resulting spread of oil will be assessed in relation to the areas of operation of fishing vessels in relation to the various probabilities of different oiling scenarios. Vessels may be excluded from operating in areas of contamination.

Project controls and industry objectives

The primary safeguard against a blow-out is the column of drilling fluid in the well, which exerts hydrostatic pressure on the wellbore. Under normal drilling conditions, this pressure should balance or exceed the natural rock formation pressure to help prevent an influx of gas or other formation fluids. As the formation pressures increase, the density of the drilling fluid is increased to help maintain a safe margin and prevent “blowouts.” However, if the density of the fluid becomes too heavy, the formation can break down. If drilling fluid is lost in the resultant fractures, a reduction of hydrostatic pressure occurs. Maintaining the appropriate fluid density for the wellbore pressure regime is therefore critical to safety and wellbore stability. Abnormal formation pressures are detected by primary well control equipment (pit level indicators, return mud-flow indicators and return mud gas detectors) on the drill unit. The drilling fluid is also tested frequently during drilling operations and its composition can be adjusted to account for changing downhole conditions. The likelihood of a blow-out is further minimised by installation of a blow-out preventer (BOP) on the wellhead at the start of the risered drilling stage. The BOP is a secondary control system, which contain a stack of independently-operated cut-off mechanisms, to ensure redundancy in case of failure. The BOP is designed to close in the well to prevent the uncontrolled flow of hydrocarbons from the reservoir. A blow-out occurs in the highly unlikely event of these pressure control systems failing.

4.2 Impact Assessment Methodology for Planned Events

For each impact, the TYPE (direct, indirect, induced or cumulative), DURATION (time scale), EXTENT (spatial scale), SCALE and FREQUENCY were described. These criteria were used to determine the MAGNITUDE (negligible, small, medium or large) of the impact. The overall SIGNIFICANCE of the impact was a function of the consequence and the MAGNITUDE of the impact and the SENSITIVITY (low, medium or high) of the receptor. Practical mitigation and optimisation measures that can be implemented effectively to reduce or enhance the significance of impacts were identified. The impact significance was re-rated assuming the effective implementation of mitigation measures.

The methodology followed for this assessment was provided by ERM and is defined below.

4.2.1 Impact Identification and Characterisation

An ‘impact’ is any change to a resource or receptor caused by the presence of a project component or by a project-related activity.

Impacts can be negative or positive.

Impacts are described in terms of their characteristics, including the impact type and the impact spatial and temporal features (namely extent, duration, scale and frequency). Terms used in this EIA are described in Table 4-1.

Table 4-1: Impact characteristics.

Characteristic	Definition	Terms
Type	A descriptor indicating the relationship of the impact to the project (in terms of cause and effect).	**Direct** - Impacts that result from a direct interaction between the project and a resource/receptor (eg between occupation of the seabed and the habitats which are affected). **Indirect** - Impacts that follow on from the direct interactions between the project and its environment as a result of subsequent interactions within the environment (eg viability of a species population resulting from loss of part of a habitat as a result of the project occupying the seabed). **Induced** - Impacts that result from other activities (which are not part of the project) that happen as a consequence of the project. **Cumulative** - Impacts that arise as a result of an impact and effect from the project interacting with those from another activity to create an additional impact and effect.
Duration	The time period over which a resource / receptor is affected.	**Temporary** - impacts are predicted to be of short duration and intermittent/occasional. **Short term** - impacts that are predicted to last only for the duration of the drilling and well testing phase, ie 6 months or less. **Medium term** - impacts that are predicted to extend beyond the drilling phase but not longer than three years.

		Long term - impacts that will continue beyond three years but within 10 years. **Permanent** - impacts that cause a permanent change in the affected receptor or resource or ecological process, and which endures beyond 10 years.
Extent	The reach of the impact (i.e. physical distance an impact will extend to)	**On-site** - impacts that are limited to the site area only, ie within 500m of drilling well (exclusion zone). **Local** - impacts that are limited to the project site and within the block. **Regional** - impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystems, ie extend to areas outside the block. **National** - impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences. **Trans-boundary/International** - impacts that affect internationally important resources such as areas protected by international conventions or impact areas outside of South Africa.
Scale	Quantitative measure of the impact (eg the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.).	Quantitative measures as applicable for the feature or resources affects. No fixed designations as it is intended to be a numerical value.
Frequency	Measure of the constancy or periodicity of the impact.	No fixed designations; intended to be a numerical value or a qualitative description.

Unplanned events (eg incidents, spills) are considered in terms of likelihood (Table 4-2). The likelihood of an unplanned event occurring is determined qualitatively, or when data are available, semi-quantitatively. It is also important to distinguish that likelihood is a measure of the degree to which the unplanned event is expected to occur, not the degree to which an impact or effect is expected to occur as a result of the unplanned event.

Table 4-2: Definitions for likelihood.

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Determining the Scale of Impact for Fisheries

Where the spatial footprint of fishing grounds for a particular fishery overlapped with the area of interest for well-drilling, a formula was applied to calculate the potential reduction in catch. This was estimated as:

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

where

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

CT = total catch recorded as taken in the impact area during fishing period (tonnes)

Di = duration of impact (days)

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

A scale rating was assigned based on the calculated loss of catch according to the following categories:

Negligible	a loss of <1% of total annual landings or fishing ground
Small	a loss of between 1% and 5% of total annual landings or fishing ground
Medium	a loss of between 5% and 10% of total annual landings or fishing ground
Large	a loss of >10% of total annual landings or fishing ground

4.2.2 Determining Impact Magnitude

Once impacts are characteristed they are assigned a ‘magnitude’. Magnitude is typically a function of some combination (depending on the resource/receptor in question) of the following impact characteristics:

- Extent;
- Duration;
- Scale; and
- Frequency.

Magnitude (from small to large) is a continuum. Evaluation along the continum requires professional judgement and experience. Each impact is evaluated on a case-by-case basis and the rationale for each determination is noted. Magnitude designations for negative effects are: negligible, small, medium and large.

The magnitude designations themselves are universally consistent, but the definition for the designations varies by issue. In the case of a positive impact, no magnitude designation has been assigned as it is considered sufficient for the purpose of the impact assessment to indicate that the project is expected to result in a positive impact.

Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes are regarded as having no impact, and characterised as having a negligible magnitude.

In the case of impacts resulting from unplanned events, the same resource/ receptor-specific approach to concluding a magnitude designation is used. The likelihood factor is also considered, together with the other impact characteristics, when assigning a magnitude designation.

Determining Magnitude for Biophysical Impacts

For biophysical impacts, the semi-quantitative definitions for the spatial and temporal dimension of the magnitude of impacts used in this assessment are provided below.

High Magnitude Impact affects an entire area, system (physical), aspect, population or species (biological) and at sufficient magnitude to cause a significant measureable numerical increase in measured concentrations or levels (to be compared with legislated or international limits and standards specific to the receptors) (physical) or a decline in abundance and/ or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations (physical and biological). A high magnitude impact may also adversely affect the integrity of a site, habitat or ecosystem.

Moderate Magnitude Impact affects a portion of an area, system, aspect (physical), population or species (biological) and at sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels (to be compared with legislated or international limits and standards specific to the receptors) (physical) and may bring about a change in abundance and/or distribution over one or more plant/animal generations, but does not threaten the integrity of that population or any population dependent on it (physical and biological). A moderate magnitude impact may also affect the ecological functioning of a site, habitat or ecosystem but without adversely affecting its overall integrity. The area affected may be local or regional.

Low Magnitude Impact affects a specific area, system, aspect (physical), group of localised individuals within a population (biological) and at sufficient magnitude to result in a small increase in measured concentrations or levels (to be compared with legislated or international limits and standards specific to the receptors) (physical) over a short time period (one plant/animal generation or less, but does not affect other trophic levels or the population itself), and localised area.

Determining Magnitude for Socio-economic Impacts

For socio-economic impacts, the magnitude considers the perspective of those affected by taking into account the likely perceived importance of the impact, the ability of people to manage and adapt to change and the extent to which a human receptor gains or loses access to, or control over socio-economic resources resulting in a positive or negative effect on their well-being. The quantitative elements are included into the assessment through the designation and consideration of scale and extent of the impact.

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 catches recorded in the area of interest (the impacted area) were extracted for the period 2000 to 2016. The average catches for a full year were extracted and used to calculate the amount of catch that could potentially be lost in the event that the fishing sector was excluded from the entire area of interest for the duration of the drilling operation (two months per well).

4.2.3 DETERMINING RECEPTOR SENSITIVITY

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity of the receptor. There are a range of factors to be taken into account when defining the sensitivity of the receptor, which may be physical, biological, cultural or human. Where the receptor is physical (for example, a water body) its current quality, sensitivity to change, and importance (on a local, national and international scale) are considered. Where the receptor is biological or cultural (ie the marine environment or a coral reef), its importance (local, regional, national or international) and sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered. As in the case of magnitude, the sensitivity designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity of receptor is low, medium and high.

For ecological impacts, sensitivity is assigned as low, medium or high based on the conservation importance of habitats and species.

For the sensitivity of individual species, Table 4-3 presents the criteria for deciding on the value or sensitivity of individual species.

For socio-economic impacts, the degree of sensitivity of a receptor is defined as the level of resilience (or capacity to cope) with sudden social and economic changes. Table 4-3 and Table 4-4 present the criteria for deciding on the value or sensitivity of biological and socio-economic receptors.

Table 4-3: Biological and species value/sensitivity criteria.

Value / Sensitivity	Low	Medium	High
Criteria	Not protected or listed as common / abundant; or not critical to other ecosystem functions (eg key prey species to other species).	Not protected or listed but may be a species common globally but rare in South Africa with little resilience to ecosystem changes, important to ecosystem functions, or one under threat or population decline.	Specifically protected under South African legislation and/or international conventions e.g. CITES Listed as rare, threatened or endangered eg IUCN

Note: The above criteria should be applied with a degree of caution. Seasonal variations and species lifecycle stage should be taken into account when considering species sensitivity. For example, a population might be deemed as more sensitive during the breeding/spawning and nursery periods. This table uses listing of species (e.g. IUCN) or protection as an indication of the level of threat that this species experiences within the broader ecosystem (global, regional, local). This is used to provide a judgement of the importance of affecting this species in the context of project-level changes.

Table 4-4: Socio-economic sensitivity criteria.

Sensitivity	Low	Medium	High
Criteria	Those affected are able to adapt with relative ease and maintain pre-impact status.	Able to adapt with some difficulty and maintain pre-impact status but only with a degree of support.	Those affected will not be able to adapt to changes and continue to maintain-pre impact status.

Determining sensitivity of Fishing Sectors with respect to Exclusion from Fishing Grounds

The sensitivity of fishing sectors (the “receptor”) to the impact of exclusion from fishing grounds was determined based on the likelihood of fishing effort being able to continue in a modified way. In practical terms this would be possible where a particular fishery could fish in alternative areas, if such exist.

4.2.4 Assessing Significance

Once magnitude of impact and sensitivity of a receptor have been characterised, the significance can be determined for each impact. The impact significance rating will be determined, using the matrix provided in Table 4-6.

Table 4-5: Impact significance.

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/ importance designations that enter into the matrix. Table 4-6 provides a context for what the various impact significance ratings signify.

Table 4-6: Context of impact significances.

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.
An impact of **minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.
An impact of **moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.
An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the project.

4.2.5 MITIGATION POTENTIAL AND RESIDUAL IMPACTS

A key objective of an EIA is to identify and define socially, environmentally and technically acceptable and cost effective measures to manage and mitigate potential impacts. Mitigation measures are developed to avoid, reduce, remedy or compensate for potential negative impacts, and to enhance potential environmental and social benefits. The approach taken to defining mitigation measures is based on a typical hierarchy of decisions and measures, as described in Table 4-7.

The priority is to first apply mitigation measures to the source of the impact (ie to avoid or reduce the magnitude of the impact from the associated project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (ie to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures. The approach taken to defining mitigation measures is based on a typical hierarchy of decisions and measures, as described in Table 4-7.

Table 4-7: Mitigation hierarchy.

Avoid at Source; Reduce at Source: avoiding or reducing at source through the design of the Project (eg avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity).
Abate/Minimize on Site: add something to the design to abate the impact (eg pollution control equipment).
Abate/Minimize at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site (eg traffic measures).
Repair or Remedy*:* some impacts involve unavoidable damage to a resource (eg material storage areas) and these impacts require repair, restoration and reinstatement measures.
Compensate in Kind; Compensate through Other Means: where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (eg financial compensation for degrading agricultural land and impacting crop yields).

As required by the South African EIA Regulations (as amended in 2017) the following additional items will be considered in the assessment of impacts and risks identified:

- The degree to which the impact and risk can be reversed (this will be rated on a scale of high, medium, or low);
- The degree to which the impact and risk may cause irreplaceable loss of resources (this will be rated on a scale of high, medium, or low).

This will inform the residual impact significance.

4.2.6 RESIDUAL IMPACT ASSESSMENT

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance.

This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

4.2.7 CUMULATIVE IMPACTS

A cumulative impact is one that arises from a result of an impact from the Project interacting with an impact from another activity to create an additional impact. How the impacts and effects are assessed is strongly influenced by the status of the other activities (eg already in existence, approved or proposed) and how much data is available to characterise the magnitude of their impacts.

The approach to assessing cumulative impacts is to screen potential interactions with other projects on the basis of:

- projects that are already in existence and are operating;
- projects that are approved but not as yet operating; and
- projects that are a realistic proposition but are not yet built.

4.3 IMPACT ASSESSMENT METHODOLOGY FOR UNPLANNED EVENTS

The methodology used to assess the significance of the risks associated with accidental events differs from the impact assessment methodology in that the risk significance is based on a combination of the likelihood (or frequency) of the incident occurring and the consequences of the incident should it occur. The assessment of likelihood and consequence of the event also includes the existing control and mitigation measures for this project.

The assessment of likelihood takes a qualitative approach based on professional judgement, experience from similar projects and interaction with the technical team.

The assessment of consequence is based on specialists' input and their professional experience gained from similar projects, and informed by the results of the various modelling studies undertaken to confirm the extent and duration of an oil spill. In order to determine the potential extent and duration of accidental oil spills (in the unlikely event that they occur) an oil spill modelling study was conducted for this project.

Definitions used in the assessment for likelihood and consequence are set out in **Error! Reference source not found.**4-8 below.

Table 4-8: Risk significance criteria for unplanned events.

Characteristic	Definition	Terms
Likelihood	Describes the probability of an event or incident actually occurring or taking place	**Low** – the event or incident is reported in the oil and gas industry, but rarely occurs **Medium** – the event or incident does occur but is not common **High** – the event or incident is likely to occur several times during the project's lifetime
Consequence	A combination of those factors that determine the magnitude of the unplanned impact (in terms of the extent, duration and intensity of the impact)	**Minor consequence** – impacts of Low intensity to receptors/resources across a local extent, that can readily recover in the short term with little or no recovery/remediation measures required. **Moderate consequence** – impacts of Low to Medium intensity across a local to regional extent, to receptors/resources that can recover in the short term to medium term with the intervention of recovery/remediation measures. **Major consequence** – exceeds acceptable limits and standards, is of Medium to High intensity affecting receptors/resources across a regional to international extent that will recover in the long term only with the implementation of significant/remediation measures

Once a rating is determined for likelihood and consequence, the risk matrix in **Error! Reference source not found.** is used to determine the risk significance for accidental events. The prediction takes into account the mitigation and/or risk control measures that are already an integral part of the project design, and the management plans to be implemented by the project.

Table 4-9: Accidental events risk significance.

Risk Significance Rating				
Likelihood		Low	Medium	High
Consequence	Minor	Minor	Minor	Moderate
	Moderate	Minor	Moderate	Major
	Major	Moderate	Major	Major

4.4 DATA SOURCES

Catch and effort data were sourced from the Department of Agriculture, Forestry and Fisheries (Branch: Fisheries) (DAFF) record for the years 2000 to 2016. 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 DAFF and from the *South Africa, Namibia and Mozambique Fishing Industry Handbook 2017 (45th Edition).*

4.5 ASSUMPTIONS AND LIMITATIONS

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

- The official governmental record of fisheries data was used to display fishing catch and effort relative to the proposed project area. These data are derived from logbooks that are completed by skippers, and it is assumed that there will be a proportion of erroneous data due to mistakes in the capturing of these data into electronic format. The proportion of erroneous data is estimated to be up to 10% of the total dataset and would be primarily related to the accurate recording or transcription of the fishing position (latitude and longitude). Where obvious errors in the reporting of fishing positions were identified these were excluded from the analysis.
- In assessing the impact of the proposed exclusion zone on fishing operations, calculations of potential loss of catch were based on the assumption that fisheries would be excluded from the area of primary interest for well drilling. In practice, the footprint of the impact would be an area of ~0.785 km^2 extending around the drilling unit (during the operational phase) and around each of the resulting wellheads. Our approach is likely to be an overestimate of the potential impact on fishing operations which in reality could continue within certain portions of the area of primary interest for well drilling.
- Normal fishing operations could be undertaken within the area of primary interest for well drilling at the same time as drilling operations are underway, provided the safe navigational limits prescribed are adhered to.

4.6 ASSESSMENT OF POTENTIAL IMPACTS ON FISHERIES

4.6.1 EXCLUSION FROM FISHING GROUND

4.6.1.1 Large Pelagic Longline Sector

In the KwaZulu-Natal region, pelagic longline vessels are prohibited from setting fishing gear within 20 nautical miles of the coastline, however, the sector does operate within much of the area covered by ER236 and both the northern and southern areas of interest for well-drilling. Figure 4-2 shows the distribution of catch at a resolution of 60 by 60 nm[4]. Over the period 2000 to 2016, the sector directed 2.0% and 2.3% of their total recorded effort in the vicinity of the northern and southern areas of interest, respectively[5]. Catch recorded within the areas amounted to 2.3% (46.5 t) and 2.0%, (39.2 t) of the total catch, respectively.

Well drilling is expected to take up to 71 days per well to complete, therefore the potential impact of fishing exclusion would be of short-term duration during the operational phase. The potential impact of exclusion from fishing ground during the operational phase of well drilling and the impact is considered to be local in extent (limited to the area of interest) and of short-term duration. This impact is considered to be fully reversible as the 500 m safety zone around the drilling unit would be temporary and applicable only during the operational phase of the activity and abandonment of the wellhead would not impact pelagic fishing operations.

The scale of the impact is determined to be small, since the catch recorded within the impacted area falls in the 1 – 5 % category (see Section 4.2.1). The frequency with which the sector operates in the proposed project area is high, as the fishery operates almost continuously all-year-round. The likelihood of the impact occurring is inevitable.

The magnitude of the impact on the fishery is considered to be medium and of overall minor significance due to the low sensitivity of the fishery to the short-term duration of the impact. The objective of mitigation would be_to further reduce the disruption of fishing activities on site and to minimise the likelihood of fishing gear entanglements with the drill unit and wellheads. Mitigation measures are recommended in the Table 4-10 and a summary assessment, before and after mitigation is included in Table 4-11. The implementation of the above-mentioned mitigation measures is considered essential; however, the residual impact is considered to remain of **minor** significance.

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[4] A 60 nautical mile grid is an appropriate resolution for reporting catch and effort for the large pelagic longline sector since fishing lines may be up to 100 km in length. Furthermore, since the gear is not static, lines drift with surface water currents thereby increasing the total area covered by fishing gear.

[5] Fishing positions are reported where the deployment of a line commences. Lines with start positions outside the areas of interest for well drilling may extend into these areas. In an attempt to include all affected fishing areas, we have tallied catch and effort reported within and beyond the boundaries of the areas of interest to a distance of 40 km.

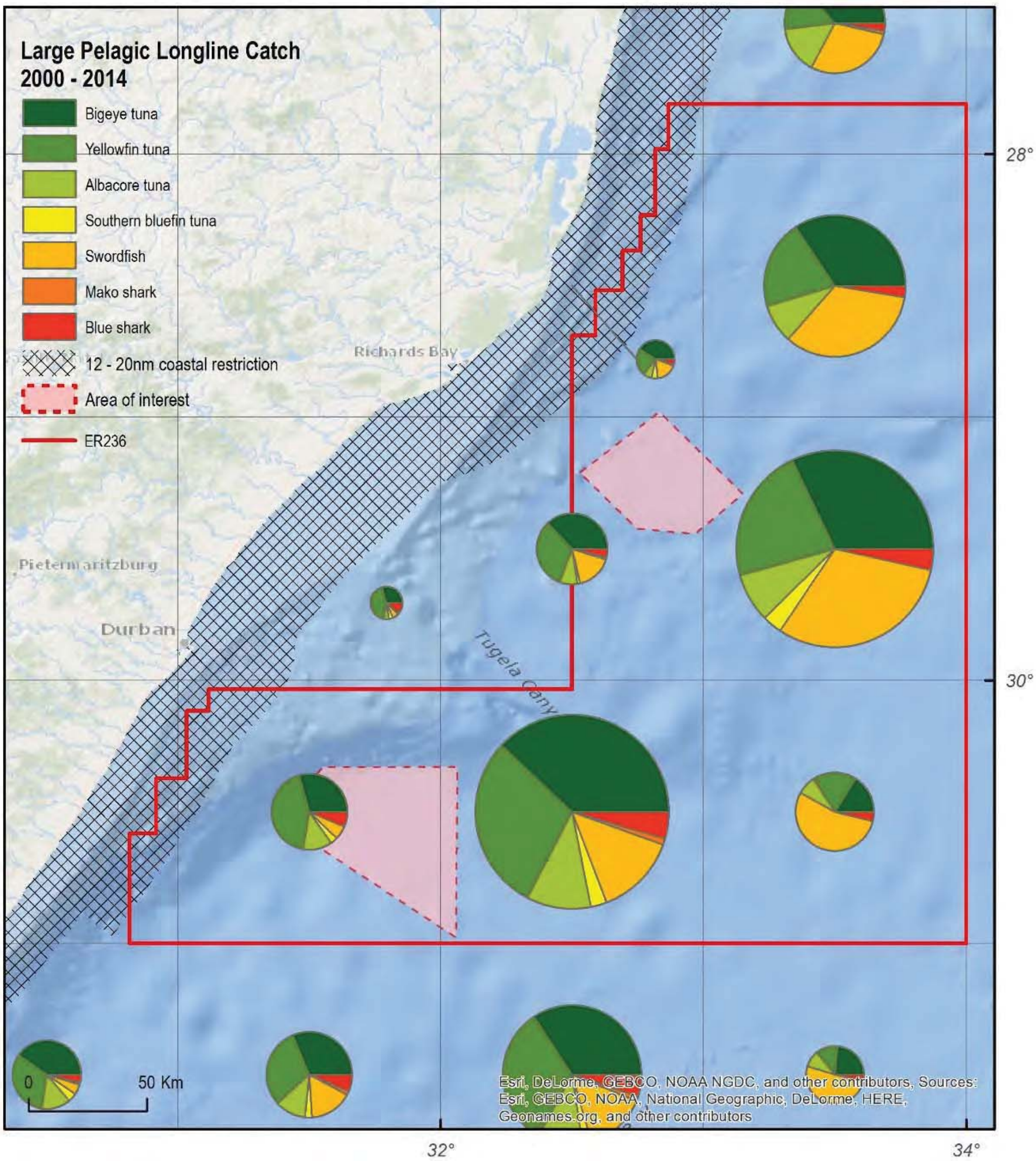

Figure 4-1: Spatial distribution of catch of large pelagic species by the longline fishing sector (2000 – 2014) in relation to ER236 and the proposed areas of interest for well-drilling.

Table 4-10: Measures proposed for mitigating the impact of the proposed drilling programme on the exclusion of the large pelagic longline fishery from fishing grounds.

No.	Mitigation measure	Classification
1	Prior to the commencement of drilling activities the following key stakeholders should be consulted and informed of the proposed drilling programme (including navigational co-ordinates of well location, timing and duration of proposed activities) and the likely implications thereof (specifically the 500 m exclusion zone and the movements of support vessels): Fishing industry / associations: SA Tuna Association Other key stakeholders: HydroSAN, South African Maritime Safety Association, Ports Authority and the Department of Agriculture, Forestry and Fisheries Vessel Monitoring, Control and Surveillance Unit in Cape Town. These stakeholders should again be notified at the completion of drilling when the drilling unit and support vessels are off location.	Avoid / reduce at source

No.	Mitigation measure	Classification
2	Request, in writing, the HydroSAN to broadcast a navigational warning via Navigational Telex (Navtext) and Cape Town radio for the duration of the activity. Distribute a Notice to Mariners prior to the commencement of the drilling operations. The Notice to Mariners should give notice of (1) the co-ordinates of the well location, (2) an indication of the proposed drilling timeframes, (3) an indication of the 500 m safety zone around the drilling unit, and (4) provide details on the movements of support vessels servicing the drilling operation. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.	Avoid / reduce at source
3	The lighting on the drilling unit 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.	Abate on site
4	Notify any fishing vessels at a radar range of 24 nm from the drilling unit via radio regarding the safety requirements around the drilling unit.	Abate on site
5	Abandoned well location must be surveyed and charted by HydroSAN	Avoid / reduce at source
6	Implement a grievance mechanism in case of disruption to fishing or navigation.	Abate off site

Table 4-11: Assessment table summarising the impact characteristics of an exclusion zone on the large pelagic longline fishery (before and after mitigation).

Exclusion from Fishing Ground		
Large Pelagic Long-line Sector		
Characteristic	**Impact**	**Residual Impact**
Extent	Local	Local
Duration	Short-term	Short-term
Scale	Small	Small
Reversibility	Fully reversible	
Loss of resource	Low	
Magnitude	Medium	
Sensitivity/Vulnerability/Importance of the Resource/Receptor	Low	Low
Significance of Impact	**Minor**	**Minor**

4.6.1.2 Traditional Linefish Sector

Exploration Rights Area 236 lies within Management Zone C (KwaZulu-Natal region) of the linefish sector. The spatial distribution of fishing activity along in the vicinity of the areas of interest for well-drilling is indicated in Figure 4-2 as catch reported on a 5 by 5 nautical mile grid resolution. Fishing effort is generally concentrated in areas of greatest reef habitat such as Richards Bay / Port Durnford, Rocky Bay / Scottburgh and Shelly Beach / Port Edward areas. There is no evident overlap of either of the proposed areas of interest for well-drilling with the areas fished by the linefish sector. Fishing effort lies at least 10 km and 35 km inshore of the northern and southern areas of interest, respectively[6]. There is no impact expected on the fishery.

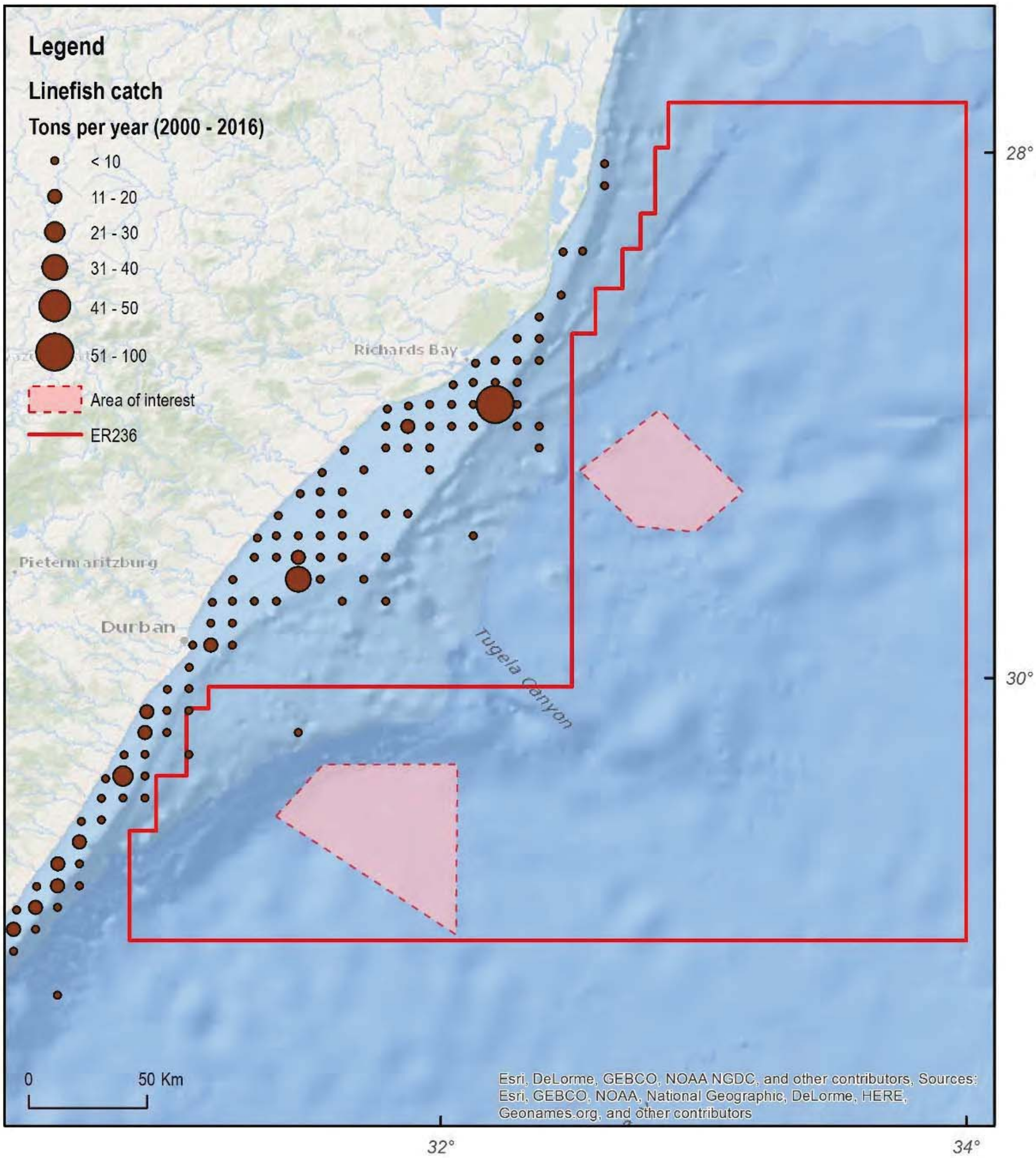

Figure 4-2: Spatial distribution of linefish catch (2000 – 2016) in relation to ER236 and the proposed areas of interest for well-drilling.

[6] Minimal amounts of catch recorded on the outer edge of the Tugela Bank approximately 10 km from the southern area of interest are thought to be insignificant.

4.6.1.3 Crustacean Trawl Sector

The KwaZulu-Natal prawn trawl fishery comprises two components; a shallow-water (5-40 m) fishery on the Thukela Bank and at St Lucia in an area of roughly 500 km^2, and a deep-water fishery (100-600 km) between Cape Vidal in the north and Amanzimtoti in the south, covering an area of approximately 1700 km^2 along the edge of the continental shelf. Catch of each of 36 different species is recorded on a trawl by trawl basis, referenced with the trawl start position, and fishing effort is recorded as the duration of the tow. Figure 4-3 shows the spatial distribution of fishing effort at a grid resolution of 5 by 5 nautical minutes in relation to the areas of interest for well drilling. There is no evident overlap of either of these areas with the shallow- or deep-water prawn trawl grounds. Fishing grounds are situated at least 35 km and 30 km inshore of the northern and southern areas of interest, respectively[7]. There is no impact expected on the crustacean trawl fishery.

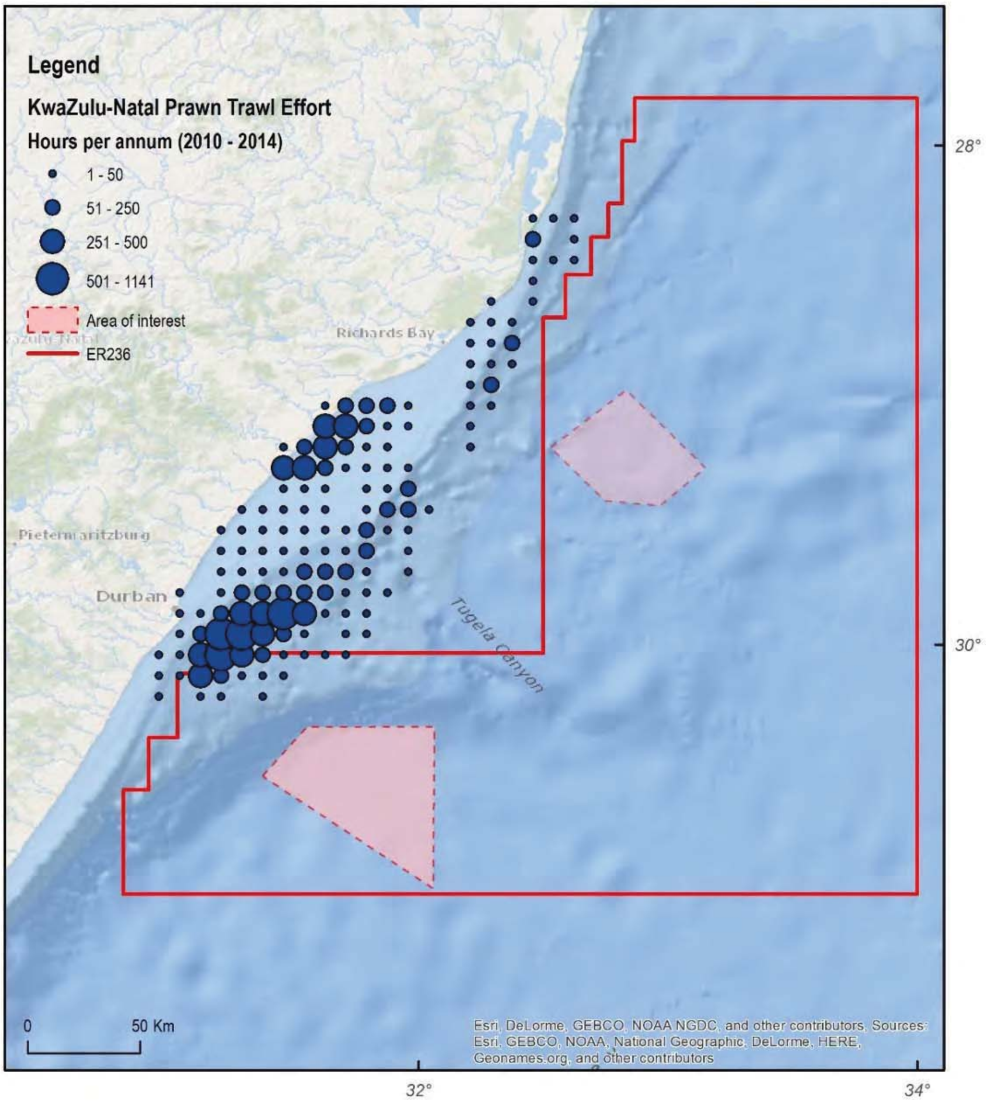

Figure 4-3: Spatial distribution of catch landed by the KwaZulu-Natal prawn trawl fishery (2010 – 2014) in relation to ER236 and the proposed areas of interest for well-drilling.

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7 The maximum fishing depth is recorded as 600m. Although a minimal number of fishing records are shown in waters deeper than 600m this is likely attributable to inaccurately recorded fishing positions.

4.6.2 POTENTIAL IMPACT OF UNPLANNED EMISSIONS AND DISCHARGES

The results of the oil spill modelling (ERM, 2018b) are summarised below:

Scenario 1: 795 m^3 of marine diesel spilled at the well site due to a vessel collision

- Diesel fuel oil is likely to travel predominantly in a southwest direction with the strong influence of the Agulhas Current parallel to the coastline
- Slick of thickness >1.0 µm (thickness for smothering of aquatic biota), travels as a narrow swath up to 320 km south-westwards from the source, remaining beyond 20 km of the coastline,
- diesel remains on the sea surface for 1 - 2 days before oil dispersion and spreading reduces the oil thickness below the minimum smothering thickness of 1.0 µm within 50 km of the point of release,
- the maximum total area contacted at some point by a smothering thickness >1.0 µm ranges from 1,684 km^2 to 2,848 km^2,
- the maximum area affected by a >10 µm slick was 243 km^2,
- no significant shoreline oiling (<100 g/m^2) occurred, although under the worst case scenario oil would reach the shore within 2-3 days potential affecting a 200 - 370 km stretch of shoreline between Durban and East London,
- the probability of the spill reaching the shoreline is low (3-15%).

Scenario 2: 7-day to 20-day blow-out of crude oil at a rate of 750 – 1050 m^3 per day

- once the oil surfaces it generally moves in a south-westerly direction as a widening plume due to the prevailing near-surface currents and winds,
- shoreline oiling would occur within 4 to 7 days but the oil reaching the shoreline would be below the significant impact threshold of for wildlife injury (100 g/ m^2)
- the maximum total area contacted at some point by a smothering thickness >1.0 µm was 4386 km^2,
- slicks >10 µm thickness did not occur,
- maximum area of DAH above the 5 ppb threshold for worst case oiling ranged from 324 km^2 to 5,874 km^2.

Scenario 3: Riser disconnect and loss of 270 to 530 m^3 of base oil

- the surface oil patch travels as a narrow swath up to 305 km south and south-westwards from the source before weathering into a thinner sheen, remaining beyond 25 km of the coastline,
- base oil remains on the sea surface for 1 - 2 days before weathering into a thin sheen within 25 km of the point of release,
- the maximum total area contacted at some point by a smothering thickness >1.0 µm ranged from 873 km^2 to 2,046 km^2,
- slicks >10 µm thickness did not occur,
- no significant shoreline oiling (<100 g/m^2) occurred, although under the worst case scenario oil would reach the shore within 2-3 days potential affecting a 48 - 205 km stretch of shoreline between Durban and East London,
- potential shoreline impacts under the worst case scenario extend over a maximum distance of 320 km,

- 6 - 15% probability of the spill reaching the coastline,
- surface plumes of elevated TSS would extend up to 6 km down-current of the point of release under maximum average current conditions, but concentrations remain below the threshold of 35 mg/l,
- particles in the solid fraction of the LTOBMs did not settle on the seabed within a 10 km radius of their release.

Summaries of the vessel collision diesel spill, the crude oil blowout and the LTOBM release model results are found in Table 4-13.

Table 4-12: Assessment table summarising the impact characteristics of an exclusion zone on the large pelagic longline fishery (before and after mitigation).

Drilling location	Most Shoreline Oiling (km)	Shortest Time to Contact Shoreline (days	Probability of Shoreline Contact	Max. Area Above 1 µm Threshold (km²)	Max. Area Above 10 µm Threshold (km²)
Diesel spill modelling results summary – Scenario 1					
N1	205	2.6	7.5%	1.896	210
N2	366	3.3	3.3%	1,684	147
S	336	2.8	15%	2.848	243
Crude oil blowout modelling results summary – Scenario 2a					
N1		4.25		401	0
S		5.00		3049	0
Crude oil blowout modelling results summary – Scenario 2b					
N1		5.75		695	0
S		5.25		4386	0
Riser disconnect modelling results summary – Scenario 3					
N1	205	2.5	8.3%	1,232	0
N2	48	3.2	5.8%	873	0
S	49	2.7	15%	2,046	0

Oil spilled in the marine environment will have an immediate detrimental effect on water quality. Most of the toxic effects are associated with the monoaromatic compounds and low molecular weight polycyclic hydrocarbons (also referred to as Dissolved-phase Aromatic Hydrocarbons - DAH, as these are the most water-soluble components of the oil. Though oil is generally described as a hydrophobic liquid with low solubility, components of the oil may dissolve with a sufficiently high solubility limit to cause an acute toxicological response (i.e. narcosis) given sufficient concentration and duration of exposure. Oil is most toxic in the first few days after the spill, losing some of its toxicity as it begins to weather and emulsify. The time of year during which a large spill takes place will significantly influence the magnitude of the impact on plankton and pelagic fish eggs and larvae. Should the spill coincide with a major spawning peak, it could result in severe mortalities and consequently a reduction in recruitment (Baker *et al.* 1990). Sensitivity of fish eggs and larvae are primarily associated with exposure to fresh (unweathered) oils (Teal & Howarth 1984), with little mortality attributable to exposure to weathered product (Neff 1991). Because of their mobility and ability to avoid floating oil masses and the associated hydrocarbon contamination, adult pelagic fish are considered less at risk from exposure to oil spills than benthic or inshore species. For the diesel and base oil scenarios, DAH may exceed an acute toxic threshold of 5 ppb beneath the slick primarily in the top 3 m. This provides opportunity for fish and marine organisms to avoid the plume if mobile. However, in the blowout cases, a much larger area could be impacted by DAH as tiny liquid droplets of oil rise from the sea floor and travel at different rates, as a function of their droplet size. Where the droplets travel, dissolve concentrations may be released into the water column until only very insoluble components remain.

Detrimental effects on marine life and fishing operations would be likely where oil thickness is above the minimum smothering thickness threshold of 1.0 µm. The results of the modelling of different unplanned discharge scenarios indicate the possibility that nearshore, inshore and offshore areas marine environment eastward of East London could be affected by the release of hydrocarbons. An uncontained blowout of crude oil from the potential well-drilling sites would result in an impact of regional extent, as would the release of marine diesel and LTOBMs.

Spawning areas are mostly located inshore (that is on the shelf from the coastline to approximately the 200 m depth contour. The coastal bays and estuarine environments are critical nursery areas for the commercial stocks most, if not all commercial, small-scale and recreational fisheries. In the unlikely event that a crude oil blowout were to occur, the resulting oil slick would not reach the spawning areas for hake, sardine, anchovy and horse mackerel situated on the southern Agulhas Bank nor the additional hake spawning areas thought to exist further eastward off the continental shelf. Spawn products of linefish species would be affected within the important nursery ground offered by the Natal Bight. The affected area would not be expected to coincide with squid spawning grounds situated along the inshore areas of the south coast (refer to section 3.2). The impact of the marine diesel and LTOBM release scenarios would likely only affect spawn product of linefish species advected by the Agulhas Current through the affected area *en route* to the Agulhas Bank and inshore nursery areas.

The results of the marine fauna impact assessment undertaken by Pisces Environmental Consulting (Pty) Ltd (2018) suggest that the impact of a large-scale crude oil blowout on benthic invertebrates would be of minor consequence and of overall minor significance. The magnitude of the impact on pelagic fish and larvae would be of moderate consequence and of overall minor significance with effective clean-up operations. The impact was considered to be partially reversible.

The magnitude of the potential impact of the release of marine diesel and/or LTOBMs on benthic invertebrates was assessed to be of minor significance due to the low sensitivity of the benthic macrofauna (the receiver) to oiling. The impact on pelagic fish and larvae was considered to be of overall minor significance (effective clean-up operations could reduce the significance to a negligible level). The impact was considered to be fully reversible.

The well drilling areas coincide with the grounds of only one main commercial fishery (large pelagic longline); however the area contaminated by a well blowout would coincide with fishing grounds of many of the other fisheries. Regardless of any potentially toxic effect on fish species, operators of fishing vessels would avoid polluted areas that contaminate fishing gear and affect cooling water intake systems. Based on the affected area, this could affect the operations of the large pelagic longline, traditional linefish, south coast rock lobster and crustacean trawl.

Since the result of the modelling indicates that no significant shoreline oiling would occur, it is unlikely that the unplanned release of hydrocarbons would affect the operations of the nearshore fisheries.

Mitigation measures would require the implementation of an oil spill contingency plan including specialised well capping facilities for uncontained blow-outs. In addition to the best industry practices, the following measures are recommended to manage the impacts associated with blow-outs. Table 4-16 shows the impact ratings on all fisheries of the potential effects of a marine diesel spill, LTOBM release and large scale oil spill.

Table 4-13: Measures proposed for mitigating the impact on the fishing industry of unplanned release of hydrocarbons

No.	Mitigation measure	Classification
1	As far as possible, and whenever the sea state permits, attempt to control and contain the spill at sea with suitable recovery techniques to reduce the spatial and temporal impact of the spill.	Abate on and off site
2	Dispersants have different levels of toxicity and dilute rapidly to below acute toxicity thresholds. Dispersants should therefore be used cautiously and as far as practicable those with known low toxic levels used so as to minimise potential effects on marine life. Use dispersants only with the permission of DEA and/or DAFF.	Abate on and off site

Table 4-14: Assessment table summarising the impact characteristics of unplanned emissions and discharges on all fisheries sectors (before and after mitigation).

Marine diesel release – Scenario 1		
Pelagic Fisheries		
Characteristic	**Impact**	**Residual Impact**
Type of impact	Direct	Direct
Likelihood	Medium	Medium
Consequence	Moderate	Moderate
Reversibility	Parially Reversible	
Loss of resource	Low	
Sensitivity/Vulnerability/Importance of the Resource/Receptor	Medium	Medium
Risk Significance	**Moderate**	**Minor**
Demersal Fisheries		
Type of impact	Direct	Direct
Likelihood	Medium	Medium
Consequence	Moderate	Moderate
Reversibility	Parially Reversible	
Loss of resource	Low	
Sensitivity/Vulnerability/Importance of the Resource/Receptor	Medium	Medium
Risk Significance	**Moderate**	**Minor**
Crude oil blowout – Scenario 2		
Pelagic Fisheries		
Characteristic	**Impact**	**Residual Impact**
Type of impact	Direct	Direct
Likelihood	Low	Low
Consequence	Moderate	Moderate
Reversibility	Parially Reversible	
Loss of resource	Low	
Sensitivity/Vulnerability/Importance of the Resource/Receptor	Medium	Medium
Risk Significance	**Minor**	**Minor**

Demersal Fisheries		
Type of impact	Direct	Direct
Likelihood	Low	Low
Consequence	Moderate	Moderate
Reversibility	Parially Reversible	
Loss of resource	Low	
Sensitivity/Vulnerability/Importance of the Resource/Receptor	Medium	Medium
Risk Significance	**Minor**	**Minor**
LTOBM release – Scenario 3		
Pelagic Fisheries		
Characteristic	Impact	Residual Impact
Type of impact	Direct	Direct
Likelihood	Low	Low
Consequence	Moderate	Moderate
Reversibility	Parially Reversible	
Loss of resource	Low	
Sensitivity/Vulnerability/Importance of the Resource/Receptor	Medium	Medium
Risk Significance	**Minor**	**Minor**
Demersal Fisheries		
Type of impact	Direct	Direct
Likelihood	Low	Low
Consequence	Moderate	Moderate
Reversibility	Parially Reversible	
Loss of resource	Low	
Sensitivity/Vulnerability/Importance of the Resource/Receptor	Medium	Medium
Risk Significance	**Minor**	**Minor**

5 FINDINGS AND RECOMMENDATIONS

The potential impacts of the drilling programme that relate specifically to the fishing industry have been identified as 1) exclusion from fishing ground and 2) the impact on fishing operations, stock spawning and recruitment resulting from unplanned hydrocarbon emissions.

A 500 m safety zone would be enforced around the drilling unit for the duration of drilling operations, resulting in a temporary (short-term) exclusion from fishing ground. Following installation of a wellhead, a permanent restriction on the setting of demersal fishing gear, trawling and anchoring would be enforced to a distance of 500 m around each wellhead, due to the physical obstruction presented by the wellhead. 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 project site. Only the pelagic longline sector is likely to be excluded from fishing areas as these vessels operate within much of the area covered by both the northern and southern areas of interest for well-drilling. Due to the nature of the gear used by the fishery however, the impact is only likely to occur whilst the drilling unit is on site (short-term) and not on abandonment of the wellhead. The magnitude of the impact on the sector is considered to be medium and of overall minor significance. Although a number of other fisheries sectors operate off the KwaZulu-Natal coastline, due to the distance of the proposed drilling operation offshore, none of these is expected to be affected by the exclusion zone around the drilling unit or wellhead.

Mitigation would not reduce this effect but the following communications strategy is considered essential. Prior to the commencement of drilling activities the South African Tuna Association should be informed of the navigational co-ordinates of the proposed drilling location, 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. Other key stakeholders should be notified prior to commencement and on completion of drilling once the drilling unit and support vessels are off location. These include; the South African Navy Hydrographic Office (HydroSAN), South African Maritime Safety Association (SAMSA), Ports Authority, Ezemvelo KZN Wildlife and the Department of Agriculture, Forestry and Fisheries Vessel Monitoring, Control and Surveillance Unit in Cape Town (Vessel Monitoring System Unit)).

Table 5-1: Assessment table summarising the impact characteristics of the proposed well-drilling project on fisheries sectors (before and after mitigation).

	Identfied Potentail Impact			
	Exclusion from drill site		Oil Spill	
	Impact	Residual Impact	Impact	Residual Impact
Demersal trawl	No impact		Moderate	Minor
Mid-water trawl	No impact		Moderate	Minor
Demersal long-line	No impact		Moderate	Minor
Small pelagic purse-seine	No impact		Moderate	Minor
Large pelagic long-line	Minor	Minor	Moderate	Minor
Tuna pole	No impact		Moderate	Minor
Traditional linefish	No impact		Moderate	Minor
West coast rock lobster	No impact		Moderate	Minor
South coast rock lobster	No impact		Moderate	Minor
Squid Jig	No impact		Moderate	Minor
Crustacean trawl	No impact		Moderate	Minor
Netfish	No impact		Moderate	Minor
Oyster	No impact		Moderate	Minor
Exploratory redeye jig	No impact		Moderate	Minor
Fisheries research surveys	No impact		Moderate	Minor
Kosi Bay traditional trap	No impact		Moderate	Minor
Subsistence linefishery	No impact		Moderate	Minor
Inshore invertebrate fishery	No impact		Moderate	Minor
Shore-based linefish	No impact		Moderate	Minor
Estuarine linefish	No impact		Moderate	Minor
Boat-based linefish	No impact		Moderate	Minor
Cast net fishery	No impact		Moderate	Minor
Drag net fishery	No impact		Moderate	Minor
Hoop net fishery	No impact		Moderate	Minor
Inshore invertebrate fishery	No impact		Moderate	Minor

Table 5-2: Measures proposed for mitigating the impact of the proposed drilling programme on fishing sectors.

Sector: Large Pelagic Long-line		
No.	**Mitigation measure**	**Classification**
1	Prior to the commencement of drilling activities the following key stakeholders should be consulted and informed of the proposed drilling programme (including navigational co-ordinates of well location, timing and duration of proposed activities) and the likely implications thereof (specifically the 500 m exclusion zone and the movements of support vessels): Fishing industry / associations: SA Tuna Association Other key stakeholders: HydroSAN, SAMSA, Ports Authority and the Department of Agriculture, Forestry and Fisheries Vessel Monitoring, Control and Surveillance Unit in Cape Town (Vessel Monitoring System in particular), Ezemvelo KZN Wildlife. These stakeholders should again be notified at the completion of drilling when the drilling unit and support vessels are off location.	Avoid / reduce at source
2	Request, in writing, the HydroSAN to broadcast a navigational warning via Navigational Telex (Navtext) and Cape Town radio for the duration of the activity. Distribute a Notice to Mariners prior to the commencement of the drilling operations. The Notice to Mariners should give notice of (1) the co-ordinates of the well location, (2) an indication of the proposed drilling timeframes, (3) an indication of the 500 m safety zone around the drilling unit, and (4) provide details on the movements of support vessels servicing the drilling operation. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.	Avoid / reduce at source
3	The lighting on the drilling unit 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.	Abate on site
4	Notify any fishing vessels at a radar range of 24 nm from the drilling unit via radio regarding the safety requirements around the drilling unit.	Abate on site
5	Abandoned well location must be surveyed and accurately charted with the HydroSAN office.	Avoid / reduce at source
6	Implement a grievance mechanism in case of disruption to fishing or navigation.	Abate off site

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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.

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APPENDICES

APPENDIX 1: DECLARATION OF INTEREST

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

Environmental Impact Assessment for a proposed exploration drilling campaign witin block ER236 off the East Coast of South Africa: Fisheries Specialist Study

Specialist:	Capricorn Marine Environmental (Pty) Ltd		
Contact person:	Sarah Wilkinson and David Japp		
Postal address:	P.O. Box 50035, Waterfront, Cape Town		
Postal code:	8001	Cell:	0827289673
Telephone:	0214256226	Fax:	0214251994
E-mail:	sarah@capfish.co.za		
Professional affiliation(s) (if any)	SACNASP		

Project Consultant:			
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

4.2 The specialist appointed in terms of the Regulations_

I, Sarah Wilkinson, declare that --

General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Capricorn Marine Environmental (Pty) Ltd

Name of company (if applicable):

03 September 2018

Date:

Contents of this report in terms of Regulation GNR 982 of 2014	Cross-reference in this report
(a) details of— the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page i and Appendix 2
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix 1
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.2
(cA) an indication of the quality and age of base data used for the specialist report;	Section 4.4
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 3 and Section 4
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 3.3.5 and Section 4.6
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4.1 to 4.3
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 4.1
(g) an identification of any areas to be avoided, including buffers;	N/a
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 3 and Section 4
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4.5
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 4.6 and Section 5
(k) any mitigation measures for inclusion in the EMPr;	Section 4.6
(l) any conditions for inclusion in the environmental authorisation;	Section 5
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 5
(n) a reasoned opinion— (i) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 5
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	-
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	-
(q) any other information requested by the competent authority.	-

APPENDIX 2: SPECIALIST CVS

CURRICULUM VITAE: SARAH WILKINSON

Date of Birth: 20 June 1979

Nationality: Dual nationality South African and British

Academic Record:

2001 University of Cape Town, South Africa; BSc Honours (Phycology and Agricultural Physiology)

1998 – 2000 University of Cape Town; BSc (Oceanography and Botany)

Employment Record:

2003 – current CapFish SA (Pty) Ltd/ CapMarine (Pty) Ltd

2002 Institute of Plant Conservation, University of Cape Town

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

Membership of Professional Bodies: SA Council for Natural Scientific Professions (SACNASP) *115666*

Key Experience:

- Specialist assessments on the impact of offshore hydrocarbon exploration and installation activities on fisheries in South Africa, Namibia, Mozambique and Angola (as a requirement of the Scoping and EIA requirements for these projects).
- Management of Marine Mammal Observer (MMO), Passive Acoustic Monitoring (PAM) and Fisheries Liaison Services for seismic survey vessels in the offshore sub-Saharan region as well as the development of an in-house MMO training programme;
- Co-ordination of observer deployments for the South African Offshore Resources Observer Programme (OROP), Indian Ocean Tuna Commission and International Commission for the Conservation of Atlantic Tunas (IOTC/ICCAT) Regional Observer Programmes;
- Analysis of data collected via the OROP and generating outputs relating to fisheries-specific catch and effort. Recent projects include spatial analyses on catch and fecundity of commercial species on behalf of the South African Deepsea Trawling Industry Association (SADSTIA);
- GIS analysis of the South African fishery catch and effort for use in the Offshore Marine Protected Area Project - contracted by the South African National Biodiversity Institute (SANBI);
- Analysis of trawl industry data and preparation of an information brochure detailing the extent of trawl grounds (conducted on behalf of SADSTIA);
- A desktop review on the effects of trawling on benthic habitat in part fulfilment of the Marine Stewardship Council certification of the South African hake trawl fishery;
- Independent consulting for Moody Marine Ltd for Marine Stewardship chain of custody audits and pre-assessments for selected Southern African fisheries;
- JNCC-certified Marine Mammal Observer.

Specialist Fisheries Impact Assessments – South Africa:

Petroleum Geo-Services: EMP for the Proposed 2D and 3D Speculative Seismic Surveys of the South and East Coast of South Africa (April 2017) Client: SLR Environmental Consulting (South Africa) (Pty) Ltd.

Sungu Sungu Oil (Pty) Ltd: Environmental Impact Assessment for a 3D Seismic Survey in the Pletmos Basin, southern Cape (March 2017) Client: SRK Consulting South Africa (Pty) Ltd.

PetroSA (Pty) Ltd: Proposed Development of the E-BK Area in Offshore Licence Block 9, South Coast, South Africa (Feb 2017) Client SRK Consulting (Pty) Ltd.

ACER Africa Environmental Consultants: Proposed marine telecommunications cable system (ACE) cable system, West Coast, South Africa (September 2016) Client: MTN (Pty) Ltd.

Spectrum ASA: Western Approaches 2D Speculative Seismic Survey, South Africa (Jan 2016). Client SLR Environmental Consulting (Pty) Ltd

Schlumberger: Proposed 3D Seismic Survey off the East Coast of South Africa (November 2015). Client: Environmental Resources Monitoring (ERM).

Rhino Oil & Gas Exploration South Africa (Pty) Ltd: Proposed Exploration Activities in Offshore Licence Blocks 3617 and 3717 off the South-West Coast of South Africa (November 2015) Client: CCA Environmental (Pty) Ltd

Sunbird Energy Pty Ltd: Proposed Development of the Ibhubesi Gas Project in Block 2A off the West Coast of South Africa (December 2014) Client: CCA Environmental Pty Ltd

Thombo Petroleum Ltd: Proposed Exploration Well Drilling within Licence Block 2B off the West Coast of South Africa (December 2014) Client: CCA Environmental Pty Ltd

Cairn South Africa Pty Ltd: Proposed Exploration Well Drilling within Licence Block 1 off the West Coast of South Africa (November 2014) Client: CCA Environmental Pty Ltd

Shell South Africa Upstream B.V.: Proposed Exploration Drilling in the Orange Basin Deep Water Licence Area off the West Coast of South Africa (July 2014) Client: CCA Environmental (Pty) Ltd

PetroSA Pty Ltd: Proposed Exploration Right to Undertake Hydrocarbon Exploration Surveys in Licence Block 3A/4A off the West Coast of South Africa (July 2014) Client: Jeffares & Green Engineering and Environmental Consulting

OK Energy Ltd: Proposed Exploration Activities in the Northern Cape Ultra-deep Licence Area in the Orange Basin, West Coast of South Africa (January 2014) Client: CCA Environmental (Pty) Ltd

Spectrum ASA: Proposed Speculative 2D Seismic Survey within the Orange Basin, West Coast, South Africa (October 2013) Client: CCA Environmental Pty Ltd.

Impact Africa Ltd: Proposed Oil and Gas Exploration Activities in the West Bredasdorp Area, off the South Coast of South Africa (January 2013) Client: CCA Environmental Pty Ltd

Sasol Exploration and Production International: Environmental Management Plan for a proposed 2D Seismic Survey Programme in the Durban and Zululand Basins off the East Coast of South Africa (November 2012) Client: CCA Environmental Pty Ltd

Total Exploration Pty Ltd: Interim Lease-Specific Environmental Management Programme Report for conducting 2D Seismic Survey, Drop Coring Sampling and Sonar Bathymetry, Outeniqua South Area, South Coast, South Africa (October 2012).

Petroleum Geo-Services: Proposed Speculative 2D Seismic Survey, South and East Coasts, South Africa (September 2012).

PetroSA (Pty) Ltd: Proposed 3D Seismic Survey in Block 1, West Coast, South Africa (February 2008 (updated September 2012))

BHP Billiton Petroleum: Interim Lease-Specific Environmental Management Programme Report For Conducting Seismic Surveys In Petroleum Licence Block 3B/4B Situated Off The West Coast Of South Africa (June 2012)

Thombo Petroleum Ltd: Proposed 3D Seismic Survey in Block 2B, West Coast, South Africa (June 2012)

CGG Veritas: Proposed 2D Speculative Survey, East Coast, South Africa (June 2012)

The Petroleum Oil & Gas Corporation of South Africa (Pty) Ltd: Proposed Seismic and Controlled Source Electromagnetic Surveys within License Block 5/6, South-West Coast, South Africa (July 2011)

Sungu Sungu Petroleum (Pty) Ltd: Mid-Orange Basin, West Coast South African Offshore 2D Seismic Survey (June 2011) Client: Nzumbululo Heritage Solutions South Africa

The Petroleum Oil and Gas Corporation of South Africa (Pty) Ltd: Proposed 3D Seismic Surveys within Block 9, South Coast, South Africa (February 2011)

Bayfield Energy Limited: Proposed 2D Seismic Survey in the Pletmos Inshore Area, South Coast, South Africa (2010)

Silver Wave Energy: Proposed 2D Seismic Survey within Blocks 2931C, 2931D, 2932A and 2932C, East Coast, South Africa (April 2010)

CNR International Limited: Proposed Exploration Well Drilling Programme within Block 11B/12B, South Coast, South Africa (March 2010)

The Petroleum Oil and Gas Corporation of South Africa (Pty) Ltd: Proposed Development of The F-O Gas Field in Petroleum Licence Block 9 (May 2008 (updated February 2009 and October 2010))

PetroSA Pty Ltd: Proposed Exploration Well Drilling Programme: Block 1, West Coast, South Africa (December 2009)

The Petroleum Agency of South Africa Geophysical Survey MD170/SWIR2008, South-West Indian Ridge (October 2008)

OVD: Proposed 3D Seismic Survey in Block 2B, West Coast, South Africa (January 2009)

Forest Oil Exploration: Assessment of the Impact of the Proposed Ibhubesi Gas Field Development (Block 2A) on the South African Fishing Industry (January 2007 (Revised April 2007))

Petroleum Agency SA: Geophysical Survey around the South African Continental Margin (September 2007)

The Petroleum Oil and Gas Corporation of South Africa (Pty) Ltd: Assessment of the Impact of the Proposed *South Coast Gas* Development on the South Coast Fishing Industry (March 2005 (revised September 2005, February 2006 and August 2006))

Specialist Fisheries Impact Assessments - Namibia:

Spectrum Geo Ltd: Proposed 3D Seismic Survey offshore northern Namibia: Baseline Study and Environmental Impact Assessment (June 2017) Client: SLR Environmental Consulting (Namibia) (Pty) Ltd.

GALP: Environmental Impact Assessment for Namibia 3D Seismic Survey for PEL 82 (May 2017) Client: ERM Iberia, S.A.

GALP: Environmental Impact Assessment for Namibia 3D Seismic Survey for PEL 83 (May 2017) Client: ERM Iberia, S.A.

Spectrum Geo Ltd: Proposed 2D Seismic Survey offshore southern Namibia: Baseline Study and Environmental Impact Assessment (October 2016) Client SLR Environmental Consulting (Namibia) (Pty) Ltd.

LK Mining (Pty) Ltd: Proposed Prospecting Licence within EPL 5965, Hottentots Bay, Namibia – Baseline Study and Environmental Impact Assessment on Fisheries (April 2016) Client: SLR Environmental Consulting (Pty) Ltd

Xaris Energy Namibia (Pty) Ltd: Proposed Construction and Operation of a LNG Facility in Walvis Bay, Namibia (July 2015) Client: Enviro Dynamics Namibia (Pty) Ltd

Murphy Ludertiz Oil Co. Ltd: Proposed Exploration Well Drilling in Licence Blocks 2613A and 2613B off the coast of Namibia (July 2015) Client: SLR Environmental Consulting Nambia (Pty) Ltd

Belton Park Trading 127 (Pty) Ltd: Basic Assessment Process for Marine Sediment Sampling Activities in Diamond Mining Concession Areas 2C-5C West Coast, South Africa (January 2015) Client CCA Environmental (Pty) Ltd

Nabirm Energy Services (Pty) Ltd: Proposed 2D Seismic Survey in Licence Block 2113A, Walvis Basin, off the coast of Namibia (January 2015) Client: CCA Environmental Pty Ltd

Shell Namibia Upstream B.V.: Environmental Impact Assessment for a 3D seismic survey within Namibian blocks 2913A & 2914B (PEL 39) (July 2014) Client: ERM South Africa (Pty) Ltd.

Tullow Oil: Proposed 3D and 2D Seismic Surveys in Licence Blocks 2012B, 2112A and 2113B, Walvis Basin, off the coast of Namibia (October 2013) Client: CCA Environmental Pty Ltd.

Enigma Oil & Gas Exploration: Proposed 2D Seismic Survey within Licence Block 2714B, Namibia (September 2013) Client: CCA Environmental Pty Ltd.

Spectrum ASA: Proposed Speculative 2D Seismic Survey in the Lüdertiz and Walvis Basins off the Coast of Namibia (August 2012).

Proposed 2D / 3D Seismic Surveys in Licence Block 2914B within the Orange Basin, Namibia. Signet Petroleum Ltd; December 2011

Enigma Oil & Gas Exploration: Proposed 3D Seismic Survey within Namibian Licence Blocks 2312A, 2312A, 2412A North and 2412B North (August 2011)

HRT Oil & Gas, UNX Energy Corp: Namibian Offshore 3D Seismic Acquisition: Specialist Report on Fisheries and Potential Interactions (January 2011)

CGG Veritas: Namibian Offshore Survey (August 2008)

Specialist Fisheries Impact Assessments – Angola:

Fish and Fisheries Distribution in Offshore Hydrocarbon Concession Areas off Southern Angola (September 2012) Client: Lwandle Technologies

Offshore Angolan Seismic Program: Fish, Fisheries and Interactions with Oil And Gas in Northern Angola (2007) Client: Ulwandle Consulting

Other Documents Prepared and Publications:

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

Description and evaluation of hake-directed trawling intensity on benthic habitat in South Africa: Prepared for the South African Deepsea Trawling Industry Association in fulfilment of the Marine

Stewardship Council certification of the South African hake-directed trawl fishery; condition 4. December 2005. Fisheries & Oceanographic Support Services cc, Cape Town

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

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

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

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

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

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

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

Environmental Monitoring Close-Out Reports for various Seismic Surveys: Client list available on request.

CURRICULUM VITAE: DAVID WILLIAM JAPP

Family Name	:	Japp
First name	:	David William
Civil Status	:	Single
Date and Place of birth	:	Kabwe, Zambia (30th June 1956)
Nationality	:	South African
Residence (Postal)	:	P.O. Box 22717, Scarborough, Cape Town 7975
Telephone / Fax	:	+27 21 7801101
Mobile	:	+27 82 788 6737
Businesses and Address	:	Capricorn Marine Environmental (Pty) Ltd
		Unit 15 Foregate Square, FW de Klerk Boulevard, Cape Town, South Africa

Education:

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

Membership of Professional Bodies :	SA COUNCIL FOR NATURAL SCIENTIFIC PROFESSIONS (SACNASP) Reg. No. 400208/12
Facilitation:	Conflict resolution course completed in 1996.
Resource Economics (2006) :	Introductory course completed (Rhodes University MBA)
Business Management :	Management of Company and Corporate structures – formed own companies since 1996 (*FOSS cc*, CapFish cc, CapMarine (SA) Pty Ltd
Project Development:	Various see below
Present Position :	International and Regional Consultant and Director CapFish cc
Years Within the Firm :	20 years
Key Qualifications :	Masters Degree in Fisheries Science
	Entrepreneur – Company development
	Project Management and Appraisal
	Environmental Impact Assessments (marine)
	Marine Stewardship Council (MSC) assessor

Relevant Professional Experience (selected)

a) South Africa : Head of Offshore Research - *Sea Fisheries Research Institute* (SFRI / DAFF) undertook 8 years of direct research and training of sea staff on biomass surveys as Chief Scientist;
b) Consultant has worked extensively in the region including South Africa, Mozambique, Angola, Mozambique, Uganda, Namibia, Kenya, Tanzania and West Indian Ocean Fisheries Sectors since 1990;
c) Masters degree in Ichthyology and Fisheries Science including aquaculture
d) Benguela System : Benguela Current Commission (BCC) Strategic Impact Assessment (SEA)
e) World Bank fisheries consultant – development and implementation of fisheries and aquaculture components : 1) MACEMP (Tanzania); 2) KCDP (Kenya) 3) SWIOFP (West Indian Ocean) 4) SWIOFish 1 (Current – WIO countries focus is Tanzania 5) LVEMP 2 (Lake Victoria)
f) Environmental Impact Assessment of the Aquaculture Development Zone in Mossel Bay (South Africa)

g) Scoping assessment and EIA of the potential for and Aquaculture Development Zone in Saldanha Bay, South Africa (pending)

Lake Victoria – field trip and overview of the "Source of the Nile" tilapia cage culture including provision of juvenile grow out and adult cage culture (conducted through LVEMP2 and the World Bank with the Lake Victoria Fisheries Organization and NAFIRI)

Date	Location	Company& reference person	Position	Description
Regional and International Experience				
1987 to 1996	South Africa	Sea Fisheries Research Institute and Marine and Coastal Management (Ref. Dr Augustyn)	Head of Offshore Research	Fisheries Research head – Management of Offshore resources including Demersal, Large Pelagic and Small Pelagic resources. Ref. Is Dr J. Augustyn (Depr Agriculture, Forestry and Fisheries, Cape Town. (johann@sadstiia.co.za)
1996 to 2016	Cape Town South Africa	Capricorn Fisheries Monitoring and Fisheries & Oceanographic Support Services	Consultant and Director	Many consulting projects with the FAO, World Bank, Benguela Current LME. Also developed the Regional Observers Programme. Specialization : Fisheries Management and Research ref. Xavier Vincent : xvincent@worldbank.org
2008 - 2009	Namibia	Benguela Current Commission	Consultant	State of Stock review – Benguela Current Commission. Hashali Hamukuaya (hashali@benguelacc.org)
2009 to 2016 (ongoing)	Mombasa - Kenya)	Development of the Kenya Coastal Development Project (KCDP) – World Bank and FAO	Fisheries Expert	Thus was an ongoing consultancy (5 years) developing the KCDP with the World Bank Team – project participation was on near continuous basis until project effectiveness in June 2011. Portfolio : Fisheries Management, Research and Development : Ref is AG. Glauber – World Bank Office, Dar Es Salaam aglauber@worldbank.org
2007 to 2012	Tanzania and Zanzibar	Appraisal of the Tanzania *Marine and Coastal Environment Project* (MACEMP) – World Ban k / FAO	Fisheries Expert	Ongoing consultancy every six months to Tanzania – Project appraisal and Mid-Term review. Presently project is winding down and new MACEMP two phase being developed. Portfolio : Fisheries Management, Research and Development : Ref is AG. Glauber – World Bank Office, Dar Es Salaam aglauber@worldbank.org
2005 to 2016	Kenya, Tanzania, Mozambique and IOC countries	World Bank and FAO – Fisheries Expert Project development and implementation (South West Indian Ocean Fisheries Shared Growth and Governance Project (SWIOFish 1)	Fisheries Expert	Consultancy up to 2015 – fisheries components – development and implementation. Specialization : Fisheries Management and Development. Ref ; AJ Glauber aglauber@worldbank.org
2004 to 2007	IOTC	IOTC	Fisheries Experts	Provision of trained tuna tagging technicians and Cruise leaders for the IOTC Tuna Tagging programme (Note: this was done through CapFish under contract to MEP). Ref : Gerard Dominique (IOTC) . gerard.domingue@iotc.org
2009 to ongoing	IOTC	IOTC	Fisheries Observers	Provision of Observers for Transhipment vessels (ongoing) Gerard Dominique (IOTC) . gerard.domingue@iotc.org
2004 to 2014	FAO	FAO – Jessica Sanders / Ross Shotton	Fisheries Expert	Consultancy undertaken for technical works relating to 1. South West Indian Ocean Fisheries 2. Regional (Indian Ocean) fisheries reporting (catches) 3. Observer training (Madagascar) 4. Development of High Sea Guidelines (FAO)

2009 to 2016	FAO and WWF	FAO - and WWF USA	Fisheries Expert	Fishery Improvement Process – fishery pre-assessments for MSC and follow-up. Contract is current. Portfolio : Fisheries Management and Development. Domingos Gove (dgove@wwfesarpo.org
2013	Angola Namibia (BCC)	ACP Fish 2	Fisheries Expert	Development of horse mackerel national plans and transboundary management (BCC)
2004-current	International	MSC Assessments – RSA Hake, Tristan da Cunha lobster, Russian Pollock and numerous pre-assessments and peer rev.	Fisheries expert : P2 and P3	Full assessments through CABs (Moody, Intertek, MRAG, Tavel, FCI, BV, Acroura)

Major Projects - Summary

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

Aquaculture-Specific

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

Fishery Economics and Governance :

- Preparation of sector economic reports for RSA fisheries to assist with rights allocation procedures: Hake Longline, Inshore Trawl (Hake and Sole), Shark longline, South Coast Rock Lobster, Patagonian Toothfish, Deepwater Fishery, Midwater Trawl & Hake Handline
- Economic Assessment of the Wetfish and Freezer Trawl apportionment of Hake in Namibia
- BCLME – Ecosystem Approach to Fisheries – Cost Benefit Analysis (March 2006)
- Review of the West Indian Ocean Tuna Fishery and Potential Opportunities and Options for the Development of the Port of Victoria (Seychelles) – Completed March 2008
- Assessment of economic loss due to hydrocarbon development – numerous ongoing projects, PetroSA, Forrest Oil west coast gas, CNR well drilling and many others.
- Value-Adding of Anchovy *Engraulis encrasicolus* in South Africa and potential for poverty relief.
- Governance of Kenya Fisheries – Consultancy and report prepared for IOC Smartfish programme (2011)

Other Projects Completed :

- Comparative assessment (socio-economic) of trawl and Longline fisheries in Benguela Region (BCLME).
- Evaluation of deepwater groundfish fishery in South West Indian Ocean 2004/2005 – FAO.
- Review of Ecosystem Approach to Fisheries Management for South African Fisheries (BCLME – MCM project).
- Review of South Africa's Indian Ocean fisheries – management and policy.
- Development of the South West Indian Ocean Fisheries Programme Implementation Plan – World Bank / FAO – Completed March 2007 (preparation of Project Documents for World Bank and GEF).
- Ecosystem Approach to Fisheries – BCLME project LMR/EAF/03/01 – Contracted consultant including Risk Assessments and Benefit Cost estimators for EAF – Ongoing as of 5 November 2006.

- Indian Ocean Tuna Tagging Programme – 2004-2007 collaborative programme with McAllister Elliot and Partners (UK) and Capricorn Fisheries Monitoring cc (RSA)
- Indian Ocean Tuna Commission – 2009 Collaborative programme between MRAG (UK) and Capricorn Fisheries Monitoring cc for the provision of Observers and monitors on Indian Ocean tuna transhipment vessels.
- International Commission for the Conservation of Atlantic Tunas – 2007 Collaborative programme between MRAG (UK) and Capricorn Fisheries Monitoring cc for the provision of Observers and monitors on Atlantic tuna transhipment vessels.
- Domestic contract awarded (Sept. 2007) for the monitoring of national and high seas tuna longline fisheries, all trawl and small pelagic sectors and deep water rock lobster trap fisheries
- FAO / World Bank – review of Tanzania MACEMP programme with WB surveillance team (2008, 2009, 2010, 2011, 2012)
- FAO / World Bank – initiation of the South West Indian Ocean Fisheries Project – development of Project Implementation Manual and Observer programme (Mombasa – 2007- 2009)
- FAO / World Bank – Project development – Kenya Coastal Development Project (KCDP) – Ongoing 2010-2015
- FAO – EAF-Nansen Programme – Mozambique Sofala Bank Shrimp fishery management plan – development of effort management recommendations.
- FAO World Bank – Lake Victoria LVEMP project. Project management and support to Lake Victoria Fisheries Organisation.
- FAO World Bank – South West Indian Ocean Fisheries Shared Growth and Governance Project (Tanzania effective from June 2015)
- ICCAT Tuna Transhipment Programme Observers – CapFish project executant (2009 to 2012) – ongoing
- IOTC Tuna Transhipment Programme Observers – CapFish project executant (2010-2012) – ongoing
- Tuna Longline – RSA Observer deployments – 100% coverage on Deep Water Fishing Nations (RSA) – Project executant (2007-2012) – on-going
- IOTC Tuna – review of economic reports undertaken by WWF (10 country reports and summaries) – May 2012

Marine Stewardship Council :

- Numerous fisheries assessed including Russian Pollock, Tristan da Cunha Lobster, RSA Hake and many others including many pre-assessments
- Fishery Improvement projects ongoing : Kenya Lobster, Mozambique shallow and deepwater shrimp and Namibian Hake assessment
- Assessment of the PNA Western Pacific tuna Fishery (current September 2016)
- Review of the Mozambique linefish fishiery (MSC preassessment) and SASSI assessment (WWF – South Africa) (Current September 2016)

Lecturing and Document Preparation:

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

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