PROPOSED SPECULATIVE 2D AND 3D SEISMIC SURVEYS OFF THE SOUTH AND WEST COAST OF SOUTH AFRICA: ENVIRONMENTAL MANAGEMENT PROGRAMME

Prepared for: Petroleum Geo-Services

SLR

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EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 BACKGROUND

In October 2018, Petroleum Geo-Services (PGS) submitted an application for a Reconnaissance Permit to the Petroleum Agency SA (PASA) in order to apply to undertake a multi-client speculative two-dimensional (2D) and three-dimensional (3D) seismic surveys in a number of petroleum licence blocks off the South and West Coast of South Africa (see Figure A). The application was made in terms of Section 74 of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA).

Actual survey commencement would ultimately depend on a permit award date and the availability of a survey vessel. Furthermore, the duration of the surveys would be dependent on whether the 2D and 3D surveys are run concurrently or at a different times. It is, however, anticipated that the surveys would take in the order of five months to complete. Should the permit be awarded, it is anticipated that the proposed surveys could commence within Q1 or Q2 2019, with the balance of the survey resuming at the end of December 2019.

PASA has requested that in order for PGS to obtain a Reconnaissance Permit, it must prepare a 'plan for managing potential environmental impacts that may result from the proposed operation and notify consult with affected parties' and submit it to them for consideration by the Minister of Mineral Resources. For this application, the plan is referred to as an Environmental Management Programme (EMP)[1].

PGS has appointed SLR Consulting (South Africa) (Pty) Ltd (SLR) to compile this EMP and undertake the required public participation process for the proposed speculative seismic surveys.

1.2 OPPORTUNITY TO COMMENT

This report has been distributed for public review and comment **from 15 November to 15 December 2018** in order to provide Interested and Affected Parties (I&APs) and authorities with an opportunity to comment on any aspect of the proposed project. Copies of the full report have been made available on the SLR website (at http://slrconsulting.com/za/slr-documents/).

All I&APs registered on the project database have been informed of the release of the report and where the full report can be reviewed. In order to be included in the final EMP, any comments on the EMP should be forwarded directly to SLR at the address, telephone/fax numbers or e-mail address shown below by no later than **15 December 2018**.

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[1] There is currently no legislated environmental process prescribed for a Reconnaissance Permit application. A legislated Environmental Impact Assessment process in terms of the National Environmental Management Act, 1998 (No. 107 of 1998) is thus not required.

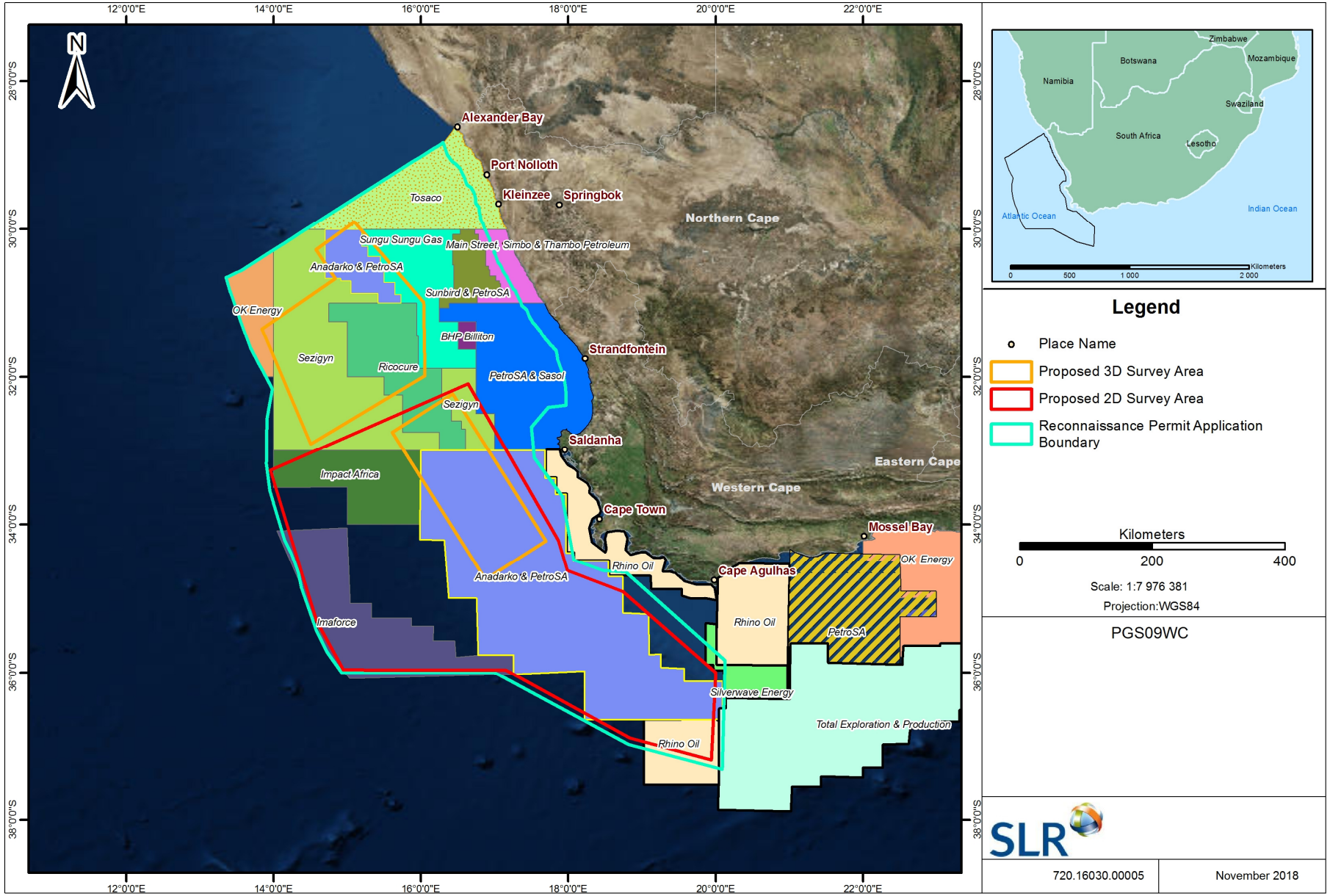

FIGURE A: LOCALITY OF THE PROPOSED RECONNAISSANCE PERMIT AREA (BLUE OUTLINE).

2. EMP PROCESS

2.1 OBJECTIVES

The objectives of the EMP process are:

- To provide a reasonable opportunity for I&APs to be consulted on the proposed project;
- To ensure that potential key environmental issues and impacts that could result from the proposed project are identified;
- To assess potential impacts related to the proposed project;
- To present appropriate mitigation or optimisation measures to minimise potential impacts or enhance potential benefits; and
- Through the above, to ensure informed, transparent and accountable decision-making by the relevant authorities.

2.2 PUBLIC PARTICIPATION PROCESS

The public participation tasks as part of the EMP process include the following:

1. A preliminary I&AP database has been compiled of authorities and organs of state (local and regional), Non-Governmental Organisations, Community-based Organisations and other key stakeholders (including the fishing industry, overlapping and neighbouring users with delineated boundaries in the oil/gas and mining industries). This database was compiled using databases of previous studies in the area. A total of 134 I&APs have been included on the project database to date (refer to Appendix 1.1).
2. Advertisements announcing the proposed project and the availability of the Draft EMP for public review and comment were placed in four regional newspapers (Namakwalander, Plattelander, The Cape Times, and Die Burger Western Cape);
3. I&APs were notified of the availability of the Draft EMP for a review and comment period between 15 November to 15 December 2018. A copy of the Executive Summary was included with the notification letter; and
4. PGS will also directly notify all existing exploration right and technical cooperation permit holders and applicants in the proposed Reconnaissance Permit area.

2.3 SPECIALIST STUDIES AND REPORT COMPILATION

Two specialist studies were undertaken to address the key issues that required further investigation, namely the impact on fishing and marine fauna. The specialist studies involved the gathering of data relevant to identifying and assessing environmental impacts that may occur as a result of the proposed project. These impacts were then assessed according to pre-defined rating scales.

The specialist studies and other relevant information were then integrated into this EMP. Many of the issues associated with seismic surveys are generic in nature and have been assessed based on previous seismic survey programmes off the coast of South Africa and the Generic EMPr prepared for seismic surveys in South Africa. Recommendations proposed are based on specialist input and are in line with the Generic EMPr and the general principles of the Joint Nature Conservation Committee (JNCC) seismic guidelines. Information was incorporated into the EMP in order to ensure compliance with Section 39 and Regulation 52 of the MPRDA.

The EMP aims to present all information in a clear and understandable format and suitable for easy interpretation by authorities, I&APs and other key stakeholders (e.g. operator and contractors).

2.4 WAY FORWARD

After closure of the comment period, all written comments received from I&APs will be collated and submitted, together with the EMP, to PASA for consideration and for acceptance by the Minister of Mineral Resources in terms of the MPRDA.

3. PROJECT DESCRIPTION

This chapter provides general information on the proposed project, the general location of the proposed multi-client 2D and 3D speculative seismic surveys, and a description of typical seismic surveys.

3.1 GENERAL INFORMATION

3.1.1 Reconnaissance Permit Application

PGS as the applicant for the Reconnaissance Permit will also be the operator for the proposed project.

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3.1.2 Existing Permit and Right Holders (and Applicants)

The proposed Reconnaissance Permit area includes a number of licence blocks off the South and West Coasts of South Africa (see Figure A). As mentioned in Section 2.2, PGS is required to obtain written consent from the existing exploration right and technical cooperation permit holders and applicants within the proposed Reconnaissance Permit area in order to apply for this permit.

3.2 SEISMIC SURVEY

Seismic surveys are carried out during marine oil and gas exploration in order to investigate subsea geological formations. During seismic surveys high-level, low frequency sounds are directed towards the seabed from near-surface sound sources towed by a seismic vessel. Signals reflected from geological interfaces below the seafloor are recorded by multiple receivers (or hydrophones) towed in a single or multiple streamer. Analyses of the returned signals allow for interpretation of subsea geological formations.

For this investigation, PGS is proposing to undertake a multi-client speculative 2D and 3D seismic surveys. The Reconnaissance Permit area is approximately 290 299 km^2.

The proposed 2D survey would cover a single target area located roughly between Lamberts Bay in the north and Cape Agulhas in the south. The distance between the eastern boundary of the 2D survey area and the coast decreases from approximately 150 km offshore of Lamberts Bay to 65 km offshore of Cape Columbine and then reaches its closest point of more than 40 km offshore of the Cape Peninsula. From Cape Point the distance starts to increase again, ultimately reaching a distance of more than 120 km offshore of Cape Agulhas. The western extent of the survey area is located more than 350 km away from the coast. The total length of the survey would be between 2 000 and 8 000 km.

The proposed 3D surveys would cover two target areas:

- A northern 3D survey area located to the north of the proposed 2D survey area and situated approximately 200 km offshore of Klienzee to the north and Strandfontein to the south. At its closest point to the West Coast, the eastern boundary of this 3D survey area would be located approximately 150 km offshore, with the furthest western boundary located approximately 390 km offshore; and
- A southern 3D survey area which overlaps with the north-eastern portion of the proposed 2D survey area. This 3D survey area is located approximately 170 km offshore of Lambert's Bay to the north and more than 60 km offshore of the Cape Peninsula to the south. The furthest western boundary of this 3D survey area is located approximately 200 km offshore.

The total extent of the 3D survey data acquisition within both areas would be between 3 000 and 10 000 km^2.

Actual survey commencement would ultimately depend on a permit award date and the availability of a survey vessel. Furthermore, the duration of the surveys would be dependent on whether the 2D and 3D surveys are run concurrently or at a different times. It is, however, anticipated that the surveys would take in the order of five months to complete. Should the permit be awarded, it is anticipated that the proposed surveys could commence within Q1 or Q2 2019, with the balance of the survey then resuming at the end of December 2019.

PGS proposes to use a vessel similar to the *M/V Ramform Sovereign* (Plate 3.1) to acquire the seismic data for the proposed surveys. A support vessel would be commissioned as a "chase" boat. This vessel would be equipped with appropriate radar and communications to patrol the area during the seismic surveys to ensure that other vessels adhere to the safe operational limits. The chase boat would assist in alerting other vessels (e.g. fishing, transport, etc.) about the proposed survey and the lack of manoeuvrability of the survey vessel. The chase boat would also be required to perform logistics support to the survey vessel. Some of the basic specifications of the survey vessel are provided in the Table 3-1 below.

TABLE 3-1: VESSEL SPECIFICATIONS OF M/V RAMFORM SOVEREIGN.

Specification	*M/V Ramform Sovereign*
Call sign	C6CR8
Length	102.2
Draft	7.4m
Gross tonnage	13688
Max speed	18 knots in transit

The airgun and hydrophone array specifications are summarised in Table 3-2. In summary, a typical survey array would consist of 24 active guns with operating pressures of 2 000 pound-force per square inch (psi). The airgun sound source would be situated approximately 50 m behind the vessel at approximately 7 to 8 m below the surface. The single hydrophone steamer would be up to 12 km long. The streamer would be towed at a variable depth of 20 to 25 m and would not be visible, except for the tail-buoy at the far end of the streamer.

TABLE 3-2: AIRGUN AND HYDROPHONE ARRAY SPECIFICATIONS.

Airgun and hydrophone array specifications	*M/V Ramform Sovereign*
No. of active air guns	24
Nominal source pressure (typical)	2000 psi
Depth of airgun	7/8m
Distance of airgun behind vessel	50 m
Streamers (max)	12
No. of hydrophones	7
Streamer depth	20-25m

4. DESCRIPTION OF THE AFFECTED ENVIRONMENT

4.1 PHYSICAL OCEANOGRAPHY

The proposed survey areas lie within the southern zone of the Benguela Current region and is characterised by the cool Benguela upwelling system. The dominant southerly and south-easterly winds in summer drive the massive offshore movement of surface water, resulting in strong upwelling of nutrient-rich bottom waters. Nutrient-rich upwelled water enhances primary production, and the West Coast region consequently supports substantial pelagic fisheries. The South Atlantic Seamounts lie on and adjacent to the southern boundary of the Reconnaissance Permit Area. Seasonal association with Child's Bank (off Namaqualand) and Tripp Seamount (off southern Namibia and approximately 100 km north of the northern 3D survey area) occurs between October and June, with commercial catches often peaking in March and April.

4.2 BIOLOGICAL OCEANOGRAPHY

The Reconnaissance Permit Application area primarily falls into the Atlantic Offshore Bioregion, with the inshore portions overlapping with the South-western Cape and Namaqua Bioregions. Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The threat status of the benthic habitats within the survey areas are mapped by SANBI as Least Threatened.

The proposed survey areas lie within the influence of the Namaqua upwelling cell, and seasonally high phytoplankton abundance can be expected, providing favourable feeding conditions for micro-, meso- and macrozooplankton, and for ichthyoplankton.

The fish species likely to be encountered comprise primarily the large pelagic species (e.g. tunas, billfish and pelagic sharks), which migrate throughout the southern oceans, between surface and deep waters (>300 m). Most seabirds in the region reach highest densities offshore of the shelf break (200 to 500 m depth). The breeding areas are distributed around the coast with islands being especially important. The closest breeding islands are the Saldanha Bay islands, Dassen Island off Yzerfontein, Robben Island in Table Bay and Dyer Island off Danger Point, approximately 75 km east of the eastern border of the proposed 2D survey area. There is a further Cape Gannet breeding colony on Bird Island at Lambert's Bay, approximately 175 km east of the northern point of the 2D survey area. African Penguins nesting sites are at Dassen Island, Robben Island, Boulders beach in False Bay, Betty's Bay and Dyer Island.

In terms of large migratory cetaceans, the humpback and southern right whale are likely to be encountered year-round, with numbers in the Cape Columbine area highest between September and February, and not during winter as is common on the South Coast breeding grounds. Several other large whale species are also most abundant on the West Coast during winter: fin whales peak in May-July and October-November; sei whale numbers peak in May-June and again in August-October and offshore Bryde's whale numbers are likely to be highest in January-February.

There are a number of Cape fur seal colonies within the broader area including, amongst others Cliff Point, Bucchu Twins, Kleinzee (incorporating Robeiland), Strandfontein Point (south of Hondeklipbaai), Bird Island at Lamberts Bay and McDougall's Bay islands and Wedge Point.

4.3 HUMAN UTILISATION

Eight commercial fishing sectors could potentially be affected by the proposed survey operations. These include: demersal trawl, mid-water trawl, demersal long-line, small pelagic purse seine, large pelagic long-line, tuna pole, traditional line-fish, and South Coast rock lobster fishery.

A large number of vessels navigate along the South and West Coasts on their way around the southern African subcontinent. The majority of shipping traffic is located on the outer edge of the continental shelf. Thus, a high degree of shipping traffic is expected to occur in, and pass through, the proposed 2D and 3D survey areas.

Exploration for oil and gas is currently undertaken in a number of licence blocks off the West Coast. There is no current development or production from the South African West Coast offshore. A number of proposed prospecting areas for glauconite and phosphorite / phosphate are located off the West and South Coasts. The proposed survey areas overlap with a number of these. However, there is a limited degree of overlap with marine diamond mining concession areas.

5. IMPACT ASSESSMENT CONCLUSIONS

A summary of the assessment of potential environmental impacts associated with the proposed 2D and 3D seismic surveys is provided in Table 5-1.

In summary, the majority of the impacts associated with the proposed 2D and 3D seismic surveys would be of short-term duration and limited to the immediate survey area. As a result, the majority of the impacts are considered to be of **INSIGNIFICANT** to **MEDIUM** significance after mitigation.

The three key issues identified in this study relate to:

- The potential impact on marine mammals (physiological injury and behavioural avoidance) as a result of seismic noise;
- The potential impact on the fishing industry (vessel interaction, disruption to fishing operations and reduced catch) due to the presence of the survey vessel with its associated safety zone, potential fish avoidance of the survey area and changes in feeding behaviour; and
- The potential impact on fisheries research (vessel interaction and disruption to the research surveys) due to the presence of the survey vessel with its associated safety zone and fish distribution and behavioural patterns which could negatively affect the findings of these surveys.

Although most of the impacts on cetaceans are assessed to have **VERY LOW to LOW** significance with mitigation, the impact could be of much higher significance due to the limited understanding of how short-term effects of seismic surveys relate to longer term impacts. For example, if a sound source displaces a species from an important breeding area for a prolonged period, impacts at the population level could be more significant. In order to mitigate the potential impact on cetaceans it is recommended that the proposed seismic survey programme be planned to avoid they key cetacean migration and breeding period which is from the beginning of June to the end of November. In addition, to avoid encountering humpback whales that may still be moving through the area on their return migrations in December, and the fact that several of the large whale species are also abundant on the West Coast between September and February, it is recommended that the inshore portions of the seismic operations be scheduled in the late summer and early winter period (February - May). Various other measures are recommended to further mitigate the potential impact on cetaceans, including a 60-minute pre-watch period (visually and using PAM technology), 20-minute “soft-start” procedure, temporary termination of survey, etc.

With regards to cumulative and confounding long-term effects on cetaceans from continuous seismic surveys, it must be noted that despite the density of seismic survey coverage over the last 17 years, the Southern Right whale population along the South African coast is reported to be increasing by 6.5% per year and the Humpback whale population by at least 5% per annum. These increases have taken place over a time period when seismic surveying frequency has increased, suggesting that, for these two populations at least, there is no evidence of long-term negative change to population size as a direct result of seismic survey activities.

The potential impact on the fishing industry relates to the temporary exclusion of fishing vessels from important fishing grounds and the potential reduction in catch rates. With regards to temporary exclusion, the potential impact ranges from **VERY LOW** (small pelagic purse-seine and south Coast rock lobster) to **LOW** (mid-water trawl) and **MEDIUM** (demersal trawl, hake demersal long-line, large pelagic long-line and tuna pole) significance with mitigation. The proposed survey area does not overlap with the inshore West Coast rock lobster and netfish fishing grounds, thus, there would be **NO IMPACT** on these fishing sectors.

The potential impact of reduced catch rates across all fishing sectors active within the proposed survey areas has been rated as of **VERY LOW** significance after mitigation. If fish, however, avoid the survey area and / or

change their feeding behaviour it could have a more significant impact on the fishing industry. Research has, however, shown that behavioural effects are generally short-term with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound. Similarly, if there was any interaction between the seismic survey vessel and a fishery the significance of the impact could be higher. Thus it is important that PGS engage timeously with the fishing industry prior to and during the surveys. Regular communication with fishing vessels in the vicinity during surveying would minimise the potential disruption to fishing operations and risk of gear entanglements.

The potential impacts on the demersal trawl and the small pelagic acoustic surveys within the proposed survey area has been rated as of **VERY LOW** significance after mitigation. While the behavioural effects on fish are generally short-term (as noted above), should there be a spatial and temporal overlap between the proposed seismic surveys and the fisheries research surveys, the significance of the impact could be higher. Thus it is recommended that survey operations should, if possible, commence in the western portions of the proposed survey areas to avoid disruption of the planned demersal research trawl survey in January to mid-February 2019. It is further recommended that the portions of the survey areas inshore of the 1 000 depth contour should be surveyed from mid-February to May to avoid disruption of the planned small pelagic acoustic research surveys.

TABLE 5-1: SUMMARY OF THE SIGNIFICANCE OF POTENTIAL IMPACTS OF THE PROPOSED SPECULATIVE 2D AND 3D SEISMIC SURVEYS OFF THE WEST AND SOUTH COASTS OF SOUTH AFRICA.

Potential impact		Significance	
		Without mitigation	With mitigation
Normal seismic / support vessels and helicopter operation:			
Discharge/disposal to the sea		VL	**VL**
Accidental oil spill during bunkering / refuelling	In Port	Insignificant	**INSIGNIFICANT**
	Offshore	VL	**VL**
Noise from seismic and support vessel operations		VL	**VL**
Noise from helicopter operation		Insignificant to VL	**INSIGNIFICANT**
Impact of seismic noise on marine fauna:			
Plankton		VL	**VL**
Invertebrates	Physiological injury	VL	**VL**
	Behavioural avoidance	Insignificant(benthic invertebrates) - VL (squid)	**INSIGNIFICANT**
Fish	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Spawning and reproductive success	VL	**VL**
	Masking sound and communication	Insignificant	**INSIGNIFICANT**
	Indirect impacts	VL	**VL**
Non-diving seabirds	Physiological injury	Insignificant	**INSIGNIFICANT**
	Behavioural avoidance	Insignificant	**INSIGNIFICANT**
Diving seabirds	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Indirect impacts	Insignificant	**INSIGNIFICANT**

Potential impact		Significance	
		Without mitigation	With mitigation
Turtles	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Reproductive success	L	**VL**
	Masking sound and communication	Insignificant	**INSIGNIFICANT**
	Indirect impacts	Insignificant	**INSIGNIFICANT**
Seals	Physiological injury	VL	**VL**
	Behavioural avoidance	VL	**VL**
	Masking sound and communication	VL	**VL**
	Indirect impacts	Insignificant	**INSIGNIFICANT**
Mysticete Cetaceans	Physiological injury	M	**VL**
	Behavioural avoidance	L-M	**VL-L**
	Masking sound and communication	VL - L	**VL**
	Indirect impacts	Insignificant	**INSIGNIFICANT**
Odontocete Cetaceans	Physiological injury	L	**VL**
	Behavioural avoidance	VL-L	**VL**
	Masking sound and communication	L	**VL**
	Indirect impacts	VL	**VL**
Impact on other users of the sea:			
Fishing industry - Temporary exclusion from fishing grounds	Demersal trawl	M	**M**
	Mid-water trawl	L	**L**
	Demersal long-line	M	**M**
	Small pelagic purse-seine	VL	**VL**
	Large pelagic long-line	M	**M**
	Tune pole	M	**M**
	Traditional line-fish	Insignificant	**INSIGNIFICANT**
	South Coast rock lobster	VL	**VL**
	West Coast rock lobster and netfish	NO IMPACT	
- Reduced catch rates	All fishing sectors	L	**VL**
	Fisheries research	L	**VL**
Marine transport routes		M	**L**
Marine prospecting, mining, exploration and production	Prospecting and mining	VL	**VL**
	Exploration and production	VL	**VL**
Job creation and business opportunities		*VL (positive)*	***VL (POSITIVE)***
H=High M=Medium L=Low VL=Very low		All impacts are negative, unless stated otherwise	

SLR is of the opinion that based on the findings of the EMP, (potential impacts generally of **VERY LOW** to **MEDIUM** significance after mitigation) and the transient nature of the proposed seismic surveys, a positive decision should be made by DMR (or delegated authority) in this regard.

5.1 RECOMMENDATIONS FOR MITIGATION

5.1.1 Compliance with EMP and Marpol Standards

- All phases of the proposed project (including pre-establishment phase, establishment phase, operational phase, and decommissioning and closure phase) must comply with the actions listed in the Environmental Management Programme presented in Chapter 7. In addition, the seismic and support vessels must ensure compliance with the MARPOL 73/78 standards.

5.1.2 Permit/Exemption Requirements

- In terms of the Marine Living Resources Act, 1998 (No. 18 of 1998) it is illegal for any vessel to approach or remain within 300 m of whales within South African waters without a permit or exemption. Thus, if the operator or seismic contractor are not able to comply with this restriction, an application should be made to DEA for a permit or exemption.

5.1.3 Communication with Key Stakeholders

- Prior to survey commencement, PGS should consult with the managers[2] of the DAFF research survey programmes to discuss their respective survey and survey programmes and the possibility of altering the exploration programme in order to minimise or avoid disruptions to both parties;
- Prior to survey commencement the following key stakeholders should be consulted and informed of the proposed survey activity (including navigational co-ordinates of the survey area, timing and duration of proposed activities) and the likely implications thereof:
  - > Fishing industry / associations: SA Tuna Association, SA Deep-Sea Trawling Industry Association (SADSTIA), Fresh Tuna Exporters Association, SA Hake Longline Association (SAHALLA), South African Tuna Long-Line Association (SATLA), South African Pelagic Fishing Industry Association (SAPFIA), SA Commercial Linefish Association and South Coast Rock Lobster Association; and
  - > Other key stakeholders: DAFF, Port Captains, South African Maritime Safety Authority (SAMSA) and South African Navy Hydrographic office, Control and Surveillance Unit in Cape Town (Vessel Monitoring System Unit) and other prospecting / exploration right holders.

  These stakeholders should again be notified at the completion of surveying when the survey vessel and support vessels are off location.
- The operator must request, in writing, the South African Navy Hydrographic office to release Radio Navigation Warnings and Notices to Mariners throughout the seismic survey period. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey areas, (2) an indication of the proposed survey timeframes and day-to-day location of the survey vessel, and (3) an indication of the 500 m safety zones and the proposed safe operational limits of the survey vessel. These notices should be distributed timeously to fishing companies and directly onto vessels where possible;
- An independent onboard FLO that is familiar with fisheries operational in the area must be appointed for the duration of the survey. The FLO should provide a fisheries facilitation role to identify and

[2] Deon Durholtz (DeonD@nda.agric.za) and Janet Coetzee (JanetC@nda.agric.za).

communicate with fishing vessels in the area to reduce the risk of gear interaction between fishing and survey activities. The FLO should:

> report on vessel activity daily;
> advise on actions to be taken in the event of encountering fishing gear;
> provide back-up on-board facilitation with the fishing industry and other users of the sea; and
> set up a daily electronic reporting routine to keep key stakeholders informed of survey activity and progress and fisheries, environmental issues.

In addition to the above, the FLO should assist in the identification of current fishing target areas to, where possible, allow for the adjustment of the survey plan to accommodate fishing.

- Any fishing vessels target a radar range of 12 nm from the survey vessel should be called via radio and informed of the navigational safety requirements around the survey vessel;
- Ongoing notification is to be undertaken throughout the duration of survey with the submission of daily reports (via email) indicating the vessel's location to key stakeholders, as appropriate;
- Any dispute arising with other right holders should be referred to DMR or PASA for resolution; and
- Marine mammal incidence data and seismic source output data arising from the survey should be made available, if requested, to the Marine Mammal Institute, DEA, DAFF and PASA for analyses of survey impacts in local waters.

5.1.4 Vessel Safety

- The survey vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident;
- Collision prevention equipment should include radar, multi-frequency radio, foghorns, etc. Additional precautions include:
  > A support / chase vessel with FLO familiar with the fisheries expected in the area;
  > The existence of an internationally agreed 500 m safety zone around the survey vessels;
  > Cautionary notices to mariners; and
  > Access to current weather service information.
- The vessels are required to fly standard flags, lights (three all-round lights in a vertical line, with the highest and lowest lights being red and the middle light being white) or shapes (three shapes in a vertical line, with the highest and lowest lights being balls and the middle light being a diamond) to indicate that they are engaged in towing surveys and are restricted in manoeuvrability, and must be fully illuminated during twilight and night; and
- Report any emergency situation to SAMSA.

5.1.5 Emissions, Discharges, into the Sea and Solid Waste

- Ensure adequate maintenance of diesel motors and generators to minimise emissions to the atmosphere;
- Route deck and machinery space drainage to a separate drainage system (oily water catchment system) for treatment to ensure compliance with MARPOL (15 ppm);
- Ensure all process areas are bunded to ensure drainage water flows into the closed drainage system;

- Use drip trays to collect run-off from equipment that is not contained within a bunded area and route contents to the closed drainage system;
- Use low toxicity, biodegradable detergents during deck cleaning to further minimise the potential impact of deck drainage on the marine environment;
- Ensure adequate maintenance of all hydraulic systems and frequent inspection of hydraulic hoses;
- Undertake spill management training and awareness of crew members of the need for thorough clean-up of any spillages immediately after they occur, as this would minimise the volume of contaminants washing off decks;
- Initiate an on-board waste minimisation system;
- Ensure on-board solid waste storage is secure;
- Ensure that waste (solid and hazardous) disposal onshore is carried out in accordance with the appropriate laws and ordinances; and
- Prepare a project specific Emergency Response Plan and Shipboard Oil Pollution Emergency Plan for the proposed seismic survey, which defines the organisational structure and protocols that would be implemented to respond to any incident (including accidental oil / fuel spills) in a safe, rapid, effective and efficient manner.

5.1.6 Offshore Bunkering

- Offshore bunkering should not be undertaken in the following circumstances:
  - Within 50 nm of the coast;
  - Wind force and sea state conditions of 6 or above on the Beaufort Wind Scale;
  - During any workboat or mobilisation boat operations;
  - During helicopter operations;
  - During the transfer of in-sea equipment; and
  - At night or times of low visibility.
- Support vessels must have the necessary spill response capability to deal with accidental spills in a safe, rapid, effective and efficient manner; and
- Crew must be trained in spill management.

5.1.7 Job Creation and the Generation of Direct Revenues

- The use of local companies for support services should be promoted as far as possible.

5.1.8 Vessel Lighting

- Lighting on board survey vessels should be reduced to the minimum safety levels to minimise stranding of pelagic seabirds on the survey vessels at night. All stranded seabirds must be retrieved and released during daylight hours.

5.2 MITIGATION RECOMMENDATIONS SPECIFIC TO SEISMIC SURVEYS

5.2.1 Survey Timing and Scheduling

- The seismic survey should be undertaken outside of the key cetacean migration and breeding period which extends from the beginning of June to the end of November.
- As no seasonal patterns of abundance are known for odontocetes occupying the proposed study area, a precautionary approach to avoiding impacts throughout the year is recommended;
- Survey operations can occur between January to end of May (subject to permit award date and vessel availability);
- For the inshore portions of the proposed survey areas, the following is recommended:
  - As several of the large whale species would be abundant on the West Coast between September and February, the inshore portions between Cape Point (approximately 34° 21'S) and Strandfontein (approximately 31° 45'S) of the seismic operations should be planned to be undertaken in late summer and early winter (February - May).
  - Survey operations should, if possible, commence in the western portions of the proposed survey areas to avoid disruption of the planned demersal research trawl survey in January to mid-February 2019. For the portions of the of the survey areas inshore of the 1 000 m depth contour, there must be simultaneous operational planning in place to avoid disruption of the planned small pelagic acoustic research surveys.

5.2.2 Equipment

- 'Turtle-friendly' tail buoys should be used by the survey contractor or existing tail buoys should be fitted with either exclusion or deflector 'turtle guards'.

5.2.3 Seismic Survey Procedures

- PAM technology
  - > The survey vessel must be fitted with PAM technology, which detects animals through their vocalisations. As the survey is taking place in waters deeper than 1 000 m depth where sperm whales and other deep-diving odontocetes are likely to be encountered, the use of PAM 24-hours a day is highly recommended. As a minimum, PAM technology must be used during the 30-minute pre-watch period and when surveying at night or during adverse weather conditions and thick fog.
  - > The PAM hydrophone streamer should ideally be towed behind the airgun array to minimise the interference of vessel noise, and should be fitted with two hydrophones to allow directional detection of cetaceans.
  - > In order to avoid unnecessary delays to the survey programme, it is recommended that a spare PAM cable and sensor are kept onboard should there be any technical problems with the system. However, if there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision/infra-red binoculars must be used at night while PAM is being repaired.
- ;

- "Soft-start" procedure, pre-watch period and airgun firing
  - > A "soft-start" procedure of a minimum of 20 minutes' duration must be implemented when initiating airgun tests (a single or a number of airguns at full power)[3] and / or seismic surveying. This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance.
  - > "Soft-starts" should be delayed until such time as the area is clear of seabirds (diving), turtles, seals or cetaceans. In the case of turtles and cetaceans the "soft-start" procedure should not begin until after the animals depart the 500 m exclusion zone or 30 minutes after they are last seen. In the case of small cetacean (<3 m in overall length) and seals, which are often attracted to survey vessels, the normal "soft-start" procedures should be allowed to commence, if after a period of 30 minutes small cetaceans or seals are still within 500 m of the airguns for at least a 20-minutes duration. The MMO should monitor small cetacean behaviour during "soft-starts" to determine if the animals display any obvious negative responses to the air-guns and gear or if there are any signs of injury or mortality as a direct result of seismic shooting operations.
  - > All breaks in airgun firing of longer than 20 minutes must be followed by a 60-minute pre-shoot watch and a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. In order to facilitate a more effective timing of proposed operations when surveying in deeper waters, the 60-minute pre-shoot watch can commence before the end of the survey line (whilst the airguns are still firing). Breaks of shorter than 20 minutes should be followed by a visual assessment for marine mammals and turtles within the 500 m mitigation zone (not a 60-minute pre-shoot watch) and a "soft-start" of similar duration.
  - > The use of the lowest practicable airgun volume, as defined by the operator, should be defined and enforced.
  - > During surveying, airgun firing should be terminated when:
    - obvious negative changes to turtle, seal and cetacean behaviour is observed;
    - turtles or cetaceans are observed within 500 m of the operating airgun and appear to be approaching the firing airgun; or
    - there is mass mortality of fish or mortality / injuries to seabirds, turtles, seals or cetaceans as a direct result of the survey.
  - > The survey should remain terminated until such time the time MMO / PAM operator confirms that:
    - turtles or cetaceans have moved to a point that is more than 500 m from the source;
    - despite continuous observation, 30 minutes has elapsed since the last sighting of the turtles or cetaceans within 500 m of the source; and
    - risks to seabirds, turtles, seals or cetaceans have been significantly reduced.
  - > A log of all termination decisions must be kept (for inclusion in both daily and "close-out" reports).
- MMO and PAM operator
  - > An independent on-board MMO and a PAM operator must be appointed for the duration of the seismic survey. The MMO and PAM operator must have experience in seabird, turtle and marine mammal identification and observation techniques.
  - > The duties of the MMO would be to:

[3] Note: If the intention is to test a single airgun on low power then a "soft-start" is not required.

Marine fauna:

- Confirm that there is no marine faunal activity within 500 m of the seismic source array prior to commencing with the "soft-start" procedures;
- Record pre-shoot observation regime;
- Record survey activities, including sound levels, "soft-start" procedures and survey periods (duration);
- Monitor marine faunal activity during daytime surveying. Observe and record responses of marine fauna to the seismic survey, including seabird, turtle, seal and cetacean incidence and behaviour and any mortality or injuries of marine fauna as a result of the seismic survey. Data captured should include species identification, position (latitude/longitude), distance from the vessel, swimming speed and direction (if applicable) and any obvious changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns) as a result of the survey activities; and
- Request the temporary termination of the seismic survey, as appropriate. It is important that the MMOs' decisions to terminate firing are made confidently and expediently;

Other:

- Record meteorological conditions;
- Monitor compliance with international marine pollution regulations (MARPOL 73/78 standards); and
- Prepare daily reports of all observations. These reports should be forwarded to the key stakeholders, as appropriate.

> The duties of the PAM operator would be to:

- Ensure that hydrophone streamers are optimally placed within the towed array;
- Confirm that there is no cetaceans activity within 500 m of the vessel prior to commencing with the "soft-start" procedures;
- Record survey activities, including sound levels, "soft-start" procedures and survey periods (duration);
- Record pre-shoot observation regime;
- Monitor cetacean activity during daytime and night time surveying. Record species identification, position (latitude/longitude) and distance from the vessel, where possible; and
- Request the temporary termination of the seismic survey, as appropriate.

> All data recorded by the MMO and PAM operator should form part of the survey "close-out" report.

5.3 MITIGATION RECOMMENDATIONS SPECIFIC TO HELICOPTER OPERATIONS (WHERE REQUIRED)

Mitigation relating to helicopter operations includes:

- Flight paths must be pre-planned to ensure that no flying occurs over MPAs (Marcus Island, Malgas Island, Jutten Island, Langebaan Lagoon, Sixteen Mile Beach, Table Mountain National Park, Helderberg, and Betty's Bay), seal (Kleinzee, Robberg Bucchu Twins, Strandfontein Point, Bird Island, Paternoster Point, Duikerklip, Robbesteen, Seal Island and Geyser Rock) and seabird colonies (Saldanha Bay islands, Dassen Island, Robben Island, Dyer Island, Bird Island, Boulders beach, and Betty's Bay);
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should be avoided. There is a restriction of coastal flights (parallel to the coast within 1 nautical mile of the shore) on the South Coast between the months of June and November to avoid Southern Right whale breeding areas;
- Aircraft may not approach to within 300 m of whales without a permit in terms of the Marine Living Resources Act, 1998;
- The operator must comply with the Seabirds and Seals Protection Act, 1973, which prohibits the wilful disturbance of seals on the coast or on offshore islands;
- The contractor should comply fully with aviation and authority guidelines and rules; and
- All pilots must be briefed on ecological risks associated with flying at a low level parallel to the coast.

CONTENTS

APPENDICES

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ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
3D	Two-dimensional
3D	Three-dimensional
CEAPSA	Certified Environmental Practitioner of South Africa
CITES	Convention on International Trade in Endangered Species
cm	centimetres
cm/s	centimetres per second
CMS	Convention on Migratory Species
CO	Carbon monoxide
CO_2	Carbon dioxide
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea
DAFF	Department of Agriculture, Forestry and Fisheries
db	decibels
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
E	EAST
EAP	Environmental Assessment Practitioner
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
ER	Exploration Right
FLO	Fisheries Liaison Officer
GN	Government Notice
I&APs	Interested and Affected Parties
IUCN	International Union for Conservation of Nature
km	kilometres
km^2	Square kilometres
m	Metres
m^2	Square metres
m^3	Cubic metre
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973/1978
MMO	Marine Mammal Observer
MPAs	Marine Protected Areas
MPRDA	Minerals and Petroleum Resources Development Act, 2002 (No. 28 of 2002)
NEMA	National Environmental Management Act, 1998 (No. 107 of 1998)
PAM	Passive Acoustic Monitoring
PASA	Petroleum Agency of South Africa
PGS	Petroleum Geo-Services

Acronym / Abbreviation	Definition
Pr.Sci.Nat.	Registered Professional Natural Scientist
SAMSA	South African Maritime Safety Authority
SAN	South African Navy
SLR	SLR Consulting (South Africa) (Pty) Ltd
SO_2	Sulphur dioxide
SSW	South-south-west
SW	South-west
t	Tons
TAC	Total Allowable Catch
TSPM	Total Suspended Particulate Matter
UNCLOS	United Nations Convention on Law of the Sea, 1982
VMEs	Vulnerable Marine Ecosystems
VOS	Voluntary Observing Ships
W	West
WACS	West Africa Cable System
WASC	West African Submarine Cable
WSW	West-south-west
µg	Micrograms
µm	Micrometre
µg/l	Micrograms per litre
µPa	Micro Pascal
°C	Degrees Centigrade
%	Percent
‰	Parts per thousand
<	Less than
>	Greater than

1 INTRODUCTION

This chapter provides a brief description of the project background, describes the assumptions of the EMP, as well as the opportunity for comment, and presents the structure of the report.

1.1 BACKGROUND

In October 2018, Petroleum Geo-Services (PGS) submitted an application for a Reconnaissance Permit to the Petroleum Agency SA (PASA) in order to apply to undertake a multi-client speculative two-dimensional (2D) and three-dimensional (3D) seismic surveys in a number of petroleum licence blocks off the South and West Coast of South Africa (see Figure 1-1). Section 74 of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) makes provision for such an application.

Actual survey commencement would ultimately depend on a permit award date and the availability of a survey vessel. Furthermore, the duration of the surveys would be dependent on whether the 2D and 3D surveys are run concurrently or at a different times. It is, however, anticipated that the surveys would take in the order of five months to complete. Should the permit be awarded, it is anticipated that the proposed surveys could commence within Q1 or Q2 2019, with the balance of the survey resuming at the end of December 2019.

PASA has requested that in order for PGS to obtain a Reconnaissance Permit, it must prepare a 'plan for managing potential environmental impacts that may result from the proposed operation and notify consult with affected parties' and submit it to them for consideration by the Minister of Mineral Resources. For this application, the plan is referred to as an Environmental Management Programme (EMP)[4].

PGS has appointed SLR Consulting (South Africa) (Pty) Ltd (SLR) to compile this EMP and undertake the required public participation process for the proposed speculative seismic surveys.

1.2 ASSUMPTIONS OF THIS EMP

This EMP was prepared with the following assumptions:

- SLR has been provided with all relevant project description information;
- There will be no significant changes to the project description or surrounding environment between the completion of the report and implementation of the proposed project that could substantially influence findings, recommendations with respect to mitigation and management, etc.;
- The assessment is based, to a large extent, on a generic description of 2D and 3D seismic survey operations;
- The study assumes that all mitigation measures incorporated into the project description would be implemented as proposed; and
- Specialists were provided with all relevant information required in order to produce accurate and unbiased assessments.

These assumptions, however, are not considered to have any negative implications in terms of the credibility of the results of the study or the required management actions included in this EMP.

[4] There is currently no legislated environmental process prescribed for a Reconnaissance Permit application. A legislated Environmental Impact Assessment process in terms of the National Environmental Management Act, 1998 (No. 107 of 1998) is thus not required.

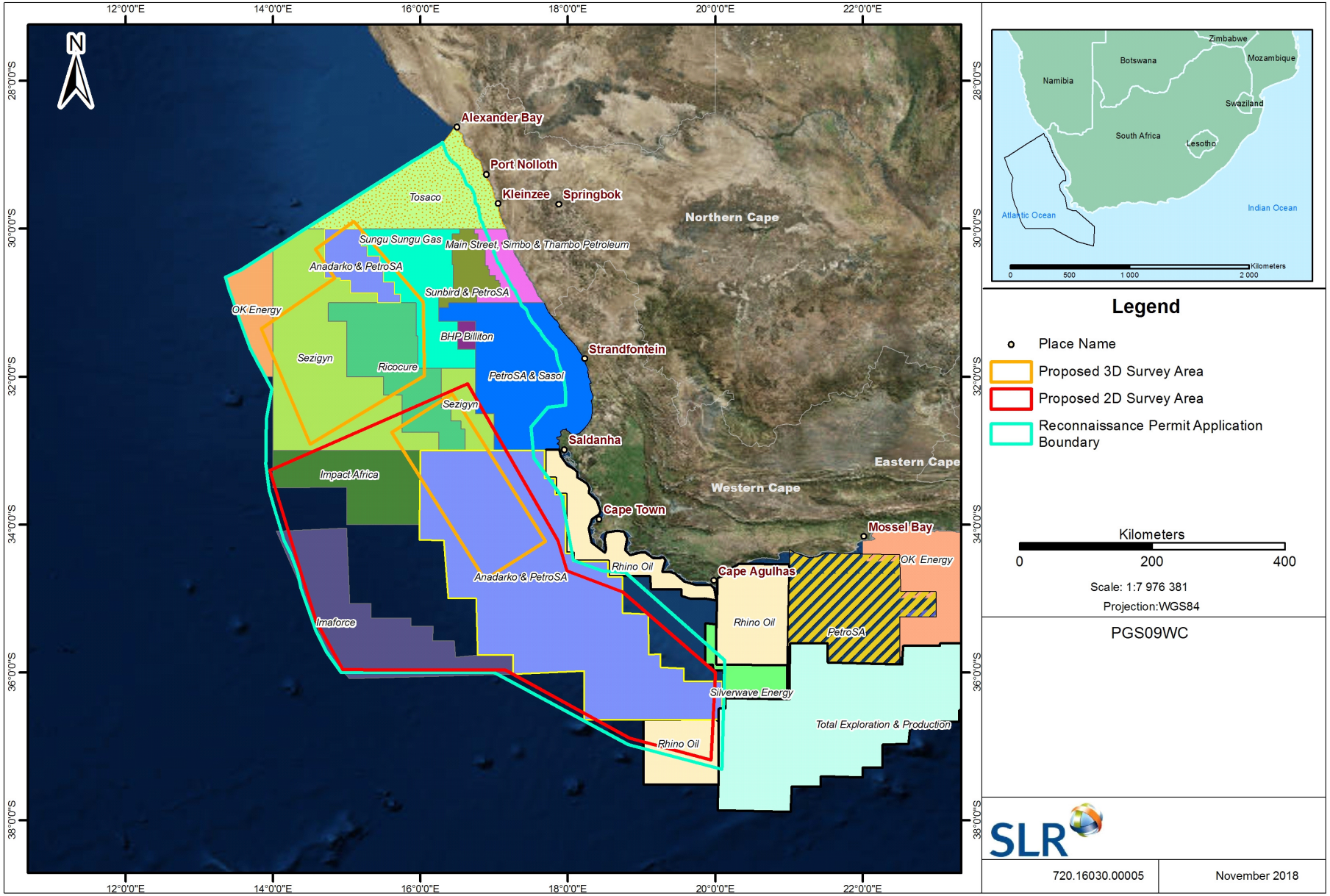


FIGURE 1-1: LOCALITY OF THE PROPOSED RECONNAISSANCE PERMIT AREA (BLUE OUTLINE).

1.3 STRUCTURE OF THIS REPORT

This report consists of eight chapters and three appendices as shown below.

Section	Contents
Executive Summary	Provides an overview of the main findings of the EMP.
Chapter 1	**Introduction** Provides background to the proposed project, the assumptions and limitations of the study, and describes the structure of the report.
Chapter 2	**Approach and methodology** Covers the legislative requirements of the EMP process and presents the process undertaken.
Chapter 3	**Project description** Provides general information on the proposed project, a general description of seismic surveys and provides details on the proposed surveys.
Chapter 4	**The affected environment** Describes the existing biophysical and socio-economic environment that could be affected by the proposed project.
Chapter 5	**Environmental Impact Assessment** Describes and assesses the potential impacts of the proposed project on the affected environment. It also presents mitigation measures that could be used to reduce the significance of any negative impacts or enhance any benefits.
Chapter 6	**Conclusion and recommendations** Provides conclusions to the EMP and summarises the recommendations for the proposed project.
Chapter 7	**Action Plan and Procedures** Provides a detailed Action Plan and Procedures for implementing the EMP.
Chapter 8	**References** Provides a list of the references used in compiling this report.
Appendices	
Appendix 1	Public Participation Process Appendix 1.1 Interested and Affected Party database Appendix 1.2 Advertisements
Appendix 2	Convention for assigning significance ratings to impacts
Appendix 3	Specialist Studies Appendix 3.1 Fishing Industry Assessment Appendix 3.2 Marine Faunal Assessment

1.4 OPPORTUNITY TO COMMENT

This report has been distributed for public review and comment **from 15 November to 15 December 2018** in order to provide Interested and Affected Parties (I&APs) and authorities with an opportunity to comment on any aspect of the proposed project. Copies of the full report have been made available on the SLR website (at http://slrconsulting.com/za/slr-documents/).

All I&APs registered on the project database have been informed of the release of the report and where the full report can be reviewed. In order to be included in the final EMP, any comments on the EMP should be forwarded directly to SLR at the address, telephone/fax numbers or e-mail address shown below by no later than **15 December 2018**.

SLR Consulting (South Africa) (Pty) Ltd
Attention: Mandy Kula

PO Box 10145, CALEDON SQUARE, 7905
Unit 39 Roeland Square, 30 Drury Lane, CAPE TOWN, 8001

Tel: (021) 461 1118/9
Fax: (021) 461 1120
E-mail: mkula@slrconsulting.com

2 APPROACH AND METHODOLOGY

This chapter outlines the key legislative requirements for the proposed project and outlines the methodology and public participation process undertaken in the study.

2.1 LEGISLATIVE REQUIREMENTS

2.1.1 Mineral and Petroleum Resources Development Act, 2002

In terms of the MPRDA, a Reconnaissance Permit must be obtained prior to the commencement of any reconnaissance activities. A requirement for obtaining a Reconnaissance Permit is that an applicant must submit an application in terms of Section 74(1) of the MPRDA to the designated agency, and they must accept the application within 14 days if, *inter alia*, no other person holds a Technical Co-operation Permit, Exploration Right or Production Right for petroleum over any part of the proposed permit area. If the application for a Reconnaissance Permit is accepted, the designated agency must request that the applicant comply with Chapter 5 of National Environmental Management Act, 1998 (No. 107 of 1998), as amended (NEMA) with regards to consultation and reporting.

It should be noted that there is no legislated process prescribing the environmental approval procedure to be followed in order to obtain a Reconnaissance Permit. Thus, the procedure followed in this EMP process is based on PASA's acceptance of the Reconnaissance Permit application and as noted above they requested that a '*plan be developed for managing potential environmental impacts that may result from the proposed operation and that affected parties are notified and consulted*'.

2.1.2 National Environmental Management Act, 1998

The Environmental Impact Assessment (EIA) Regulations 2014 (as amended) promulgated in terms of Chapter 5 of NEMA, as amended, provide for the control of certain listed activities. These activities are prohibited until Environmental Authorisation has been obtained from the competent authority.

There are currently no listed activities applicable to Reconnaissance Permits or seismic surveys in the EIA Regulations 2014 (as amended). Thus, Environmental Authorisation is not required in terms of NEMA. In line with the principles of sustainable development in NEMA, the applicant is, however, still responsible for acting with due care so that damage to others and the environment through its actions is avoided.

2.1.3 Other Relevant Legislation

In addition to the foregoing, PGS must also comply with the provisions of other relevant international and national legislation and conventions, which include, but are not limited to, the following:

International Marine Pollution Conventions

- International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL);
- Amendment of the International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL) (Bulletin 567 – 2/08);
- International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (OPRC Convention);
- United Nations Convention on Law of the Sea, 1982 (UNCLOS);
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (the London Convention) and the 1996 Protocol (the Protocol);
- International Convention relating to Intervention on the High Seas in case of Oil Pollution Casualties (1969) and Protocol on the Intervention on the High Seas in Cases of Marine Pollution by substances other than oil (1973);
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (1989); and
- Convention on Biological Diversity (1992).

Other International Legislation

- International Commission on Radiological Protection (ICRC); and
- International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material, 1984.

Other South African Legislation

- Carriage of Goods by Sea Act, 1986 (No. 1 of 1986);
- Dumping at Sea Control Act, 1980 (No. 73 of 1980);
- Hazardous Substances Act, 1983 and Regulations (No. 85 of 1983);
- Marine Living Resources Act, 1998 (No. 18 of 1998);
- Marine Traffic Act, 1981 (No. 2 of 1981);
- Marine Pollution (Control and Civil Liability) Act, 1981 (No. 6 of 1981);
- Marine Pollution (Prevention of Pollution from Ships) Act, 1986 (No. 2 of 1986);
- Marine Pollution (Intervention) Act, 1987 (No. 65 of 1987);
- Maritime Safety Authority Act, 1998 (No. 5 of 1998);
- Maritime Safety Authority Levies Act, 1998 (No. 6 of 1998);
- Maritime Zones Act 1994 (No. 15 of 1994);
- Merchant Shipping Act, 1951 (No. 57 of 1951);
- Mine Health and Safety Act, 1996 (No. 29 of 1996);
- National Environmental Management: Air Quality Act, 2004 (No. 39 of 2004);
- National Environmental Management: Biodiversity Act, 2004 (No. 10 of 2004);
- National Environmental Management: Integrated Coastal Management Act, 2008 (No. 24 of 2008);
- National Environmental Management: Waste Act, 2008 (No. 59 of 2008);
- National Heritage Resources Act, 1999 (No. 25 of 1999);
- National Nuclear Energy Regulator Act, 1999 (No. 47 of 1999);
- National Ports Act, 2005 (No. 12 of 2005);

- National Water Act, 1998 (No. 36 of 1998);
- Nuclear Energy Act, 1999 (No. 46 of 1999);
- Occupational Health and Safety Act, 1993 (No. 85 of 1993) and Major Hazard Installation Regulations;
- Sea-Shore Act, 1935 (No. 21 of 1935);
- Sea Birds and Seals Protection Act, 1973 (No. 46 of 1973);
- Ship Registration Act, 1998 (No. 58 of 1998); and
- Wreck and Salvage Act, 1995 (No. 94 of 1995).

2.2 EMP PROCESS

2.2.1 Objectives

The objectives of the EMP process are:

- To provide a reasonable opportunity for I&APs to be consulted on the proposed project;
- To ensure that potential key environmental issues and impacts that could result from the proposed project are identified;
- To assess potential impacts related to the proposed project;
- To present appropriate mitigation or optimisation measures to minimise potential impacts or enhance potential benefits; and
- Through the above, to ensure informed, transparent and accountable decision-making by the relevant authorities.

2.2.2 Specialist Studies

Two specialist studies were undertaken to address the key issues that required further investigation, namely the potential impact on fishing and marine fauna. The specialists and their details are provided in Table 2-1.

The specialist studies involved the gathering of data relevant to identifying and assessing environmental impacts that may occur as a result of the proposed project. These impacts were then assessed according to pre-defined rating scales (see Appendix 2). Specialists also recommended appropriate mitigation / control or optimisation measures to minimise potential negative impacts or enhance potential benefits, respectively.

TABLE 2-1: LIST OF SPECIALIST STUDIES AND SPECIALISTS.

No.	Specialist study	Specialist/s	Qualifications	Company	Appendix
1	Fishing	Mr Dave Japp	MSc (Ichthyology and Fisheries Science), Rhodes University	Capricorn Marine Environmental	3.1
		Ms Sarah Wilkinson	BSc (Hons) (Botany), University of Cape Town		
2	Marine fauna	Dr Andrea Pulfrich	PhD (Fisheries Biology), Christian-Albrechts University, Kiel, Germany	Pisces Environmental Services (Pty) Ltd	3.2

2.2.3 EMP Compilation

The specialist studies and other relevant information have been integrated into this EMP. Many of the issues associated with seismic surveys are generic in nature and have been assessed based on previous seismic survey programmes off the coast of South Africa and the Generic EMPr[2] prepared for seismic surveys in South Africa. Recommendations proposed are based on specialist input and are in line with the Generic EMPr and the general principles of the Joint Nature Conservation Committee (JNCC) seismic guidelines.

The EMP aims to present all information in a clear and understandable format and suitable for easy interpretation by authorities, I&APs and other key stakeholders (e.g. operator and/or contractors).

2.2.4 Public Participation Process

The public participation tasks as part of the EMP process include the following:

5. A preliminary I&AP database has been compiled of authorities and organs of state (local and regional), Non-Governmental Organisations, Community-based Organisations and other key stakeholders (including the fishing industry, overlapping and neighbouring users with delineated boundaries in the oil/gas and mining industries). This database was compiled using databases of previous studies in the area. A total of 134 I&APs have been included on the project database to date (refer to Appendix 1.1).
6. Advertisements announcing the proposed project and the availability of the Draft EMP for public review and comment were placed in four regional newspapers (Namakwalander, Plattelander, The Cape Times, and Die Burger Western Cape);
7. I&APs were notified of the availability of the Draft EMP for a review and comment period between 15 November to 15 December 2018. A copy of the Executive Summary was included with the notification letter; and
8. PGS will also directly notify all existing exploration right and technical cooperation permit holders and applicants in the proposed Reconnaissance Permit area (refer to Table. 3.1).

2.2.5 Way Forward

After closure of the comment period, all written comments received from I&APs will be collated and submitted, together with the EMP, to PASA for consideration and for acceptance by the Minister of Mineral Resources in terms of the MPRDA.

[2] Crowther Campbell & Associates and Centre for Marine Studies (1999) Generic Environmental Programme Reports for oil and gas exploration off the coast of South Africa. Volume 4: Generic Manual for the preparation of a Lease Specific Environmental Management Programme Report for seismic surveys. Petroleum Agency of South Africa, Cape Town, South Africa.

3 PROJECT DESCRIPTION

This chapter provides general information on the proposed project, the general location of the proposed multi-client 2D and 3D speculative seismic surveys, and a description of typical seismic surveys.

3.1 GENERAL INFORMATION

3.1.1 Reconnaissance Permit Application

PGS as the applicant for the Reconnaissance Permit will also be the operator for the proposed project.

Address:	Petroleum Geo-Services No. 4, The Heights Brooklands, Weybridge Surrey KT13 0NY United Kingdom
Project Manager:	Mr James Gara (New Ventures Manager - Africa & Middle East)
Telephone:	+44 (0) 1932 376 000
Cell:	+44 (0) 7880 872 317
E-mail:	James.Gara@pgs.com

3.1.2 Existing Permit and Right Holders (and Applicants)

The proposed Reconnaissance Permit area includes a number of licence blocks off the South and West Coasts of South Africa (see Figure 3-1). Licence block rights/permit holders and applicants within the proposed Reconnaissance Permit area are listed in Table 3-1.

As mentioned in Section 2.2.4, PGS is required to obtain written consent from the existing exploration right and technical cooperation permit holders and applicants within the proposed Reconnaissance Permit area in order to apply for this permit.

3.1.3 Details of Reconnaissance Area and Survey Extent

The Reconnaissance Permit area is approximately 290 299 km^2 in extent. The western extent of the permit area would be located more than 370 km offshore. The distance from the coast of the eastern extent of the permit area would be as follows (see Figure 3-1):

- From the Orange River Mouth to a point approximately 20 km north of Strandfontein it would be located 25 km offshore;
- From this point to Elands Bay it would be located approximately 30 km offshore;
- From Elands Bay to Cape Point (and directly across of False Bay to Pringle Bay), the distance varies between 35 – 30 km; and
- From Pringle Bay the distance progressively increases to ultimately 100 km offshore of Cape Agulhas.

The co-ordinates of the boundary points of the Reconnaissance Permit area are provided in Table 3-2 below.

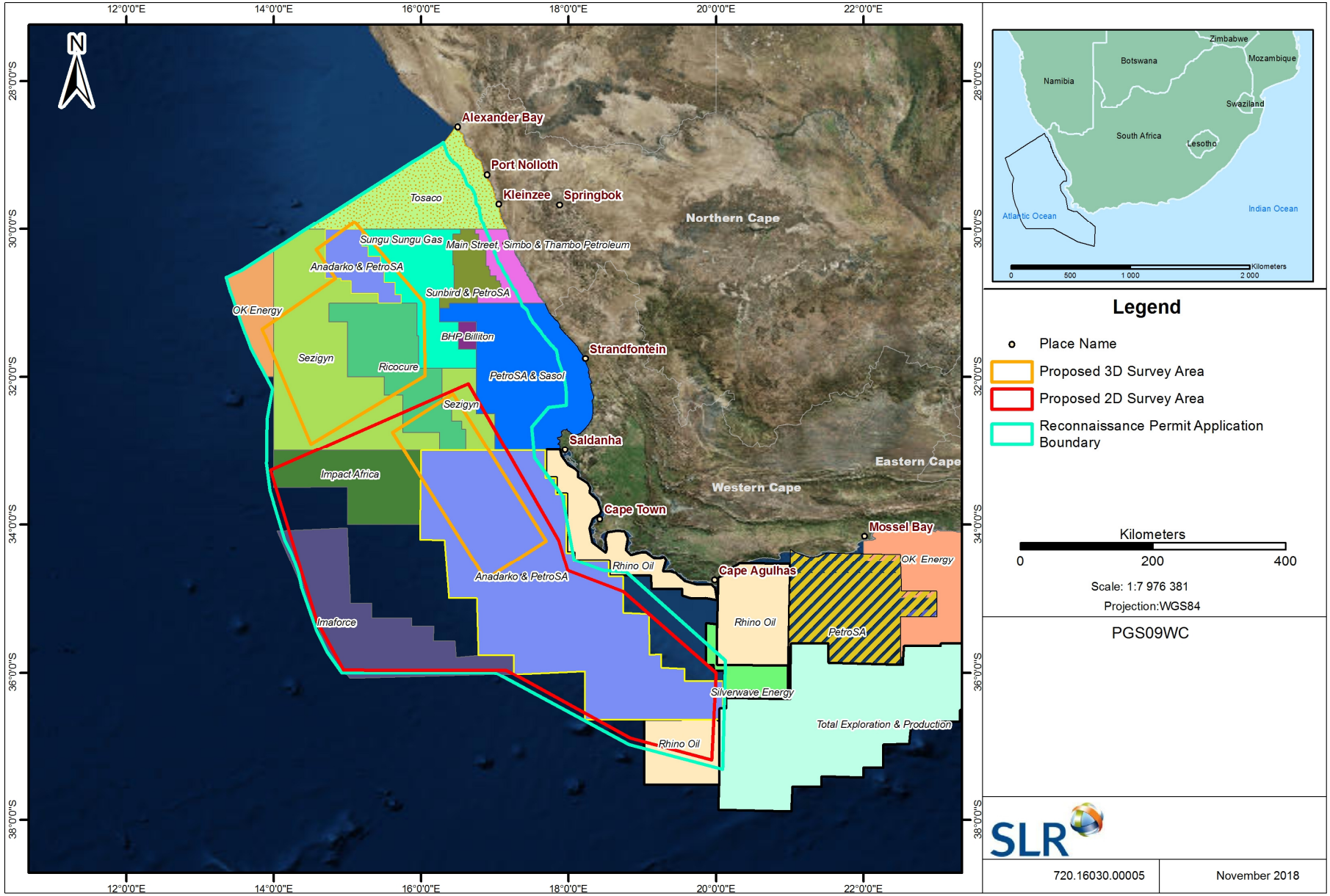


FIGURE 3-1: THE RECONNAISSANCE PERMIT APPLICATION AREA BOUNDARY AND PRELIMINARY 2D SEISMIC SURVEY AND 3D SEISMIC SURVEY TARGET AREAS.

The proposed 2D survey would cover a single target area located roughly between Lamberts Bay in the north and Cape Agulhas in the south. The distance between the eastern boundary of the 2D survey area and the coast decreases from approximately 150 km offshore of Lamberts Bay to 65 km offshore of Cape Columbine and then reaches its closest point of more than 40 km offshore of the Cape Peninsula. From Cape Point the distance starts to increase again, ultimately reaching a distance of more than 120 km offshore of Cape Agulhas. The western extent of the survey area is located more than 350 km away from the coast. The total length of the survey would be between 2 000 and 8 000 km.

The proposed 3D surveys would cover two target areas:

- A northern 3D survey area located to the north of the proposed 2D survey area and situated approximately 200 km offshore of Klienzee to the north and Strandfontein to the south. At its closest point to the West Coast, the eastern boundary of this 3D survey area would be located approximately 150 km offshore, with the furthest western boundary located approximately 390 km offshore; and
- A southern 3D survey area which overlaps with the north-eastern portion of the proposed 2D survey area. This 3D survey area is located approximately 170 km offshore of Lambert's Bay to the north and more than 60 km offshore of the Cape Peninsula to the south. The furthest western boundary of this 3D survey area is located approximately 200 km offshore.

The total extent of the 3D survey data acquisition within both areas would be between 3 000 and 10 000 km^2.

Actual survey commencement would ultimately depend on a permit award date and the availability of a survey vessel. Furthermore, the duration of the surveys would be dependent on whether the 2D and 3D surveys are run concurrently or at a different times. It is, however, anticipated that the surveys would take in the order of five months to complete. Should the permit be awarded, it is anticipated that the proposed surveys could commence within Q1 or Q2 2019, with the balance of the survey then resuming at the end of December 2019.

TABLE 3-1: LIST OF RIGHT HOLDERS (AND APPLICANTS) IN THE RECONNAISSANCE PERMIT APPLICATION AREA BOUNDARY.

NO.	RIGHT HOLDER	CONTACT DETAILS	
1.	Anadarko	Address:	P O Box 7980 Roggebaai 8012
		Contact person:	Marek Ranoszek
		Email:	marek.ranoszek@anadarko.com
		Tel:	021 425 5012
2.	Imaforce	Address:	P O Box 61495 Marshaltown 2107
		Contact person:	Mr Gugulethu Dlamini
		Email:	gugulethu.dlamini@imaforce.co.za

NO.	RIGHT HOLDER	CONTACT DETAILS
3.	Impact Africa	Address: Church Gate 9-11 Church Street West Woking, Surrey United Kingdom Contact person: Phil Birch / Mike Doherty Email: mdoherty@impactoilandgas.com
4.	Main Street	Address: 22nd Floor Metlife Centre 7 Walter Sisulu Avenue Cape Town 8001 Contact person: Jan Maier Email: jan.maier@africaenergycorp.com Tel: 021 003 5505
5.	OK Energy	Address: 49 Mill Lane Chalgrove, OX4475L United Kingdom Contact person: Erika Syba Email: erika.syba@btinternet.com Tel: +44 7973 342877
6.	PetroSA	Address: Private Bag X5 Parow 7955 Contact person: Mr Saleem Soobader Email: saleem.soobader@petrosa.co.za Tel: 021 928 4715
7.	Rhino Oil	Address: Icon Building, Suite 300 cnr, Long Street & Hans Strijdom Ave Foreshore 8001 Contact person: Mr Phillip Steyn Email: psteyn@rhinosourcesltd.com Tel: 079 716 1030
8.	Ricocure	Address: P O Box 966 Bedfordview Johannesburg 2008 Contact person: Solomon Lephoto Email: sungusungu@mwe.com Tel: 011 021 5397
9.	Sasol	Address: P O Box 5486 Johannesburg 2000 Contact person: Mr David Holmes Email: david.holmes@sasol.com Tel: 011 344 0795

NO.	RIGHT HOLDER	CONTACT DETAILS
10.	Simbo	Address: 22nd Floor Metlife Centre 7 Walter Sisulu Avenue Cape Town 8001 Contact person: Jan Maier Email: jan.maier@africaenergycorp.com Tel: 021 003 5505
11.	Sezigyn	Address: P O Box 966 Bedfordview Johannesburg 2008 Contact person: Solomon Lephoto Email: sungusungu@mwe.com Tel: 011 021 5397
12.	Sunbird	Address: 201 Two Oceans House, Surrey Place, 6 Bay Road Mouille Point 8005 Contact person: Kerwin Rana / Anschen Friedricks Email: afriedrichs@sunbirdenergy.com Tel: 011 848 5005
13.	Sungu Sungu	Address: P O Box 966 Bedfordview Johannesburg 2008 Contact person: Mr Thabang Khomo / Solomon Lephoto Email: Solomon@sungusungugroup.com Tel: 011 615 4451
14.	Thombo Petroleum	Address: 1C Barnes High Street London SW139LB United Kingdom Contact person: Trevor Ridley Email: trevor@thombopetroleum.com Tel: +44 20 887 80212
15.	Tosaco Energy	Address: 1st Floor, 4 Fricker Road Illovo Johannesburg 2196 Contact person: Bradley Cerff Email: bradley@tosacoenergy.com Tel: +27 10 001 5550

TABLE 3-2: CORNER CO-ORDINATES OF THE PROPOSED RECONNAISSANCE PERMIT AREA

Point	Latitude (S)	Longitude (E)
1	32° 40' 57.03223440"	17° 29' 47.23452852"
2	33° 05' 48.55911684"	17° 32' 11.22014400"
3	33° 36' 59.83808184"	17° 54' 52.10099676"
4	34° 28' 59.97828072"	18° 04' 18.92828424"
5	34° 37' 27.74383320"	18° 27' 58.69818864"
6	34° 38' 58.48494180"	18° 46' 42.58159356"
7	35° 50' 02.84490132"	20° 07' 45.44821416"
8	37° 18' 34.59151764"	20° 05' 15.82154880"
9	36° 58' 37.57819584"	18° 49' 12.20825856"
10	36° 00' 01.71321192"	17° 00' 00.00000000"
11	36° 00' 01.71321192"	14° 55' 24.66840000"
12	35° 43' 41.67081192"	14° 43' 37.22520000"
13	35° 32' 31.69281192"	14° 37' 58.22040000"
14	35° 28' 31.72041192"	14° 35' 57.21360000"
15	35° 25' 06.17481192"	14° 34' 27.84360000"
16	34° 51' 46.76361192"	14° 22' 45.89040000"
17	34° 39' 11.84001192"	14° 20' 07.20960000"
18	34° 31' 04.16961192"	14° 16' 52.13640000"
19	34° 23' 11.88201192"	14° 13' 57.21600000"
20	34° 12' 21.88761192"	14° 08' 57.21360000"
21	33° 43' 12.12201192"	14° 00' 00.00000000"
22	33° 43' 02.70441192"	14° 00' 00.00000000"
23	33° 33' 11.72121192"	13° 57' 00.00000000"
24	33° 31' 01.71081192"	13° 56' 40.00200000"
25	33° 11' 11.69841192"	13° 54' 10.00080000"
26	32° 43' 34.96761192"	13° 54' 24.56640000"
27	32° 33' 06.78921192"	13° 54' 30.93120000"
28	32° 25' 50.76801192"	13° 55' 52.72680000"
29	32° 10' 01.70361192"	13° 58' 50.00160000"
30	31° 53' 41.70441192"	13° 50' 20.00040000"
31	31° 49' 21.71961192"	13° 47' 50.00280000"
32	31° 42' 16.04481192"	13° 44' 07.16280000"
33	31° 36' 41.69841192"	13° 41' 20.00760000"
34	31° 15' 31.71921192"	13° 33' 10.00080000"
35	30° 53' 36.05601192"	13° 25' 39.84960000"
36	30° 50' 41.70081192"	13° 24' 40.00320000"
37	30° 50' 21.71001192"	13° 24' 29.99880000"
38	30° 39' 11.95161192"	13° 21' 00.02880000"
39	30° 35' 00.33321192"	13° 30' 00.00000000"
40	30° 33' 32.38881192"	13° 33' 20.85480000"
41	30° 19' 35.83431696"	13° 55' 23.28524976"
42	30° 10' 12.25789752"	14° 10' 04.91154240"
43	30° 02' 52.52601192"	14° 21' 30.07800000"
44	29° 31' 01.11720000"	15° 12' 20.54880000"
45	29° 16' 44.05470600"	15° 34' 54.05448720"
46	29° 05' 14.29956960"	15° 53' 05.81247960"
47	29° 01' 09.99120000"	15° 59' 56.14440000"
48	28° 56' 42.17986320"	16° 07' 01.96888080"
49	28° 54' 30.16440000"	16° 10' 44.22000000"
50	28° 52' 31.43579520"	16° 14' 13.37790840"
51	28° 51' 01.94272560"	16° 16' 22.89321120"
52	28° 49' 52.88431440"	16° 18' 06.26062680"
53	28° 52' 16.40824644"	16° 18' 55.77452820"
54	28° 59' 26.59277364"	16° 21' 09.66519972"
55	29° 03' 40.14813852"	16° 24' 18.11851128"
56	29° 05' 53.77866864"	16° 26' 35.17546524"
57	29° 07' 33.14496036"	16° 28' 45.37957152"
58	29° 09' 12.51125172"	16° 30' 31.59871092"
59	29° 11' 05.58323880"	16° 31' 57.25930692"
60	29° 14' 58.58006064"	16° 33' 50.33129400"
61	29° 18' 07.03337220"	16° 35' 22.84473804"
62	29° 22' 06.88304172"	16° 36' 34.79963868"
63	29° 23' 59.73563040"	16° 37' 47.00665632"
64	29° 26' 23.33257152"	16° 40' 50.51586324"
65	29° 27' 33.40818828"	16° 41' 30.90830748"
66	29° 27' 40.03206336"	16° 41' 37.37621508"
67	29° 30' 29.85678864"	16° 43' 18.24371184"
68	29° 32' 47.92324596"	16° 43' 52.16063124"
69	29° 33' 58.35680136"	16° 44' 20.92354440"
70	29° 38' 38.38569864"	16° 44' 35.17868292"
71	29° 41' 58.26403248"	16° 47' 05.06759820"
72	29° 41' 58.94022228"	16° 47' 05.17756920"
73	29° 42' 51.38356644"	16° 47' 23.72663436"
74	29° 43' 22.16656344"	16° 47' 19.04922636"
75	29° 44' 13.12913364"	16° 47' 34.60858116"
76	29° 45' 33.18141060"	16° 47' 27.73910508"
77	29° 48' 40.27930128"	16° 48' 08.99126712"
78	29° 49' 20.54139564"	16° 48' 23.98599936"
79	29° 50' 39.08280084"	16° 48' 07.31494908"
80	29° 52' 48.30126708"	16° 49' 14.75793912"
81	29° 53' 43.86805440"	16° 49' 22.32507036"
82	29° 54' 25.05303360"	16° 50' 05.29276920"
83	29° 54' 57.47642424"	16° 50' 22.23510612"
84	29° 55' 03.33475068"	16° 50' 21.71153148"
85	29° 58' 03.98579232"	16° 51' 30.25934532"
86	29° 58' 16.71038400"	16° 51' 29.66050332"
87	30° 00' 07.55910180"	16° 52' 17.20169436"
88	30° 01' 55.91786484"	16° 52' 58.39911768"
89	30° 02' 05.17276932"	16° 53' 07.68128064"
90	30° 07' 19.60117788"	16° 55' 22.82129328"
91	30° 07' 23.59578648"	16° 55' 36.90168492"
92	30° 11' 11.86089900"	16° 56' 34.29040704"
93	30° 15' 01.64694096"	16° 57' 03.00048336"
94	30° 16' 40.51116264"	16° 59' 23.72102484"
95	30° 17' 11.57033400"	16° 59' 32.42503500"
96	30° 17' 43.75817736"	16° 59' 45.66032268"
97	30° 18' 00.05073912"	16° 59' 43.26918180"
98	30° 18' 00.31558500"	16° 59' 43.40928372"

Point	Latitude (S)	Longitude (E)
99	30° 18' 26.17972920"	16° 59' 31.50371040"
100	30° 19' 43.28175432"	17° 00' 09.29360196"
101	30° 19' 08.64173748"	17° 00' 19.56171312"
102	30° 19' 27.12658260"	17° 00' 29.34516276"
103	30° 20' 09.22478712"	17° 00' 17.49506076"
104	30° 26' 47.56781328"	17° 02' 47.31285156"
105	30° 27' 20.48448888"	17° 03' 19.62473364"
106	30° 27' 52.84808100"	17° 03' 30.78929700"
107	30° 28' 41.89542096"	17° 04' 19.16406984"
108	30° 30' 21.75925248"	17° 05' 14.63635860"
109	30° 32' 40.30770336"	17° 06' 22.27336452"
110	30° 33' 13.73061816"	17° 06' 31.31429976"
111	30° 33' 15.93662688"	17° 06' 32.83954596"
112	30° 33' 48.47806512"	17° 06' 39.96637992"
113	30° 35' 05.01296244"	17° 07' 32.98284552"
114	30° 35' 30.86748348"	17° 07' 45.62373000"
115	30° 35' 38.00735844"	17° 07' 55.84730088"
116	30° 37' 44.02521156"	17° 09' 23.22468504"
117	30° 38' 20.94721620"	17° 10' 02.25048144"
118	30° 38' 43.81943892"	17° 10' 19.15040064"
119	30° 39' 32.13110448"	17° 10' 13.23149484"
120	30° 45' 23.89153176"	17° 13' 36.25776480"
121	30° 48' 16.54363980"	17° 15' 06.61360284"
122	30° 50' 12.70017636"	17° 17' 01.39443432"
123	30° 51' 37.84561812"	17° 17' 31.25618772"
124	30° 54' 46.53362556"	17° 18' 58.46097960"
125	30° 55' 34.78943460"	17° 19' 28.06275648"
126	30° 56' 23.79103404"	17° 19' 58.13737140"
127	30° 57' 39.45380472"	17° 20' 30.14845764"
128	30° 58' 21.58367340"	17° 20' 53.79899928"
129	31° 01' 54.23852820"	17° 21' 56.20537440"

Point	Latitude (S)	Longitude (E)
130	31° 04' 38.99233128"	17° 25' 20.68905180"
131	31° 05' 57.84034416"	17° 26' 10.50150804"
132	31° 05' 59.15869404"	17° 26' 11.67354348"
133	31° 07' 32.70026640"	17° 26' 59.56619640"
134	31° 08' 24.02231784"	17° 27' 19.42452828"
135	31° 10' 57.81306288"	17° 28' 18.89006304"
136	31° 11' 16.58255496"	17° 28' 36.24541464"
137	31° 11' 39.45189408"	17° 28' 44.76180828"
138	31° 12' 28.24040052"	17° 29' 25.00833948"
139	31° 13' 12.68997096"	17° 29' 39.01938252"
140	31° 14' 01.79900592"	17° 30' 20.42781804"
141	31° 15' 17.94909816"	17° 30' 50.18334984"
142	31° 17' 06.77653836"	17° 32' 43.44412848"
143	31° 18' 27.70180776"	17° 33' 36.98724672"
144	31° 21' 34.59155544"	17° 36' 12.82303764"
145	31° 22' 47.34055848"	17° 37' 38.55149292"
146	31° 24' 45.00544212"	17° 38' 11.99970708"
147	31° 27' 28.07575272"	17° 40' 11.80735212"
148	31° 27' 19.96803252"	17° 40' 07.20250500"
149	31° 29' 00.19364352"	17° 41' 04.15722228"
150	31° 31' 40.62467640"	17° 43' 39.16112124"
151	31° 33' 24.31735812"	17° 44' 54.03082560"
152	31° 34' 44.15216196"	17° 46' 26.74424064"
153	31° 35' 14.23537512"	17° 46' 51.97473264"
154	31° 37' 09.18674976"	17° 48' 28.43927424"
155	31° 38' 24.02360196"	17° 49' 50.29766508"
156	31° 41' 25.07294904"	17° 50' 38.30029944"
157	31° 45' 50.62079736"	17° 51' 21.13059744"
158	31° 59' 37.16728260"	17° 56' 16.60846128"
159	32° 09' 40.55462208"	17° 57' 44.48898504"
160	32° 23' 03.83168544"	17° 58' 04.86162120"

3.1.4 Environmental Policy Statement

PGS is committed to preventing harm to the environment by reducing risk related to their activities, complying with applicable legal requirements and continuously improving environmental performance. In order to maintain its reputation as a corporate citizen PGS is committed to the proper handling of all materials stored, distributed, processed, manufactured, produced, handled, installed or otherwise utilised in its activities as required by all applicable environmental, health and safety laws (https://www.pgs.com/responsibility/code-of-conduct/).

3.1.5 Monitoring and Performance Assessment

PGS would undertake appropriate monitoring and EMP Performance Assessments during the proposed seismic survey operations. PGS would track performance against objectives and targets specified in the Action Plan and Procedures (see Section 7).

At the conclusion of the proposed seismic surveys a "close-out" report would be prepared, which would include monitoring and performance assessment. This report would outline the implementation of the EMP and highlight any problems and issues that arose during the seismic surveys. A copy of this report would be submitted to PASA.

3.1.6 Plans and Procedures for Environmental Related Emergencies and Remediation

All offshore emergencies would be managed in terms of an Emergency Response Plan (ERP) and Shipboard Oil Pollution Emergency Plan (SOPEP), which will be prepared by PGS or the appointed seismic contractor. These documents capture the immediate actions required by the vessel and provide the full details of the resources that would be mobilised. These plans would be submitted to PASA for information purposes as part of PGS's formal notification prior to survey commencement.

3.2 SEISMIC SURVEYS

3.2.1 Introduction

Seismic surveys are carried out during oil and gas exploration activities in order to investigate subsea geological formations. During seismic surveys, high-level, low frequency acoustics are directed towards the seabed from near-surface sound sources towed by a seismic vessel. Signals reflected from geological interfaces below the seafloor are recorded by multiple receivers (or hydrophones) towed in a single or multiple streamers (see Figure 3-2). Analyses of the returned signals allow for interpretation of subsea geological formations.

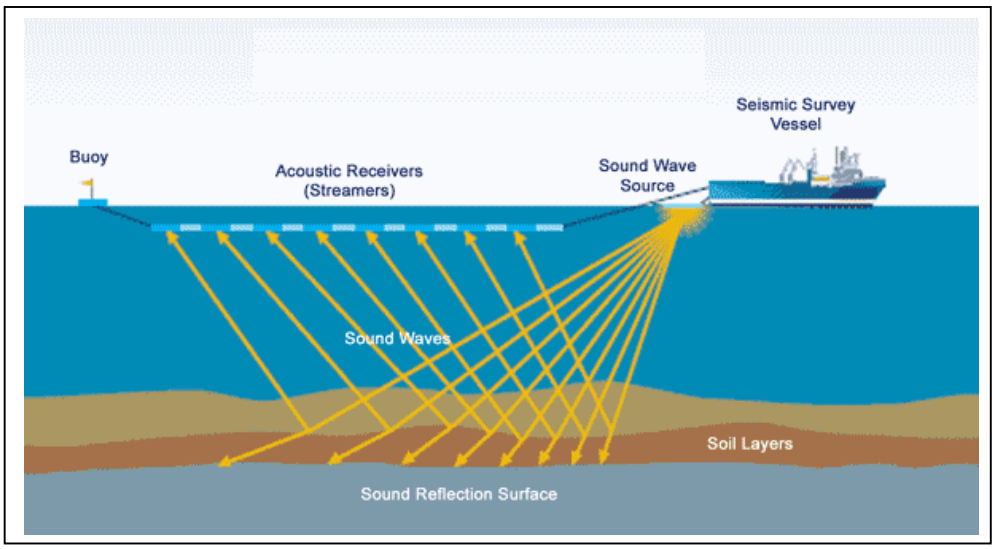


FIGURE 3-2: PRINCIPLES OF OFFSHORE 2D / 3D SEISMIC SURVEYS (FROM FISHSAFE.EU).

Seismic surveys are undertaken to collect either 2D or 3D data. A 2D survey is typically applied to obtain regional data from widely spaced survey grids (tens of kilometres) and infill surveys on closer grids (down to a 1 km spacing) are applied to provide more detail over specific areas of interest such as potentially drillable petroleum prospects. A 2D survey provides a vertical slice through the earth's crust along the survey track-line.

The vertical scales on displays of such profiles are generally in two-way sonic time, which can be converted to depth displays by using sound velocity data.

In the case of 3D seismic surveys they are typically applied to promising petroleum prospects to assist in fault interpretation, distribution of sand bodies, estimates of oil and gas in place and the location of exploration wells. A 3D survey operation requires multiple traverses of the survey area over the region of interest. Typically the surface sail line tracks of the vessel are separated by half the streamer array width. For this investigation PGS is proposing to undertake the acquisition of both 2D and 3D seismic survey data.

3.2.2 Survey Methodology and Airgun Array

The seismic surveys would be conducted using purpose-built seismic vessels. The seismic vessels would travel along transects of a prescribed grid within the survey areas that have been carefully chosen to cross any known or suspected geological structures. During surveying, the seismic vessels would travel at a speed of between four and six knots (i.e. 2 to 3 metres per second).

The seismic surveys would involve towed airgun arrays, which provides the seismic source energy for the profiling process, and seismic wave detector systems, usually known as hydrophone streamers. The anticipated airgun and hydrophone array would be dependent on whether a 2D or 3D seismic survey is undertaken. The sound source or airgun array (one for 2D and two for 3D) would be situated some 80 m to 150 m behind the vessel at a depth of 5 m to 25 m below the surface. A 2D survey typically involves a single streamer, whereas 3D surveys use multiple streamers (up to 12 streamers spaced 100 m apart). The array can be up to 12 000 m long. The streamer/s would be towed at a depth of between 6 m and 30 m and would not be visible, except for the tail-buoy at the far end of the cable. A typical 3D seismic survey configuration and safe operational limits (applicable to both 2D and 3D surveys) are illustrated in Figure 3-3.

Airguns, which are the most common sound source used in modern seismic surveys, would be used for the proposed survey. The airgun is an underwater pneumatic device from which high-pressure air is released suddenly into the surrounding water. On release of pressure the resulting bubble pulsates rapidly producing an acoustic signal that is proportional to the rate of change of the volume of the bubble. The frequency of the signal depends on the energy of the compressed air prior to discharge. Airguns are used on an individual basis (usually for shallow water surveys) or in arrays. Arrays of airguns are made up of towed parallel strings, usually comprised of between 12 and 70 airguns in total. The airgun would be fired at approximately 10 to 20 second intervals.

The sound waves are reflected by boundaries between sediments of different densities and returned signals are recorded by hydrophones mounted inside streamer cables and transmitted to the seismic vessel for electronic processing. Analyses of the returned signals allow for interpretation of subsea geological formations.

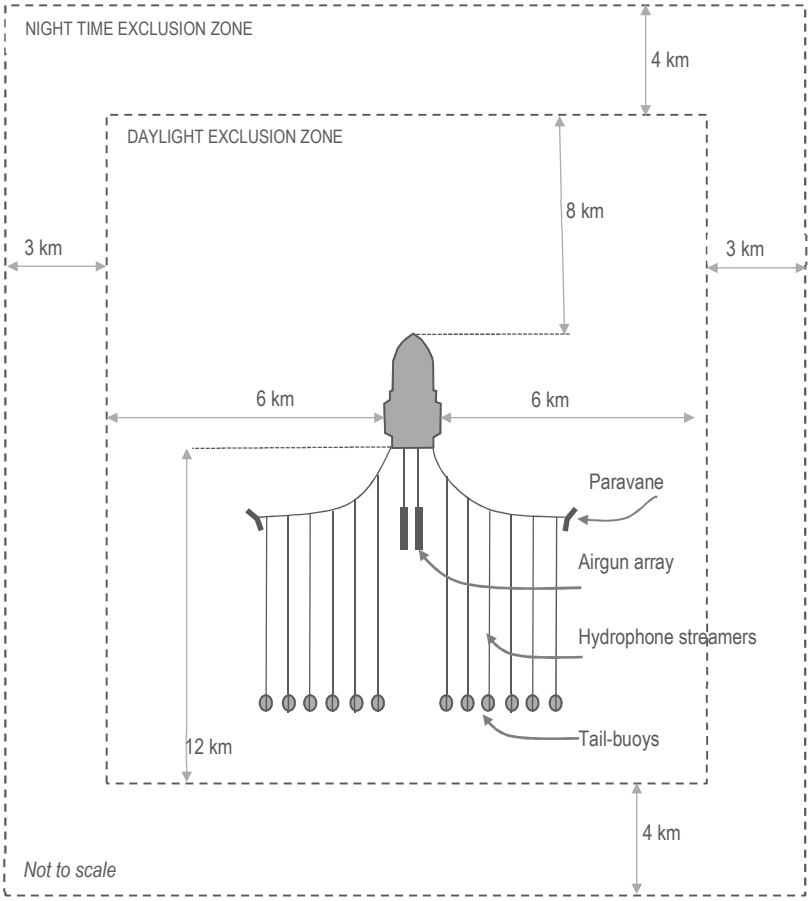


FIGURE 3-3: TYPICAL CONFIGURATION FOR A 3D SEISMIC SURVEY OPERATION. SAFE OPERATIONAL LIMITS APPLICABLE TO BOTH 2D AND 3D SURVEYS ARE ALSO SHOWN.

3.2.3 Sound Pressure Emission Levels

A single airgun could typically produce sound levels in the order of 220-230 dB re 1 mPa @ 1m, while arrays produce sounds typically in the region of 250 dB re 1 mPa @ 1m. The majority of energy produced is in the 0 to 120 Hz bandwidth, although energy at much higher frequencies is also recorded. High-resolution surveys and shallow penetration surveys require relatively high frequencies of 100 to 1000 Hz, while the optimum wavelength for deep seismic work is in the 10 to 80 Hz range.

One of the required characteristics of a seismic shot is that it is of short duration (the main pulse is usually between 5 and 30 milliseconds). The main pulse is followed by a negative pressure reflection from the sea surface of several lower magnitude bubble pulses (see Figure 3-4). Although the peak levels during the shot may be high, the overall energy is limited by the duration of the shot.

3.2.4 Recording Equipment

Signals reflected from geological discontinuities below the seafloor are recorded by hydrophones mounted inside streamer cables. Hydrophones are typically made from piezoelectric material encased in a rubber plastic hose. This hose containing the hydrophones is called a streamer. The reflected acoustic signals are recorded and transmitted to the seismic vessel for electronic processing. Analyses of the returned signals allow for interpretation of subsea geological formations.

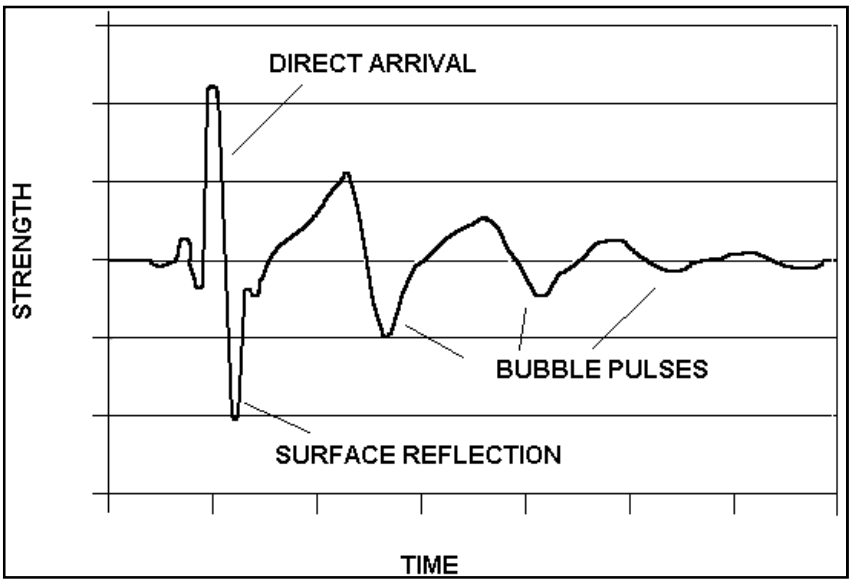


FIGURE 3-4: A TYPICAL PRESSURE SIGNATURE PRODUCED ON FIRING OF AN AIRGUN.

3.2.5 Vessel Exclusion Zone

The acquisition of high quality seismic data requires that the position of the survey vessel and the array be accurately known. Seismic surveys consequently require accurate navigation of the sound source over pre-determined survey transects. This, and the fact that the array and the hydrophone streamer(s) need to be towed in a set configuration behind the survey vessel, means that the survey operation has little manoeuvrability while operating.

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Rule 18), survey vessels that are engaged in surveying or towing operations are defined as "vessel restricted in its ability to manoeuvre"[3] which requires that power-driven and sailing vessels give way to a vessel restricted in

[3] Definition: The term "vessel restricted in her ability to manoeuvre" means a vessel which from the nature of her work is restricted in her ability to manoeuvre as required by these Rules and is therefore unable to keep out of the way of another vessel. The term "vessels restricted in their ability to manoeuvre" shall include but not be limited to:

(i) a vessel engaged in laying, servicing, or picking up a navigation mark, submarine cable or pipeline;
(ii) a vessel engaged in dredging, surveying or underwater operations;
(iii) a vessel engaged in replenishment or transferring persons, provisions or cargo while underway;
(iv) a vessel engaged in the launching or recovery of aircraft;
(v) a vessel engaged in mine clearance operations; and
(vi) a vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course.

its ability to manoeuvre. Vessels engaged in fishing shall, so far as possible, keep out of the way to a vessel restricted in its ability to manoeuvre. Furthermore, under the Marine Traffic Act, 1981 (No. 2 of 1981), a vessel (including array of airguns and hydrophones) used for the purpose of exploiting the seabed falls under the definition of an “offshore installation” and as such it is protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter the safety zone. In addition to a statutory 500 m safety zone, a seismic contractor would typically request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond. Typical safe operational limits for a 2D and 3D survey are illustrated in Figure 3-3.

At least a 500 m exclusion zone would need to be enforced around the survey vessel (including its array of airguns and hydrophones) at all times. A chase boat with appropriate radar and communications would be used during the seismic survey to warn vessels that are in danger of breaching the exclusion zone.

The 500 m safety zone and proposed safe operational limits would be communicated to key stakeholders well in advance of the proposed exploration programme. Notices to Mariners will also be communicated through the proper channels.

3.2.6 Support Services

A support vessel may be required to perform logistics support to the seismic vessel. Bunkering of the survey vessels is expected to be undertaken at port of operation or at sea during the survey. Standard operating procedures for refuelling would be adhered to at all times.

3.3 DETAILED SEISMIC SURVEY SPECIFICATIONS

PGS proposes to use a vessel similar to the *M/V Ramform Sovereign* (Plate 3.1) to acquire the seismic data for the proposed surveys. A support vessel would be commissioned as a "chase" boat. This vessel would be equipped with appropriate radar and communications to patrol the area during the seismic surveys to ensure that other vessels adhere to the safe operational limits. The chase boat would assist in alerting other vessels (e.g. fishing, transport, etc.) about the proposed survey and the lack of manoeuvrability of the survey vessel. The chase boat would also be required to perform logistics support to the survey vessel. Some of the basic specifications of the survey vessel are provided in Table 3-3 below.

PLATE 3.1: POSSIBLE SURVEY VESSEL, *M/V RAMFORM SOVEREIGN.*

TABLE 3-3: VESSEL SPECIFICATIONS OF M/V RAMFORM SOVEREIGN.

Specification	*M/V Ramform Sovereign*
Call sign	C6CR8
Length	102.2
Draft	7.4m
Gross tonnage	13688
Max speed	18 knots in transit

The airgun and hydrophone array specifications are summarised in Table 3-4. In summary, a typical survey array would consist of 24 active guns with operating pressures of 2 000 pound-force per square inch (psi). The airgun sound source would be situated approximately 50 m behind the vessel at approximately 7 to 8 m below the surface. The single hydrophone steamer would be up to 12 km long. The streamer would be towed at a variable depth of 20 to 25 m and would not be visible, except for the tail-buoy at the far end of the streamer.

TABLE 3-4: AIRGUN AND HYDROPHONE ARRAY SPECIFICATIONS.

Airgun and hydrophone array specifications	*M/V Ramform Sovereign*
No. of active air guns	24
Nominal source pressure (typical)	2000 psi
Depth of airgun	7/8m
Distance of airgun behind vessel	50 m
Streamers (max)	12
No. of hydrophones	7
Streamer depth	20-25m

4 THE AFFECTED ENVIRONMENT

This chapter provides a description of the biophysical and socio-economic environment likely to be affected by the proposed seismic surveys.

4.1 INTRODUCTION

The West Coast region lies between the Namibian border at the Orange River mouth (28° 38' S, 16° 27' E) and Cape Agulhas (34° 35'S; 20° 00'E) to the offshore limit of the South African Exclusive Economic Zone (EEZ). The South Coast region is typically defined as lying between Cape Agulhas (34° 35'S; 20° 00'E) and Cape Padrone (33° 45'S; 26° 30'E). The baseline description of the physical and biological environments along the South African West and South Coasts set out below focus primarily on the broader study area between the Orange River mouth and Cape Agulhas (i.e. predominately the West Coast).

4.2 METEOROLOGY

Wind and weather patterns along the West Coast are primarily due to the South Atlantic high-pressure cell and the eastward movement of mid-latitude cyclones (which originate within the westerly wind belt between 35° to 45°S), south of the subcontinent. The high-pressure cell is a perennial feature that forms part of a discontinuous belt of high-pressure systems, which encircle the subtropical southern hemisphere. This undergoes seasonal variations, being strongest in the austral summer, when it also attains its southernmost extension, lying south west and south of the subcontinent. In winter, the south Atlantic anticyclone weakens and migrates north-westwards.

These seasonal changes result in substantial differences between the typical summer and winter wind patterns in the region, as the southern hemisphere anti-cyclonic high-pressures system, and the associated series of cold fronts, moves northwards in winter, and southwards in summer. The strongest winds occur in summer (October to March), during which winds blow 98% of the time, with a total of 226 gales (winds exceeding 18 m/s or 35 kts) being recorded over the period (CSIR 2006). Virtually all winds in summer come from the south to south-southeast (Figure 4-1). The combination of these southerly/south-easterly winds drives the massive offshore movements of surface water, and the resultant strong upwelling of nutrient-rich bottom waters, which characterise this region in summer.

The winds in the offshore environment of the Reconnaissance Permit Area are less extreme than closer to the coast (NCEP 2012). However, during winter the westerly winds blow in synchrony with the prevailing south-westerly swell direction, resulting in heavier swell conditions.

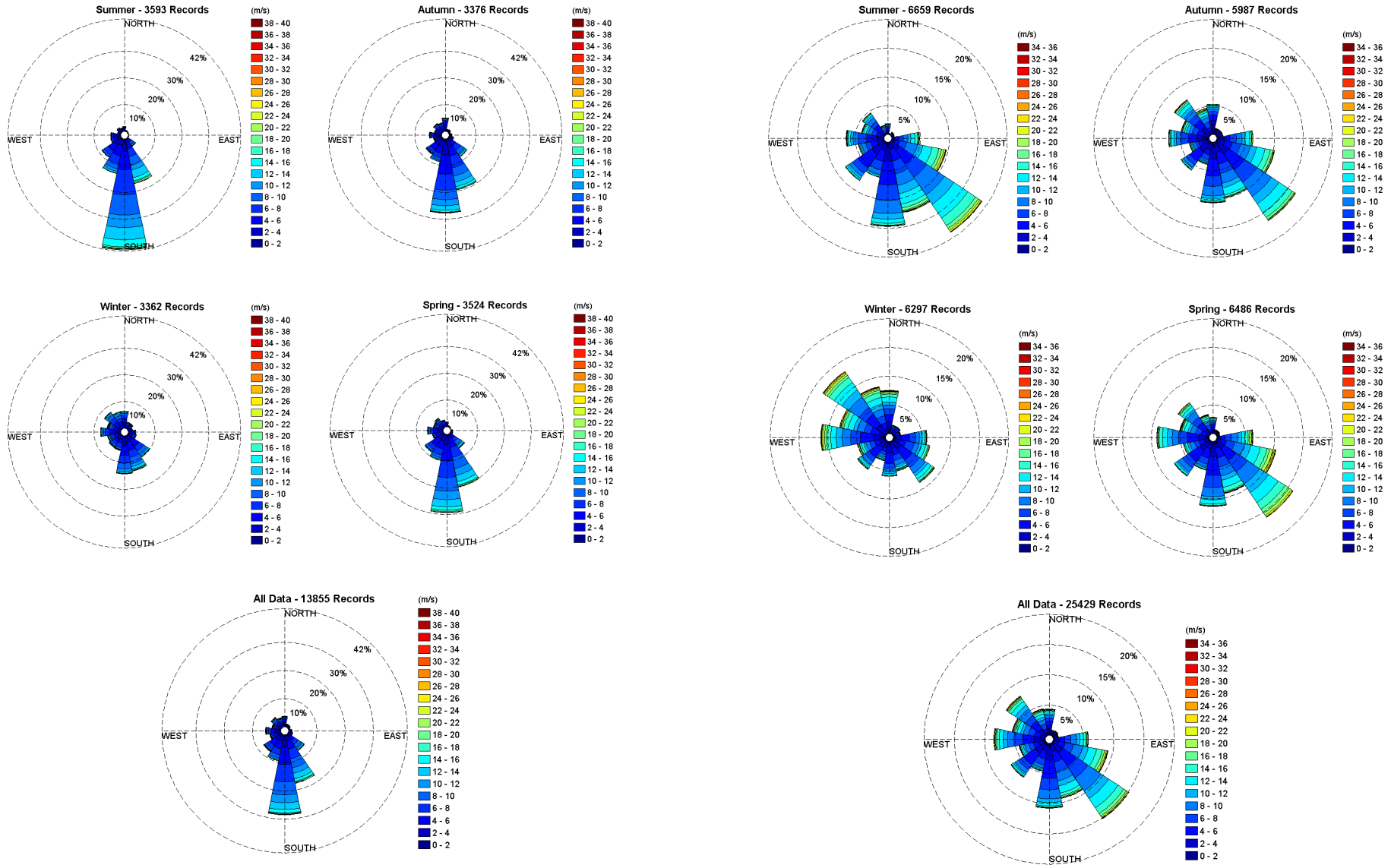


FIGURE 4-1: VOS WIND SPEED VS. WIND DIRECTION DATA FOR THE CAPE COLUMBINE AREA (LEFT) AND THE CAPE POINT AREA (RIGHT) (FROM CSIR).

4.3 PHYSICAL OCEANOGRAPHY

4.3.1 Bathymetry and Sediments

The continental shelf along the West Coast is generally wide and deep, although large variations in both depth and width occur. The shelf maintains a general north-north-west trend, widening north of Cape Columbine and reaching its widest off the Orange River (180 km). The shelf widens again south of Cape Point due to the presence of the Agulhas Bank (see Figure 4-2).

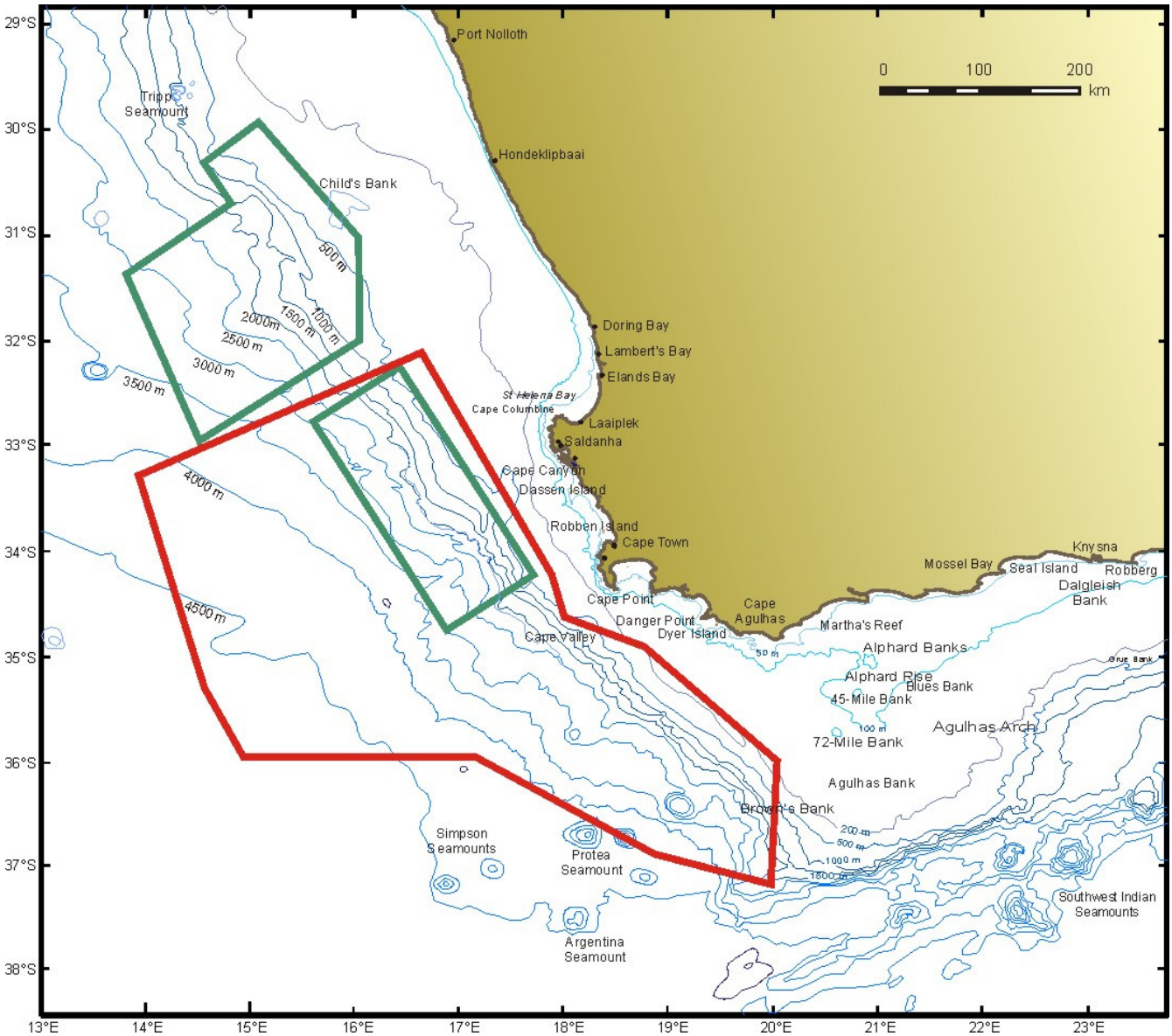


FIGURE 4-2: LOCATION OF THE PROPOSED 2D SURVEY AREA (RED POLYGON) AND 3D SURVEY AREAS (GREEN POLYGONS) IN RELATION TO BATHYMETRIC FEATURES OFF THE SOUTH AND WEST COAST OF SOUTH AFRICA.

The inner shelf along the West Coast is underlain by Precambrian bedrock (Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle 1973; Dingle *et al.*

1987; Birch *et al.* 1976; Rogers 1977; Rogers & Bremner 1991). As a result of erosion on the continental shelf along the West Coast, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. Further offshore and within the Reconnaissance Permit Area, benthic habitats are dominated by lower bathyal and abyssal unconsolidated muds and sandy muds (Sink *et al.* 2011; Figure 4-3). The continental slope, seaward of the shelf break, has a smooth seafloor, underlain by calcareous ooze.

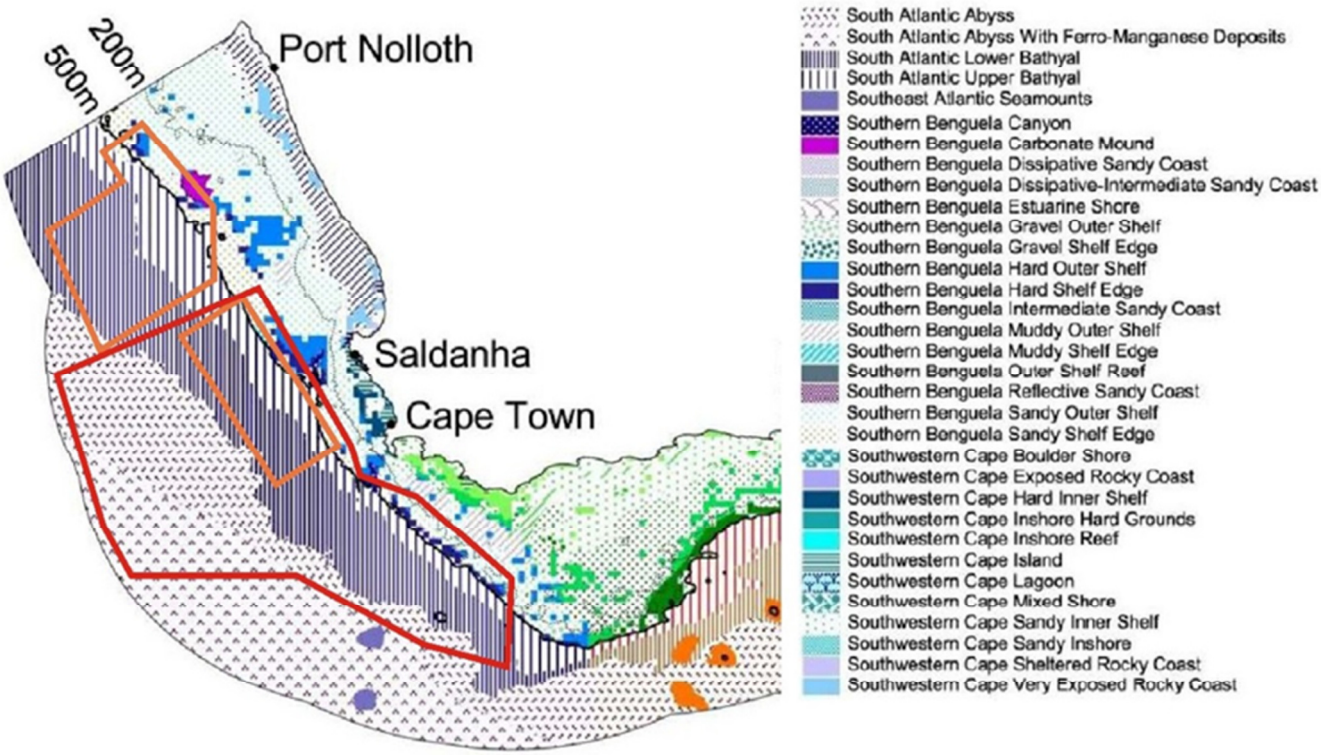


FIGURE 4-3: OFFSHORE BENTHIC HABITAT TYPES ON THE WEST AND SOUTH COASTS (ADAPTED FROM SINK *ET AL.* 2012). COASTAL AND AGULHAS BANK HABITAT TYPES ARE NOT SHOWN IN THE KEY.

4.3.2 Large-Scale Circulation and Coastal Currents

The southern African West Coast is strongly influenced by the Benguela Current. The ocean currents are complex and are summarised in Figure 4-4. Current velocities in continental shelf areas generally range between 10 – 30 cm/s (Boyd & Oberholster 1994). On the western side of the Benguela Current, flow is more transient and characterised by large eddies that are shed from the retroflection of the Agulhas Current. This results in considerable variation in current speed and direction over the domain. In the south, the Benguela current has a width of 200 km, widening rapidly northwards to 750 km. The surface flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington *et al.* 1990; Nelson & Hutchings 1983).

Fluctuation periods of these flows are 3 - 10 days, although the long-term mean current residual is in an approximate northwest (alongshore) direction. Current speeds decrease with depth, while directions rotate

from predominantly north-westerly at the surface to south-easterly near the seabed. Near bottom shelf flow is mainly poleward with low velocities of typically <5 cm/s (Nelson 1989).

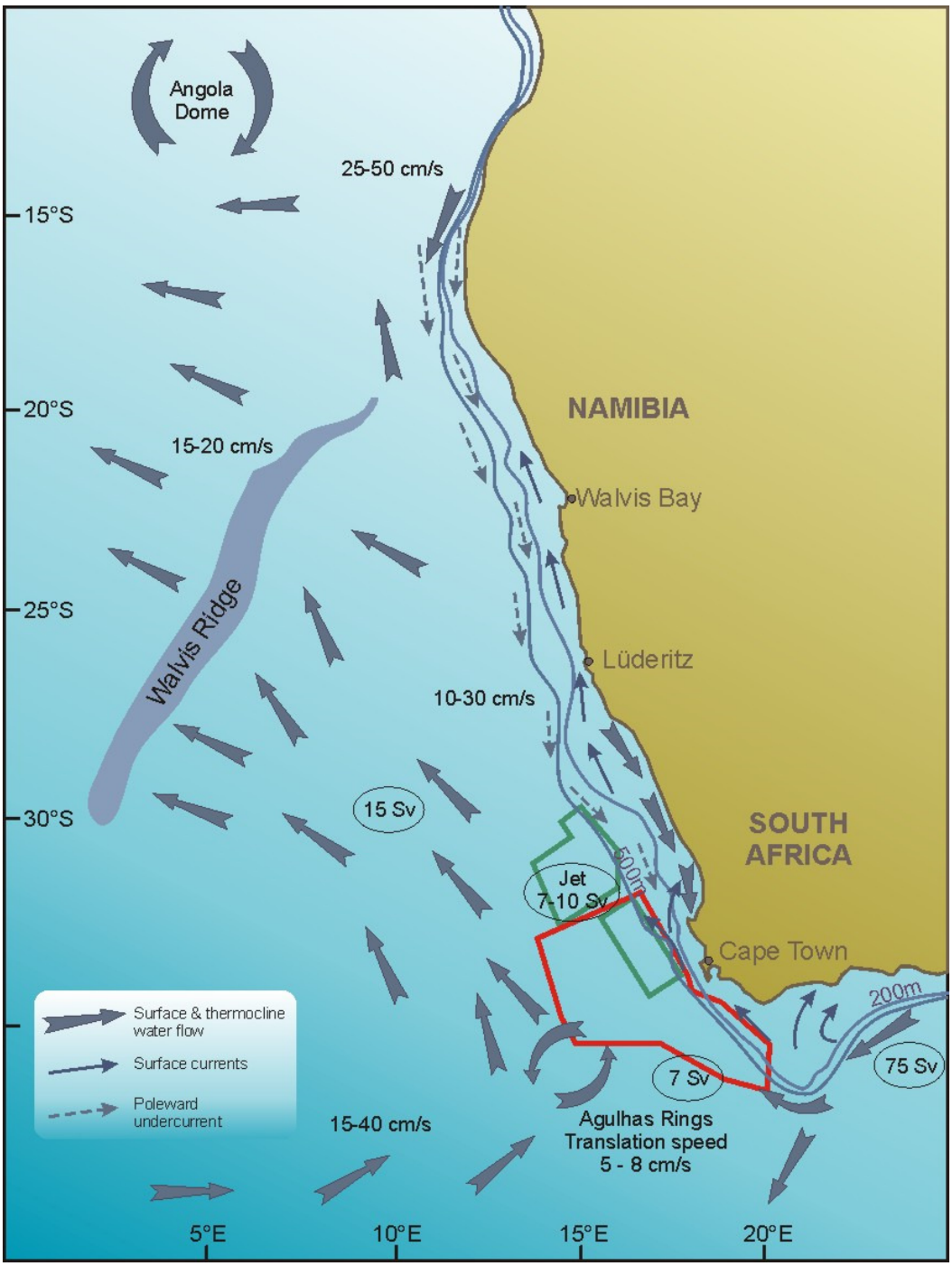


FIGURE 4-4: MAJOR FEATURES OF THE PREDOMINANT CIRCULATION PATTERNS AND VOLUME FLOWS IN THE BENGUELA SYSTEM, ALONG THE SOUTHERN NAMIBIAN AND SOUTH AFRICAN WEST COASTS (RE-DRAWN FROM SHANNON & NELSON 1996). THE PROPOSED SURVEY AREAS ARE ALSO SHOWN.

The major feature of the Benguela Current is coastal upwelling (see Section 4.3.4). As a consequence, the high nutrient supply to surface waters leads to high primary phytoplankton production, which in turn, serves as the basis for a rich food chain. The prevailing longshore, equatorward winds move nearshore surface water northwards and offshore. To balance the displaced water, cold, nutrient-rich water wells up inshore. Although

the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest.

There are three upwelling centres in the southern Benguela, namely the Namaqua (30°S), Cape Columbine (33°S) and Cape Point (34°S) upwelling cells (Taunton-Clark 1985). Upwelling in these cells is seasonal, with maximum upwelling occurring between September and March. The proposed 2D and 3D survey areas are located offshore of these upwelling events.

Where the Agulhas Current passes the southern tip of the Agulhas Bank (Agulhas Retroflection area), it may shed a filament of warm surface water that moves north-westward along the shelf edge towards Cape Point, and Agulhas Rings, which similarly move north-westwards through the Reconnaissance Permit Area into the South Atlantic Ocean. These rings may extend to the seafloor and west of Cape Town may split, disperse or join with other rings. During the process of ring formation, intrusions of cold subantarctic water moves into the South Atlantic. The contrast in warm (nutrient-poor) and cold (nutrient-rich) water is thought to be reflected in the presence of cetaceans and large migratory pelagic fish species (Best 2007).

4.3.3 Waves and Tides

Much of the coastline (i.e. east of the Reconnaissance Permit Application area) is exposed and experiences strong wave action, rated 13 to 17 on the 20 point exposure scale (McLachlan 1980). It is impacted by heavy south-westerly swells generated in the roaring forties, as well as significant sea waves generated locally by the prevailing moderate to strong southerly winds. The peak wave energy periods fall in the range 9.7 – 15.5 seconds.

The wave regime along the southern African West Coast shows only moderate seasonal variation in direction, with virtually all swells throughout the year coming from the south and south-southwest direction. Winter swells are strongly dominated by those from south and south-southwest, which occur almost 80% of the time, and typically exceed 2 m in height, averaging about 3 m, and often attaining over 5 m. With wind speeds capable of reaching 100 km/h during heavy winter south-westerly storms, winter swell heights can exceed 10 m.

In comparison, summer swells tend to be smaller on average, typically around 2 m, not reaching the maximum swell heights of winter. There is also a slightly more pronounced southerly swell component in summer. These southerly swells tend to be wind-induced, with shorter wave periods (approximately 8 seconds), and are generally steeper than swell waves (CSIR 1996). These wind-induced southerly waves are relatively local and, although less powerful, tend to work together with the strong southerly winds of summer to cause the northward-flowing.

In common with the rest of the southern African coast, tides are semi-diurnal, with a total range of some 1.5 m at spring tide, but only 0.6 m during neap tide periods.

4.3.4 Organic Inputs

The Benguela upwelling region is an area of particularly high natural productivity, with extremely high seasonal production of phytoplankton and zooplankton. These plankton blooms in turn serve as the basis for a rich food chain up through pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (snoek), mammals (primarily seals and dolphins) and seabirds (African penguins, cormorants, pelicans, terns and others). All of these species are subject to natural mortality, and a proportion of the annual production of all these trophic levels, particularly the plankton communities, die naturally and sink to the seabed.

Balanced multispecies ecosystem models have estimated that the Benguela region supported biomasses of 76.9 tons/km^2 of phytoplankton and 31.5 tons/km^2 of zooplankton alone (Shannon *et al.* 2003). Thirty-six percent (36%) of the phytoplankton and 5% of the zooplankton are estimated to be lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters.

An associated phenomenon ubiquitous to the Benguela system are red-tides (dinoflagellate and/or ciliate blooms) (see Shannon & Pillar 1985; Pitcher 1998). Also referred to as Harmful Algal Blooms (HABs), these red-tides can reach very large proportions, extending over several square kilometres of ocean. Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water. As the Reconnaissance Permit Application area is located offshore of the upwelling cells, organic inputs into the area are likely to be minimal, and HABs are not expected to occur.

4.3.5 Low Oxygen Events

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations with less than 40% saturation occurring frequently (e.g. Bailey *et al.* 1985). The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman & Shannon 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches, there are corresponding preferential areas for the formation of oxygen-poor water. The two main areas of low-oxygen water formation in the southern Benguela region are in the Orange River Bight and St Helena Bay (Bailey 1991; Shannon & O'Toole 1998; Bailey 1999; Fossing *et al.* 2000).

The spatial distribution of oxygen-poor water in each of the areas is subject to short- and medium-term variability in the volume of hypoxic water that develops. Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

The subsurface water masses of the offshore areas within the Reconnaissance Permit Application area boundary, comprise the Antarctic Intermediate water and Antarctic Bottom water (>4 000 m depth). Antarctic bottom water has a high oxygen content relative to the rest of the oceans' deep waters.

4.3.6 Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) can be divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays.

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/l to several tens of mg/l (Fegley *et al.* 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/l, showing significant long-shore variation (Zoutendyk 1995). Considerably higher concentrations of PIM have, however, been reported from southern African West Coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions. During storm events, concentrations near the seabed may even reach up to 10 000 mg/l (Miller & Sternberg 1988). In the vicinity of the Orange River mouth, where river outflow strongly influences the turbidity of coastal waters, measured concentrations ranged from 14.3 mg/l at Alexander Bay just south of the mouth (Zoutendyk 1995) to peak values of 7 400 mg/l immediately upstream of the river mouth during the 1988 Orange River flood (Bremner *et al.* 1990).

On the inner and middle continental shelf, the ambient currents are insufficient to transport coarse sediments typical of those depths, and re-suspension and shoreward movement of these by wave-induced currents occur primarily under storm conditions. Data from a Waverider buoy at Port Nolloth have indicated that 2 m waves are capable of re-suspending medium sands (200 µm diameter) at approximately 10 m depth, whilst 6 m waves achieve this at approximately 42 m depth. Low-amplitude, long-period waves will, however, penetrate even deeper. Most of the sediment shallower than 90 m can therefore be subject to re-suspension and transport by heavy swells (Lane & Carter 1999).

Offshore of the continental shelf, the oceanic waters are typically clear as they are beyond the influence of Aeolian and riverine inputs. The waters in the Reconnaissance Permit Application area are thus expected to be comparatively clear.

4.3.7 Sedimentary Phosphates

In the marine environment, phosphorite (sedimentary rock typically containing between 5%-20% phosphate) occurs either as a nodular hard ground capping of a few metres thick or as series of unconsolidated sediments (Morant 2013). Several types of sedimentary phosphates occur offshore and onshore in South Africa, the largest of which is the diagenetic replacement resource on the Agulhas Bank. These replacement phosphate

resources occur as near-continuous 'pavements' or cappings of limestones at depths between 200 m and 500 m on the continental shelf between Cape Agulhas and Cape Recife, covering an approximate area of 21 500 km^2. Further sporadic phosphate mantles over the continental shelf are known to occur from Lamberts Bay, north to the mouth of the Orange River (see Figure 4-5).

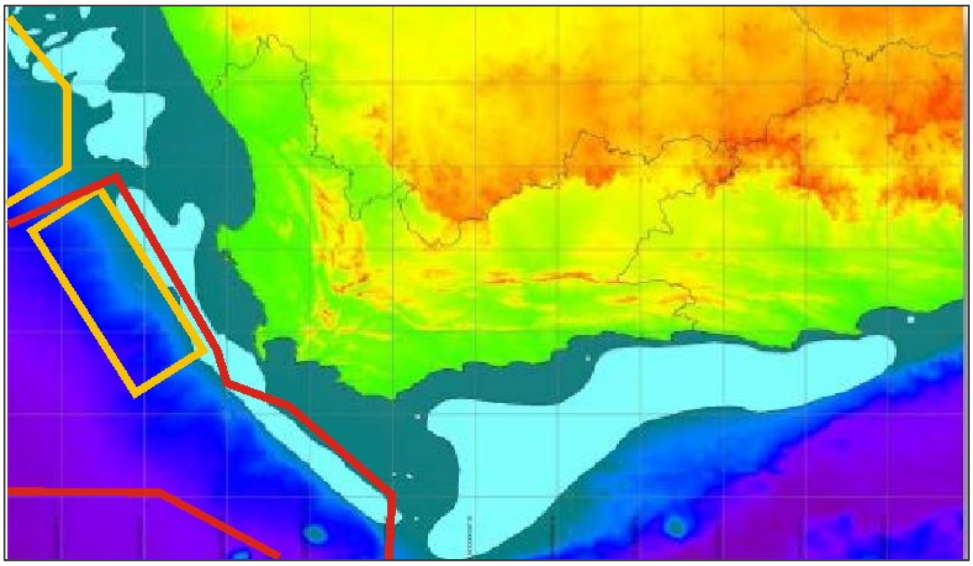


FIGURE 4-5: THE PROPOSED 2D AND 3D SURVEY AREAS (ORANGE AND RED POLYGONS) IN RELATION TO PHOSPHORITE (BLUE) ON THE SOUTH AFRICAN CONTINENTAL SHELF (ADAPTED FROM MORANT 2013).

The "open shelf" phosphorite deposits formed during several episodes over the last 1.7 – 65 million years. They originated from the precipitation of phosphate (from calcium phosphate) in an environment of intense upwelling and high biological activity along the continental margin of South Africa. The upwelling resulted in a change in temperature and pressure of the phosphate-laden oceanic waters. This consequently precipitated the phosphates (in the form of apatite) over the continental shelf to form phosphatic packstones and colitic pellets at the sediment-water interface.

The phosphate-bearing lithologies comprise three non-conglomeratic and two conglomeratic rock types. The non-conglomeratic types are phosphatized foraminiferal lime packstones (a type of limestone), which are either poor in glauconite and quartz, rich in goethite, or highly glauconitic. The first conglomeratic type is also rich in glauconite, but contains pebble inclusions of phosphatized foraminiferal limestone. The second conglomeratic type is distinguished by its low glauconite content and high macrofossil and goethite abundance. The depth of mineralization within the conglomeratic ores is typically restricted to the upper few metres of sediment. The Agulhas Bank offshore phosphate deposits are estimated to contain in the order of 5 000 million tons of phosphorus pentoxide (Birch 1990).

4.4 BIOLOGICAL OCEANOGRAPHY

Biogeographically, the Reconnaissance Permit Application area primarily falls into the Atlantic Offshore Bioregion (see Figure 4-6), with the inshore portions overlapping with the South-western Cape and Namaqua Bioregions. The coastal, wind-induced upwelling characterising the Western Cape coastline, is the principle physical process that shapes the marine ecology of the southern Benguela region. The Benguela system is

characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions.

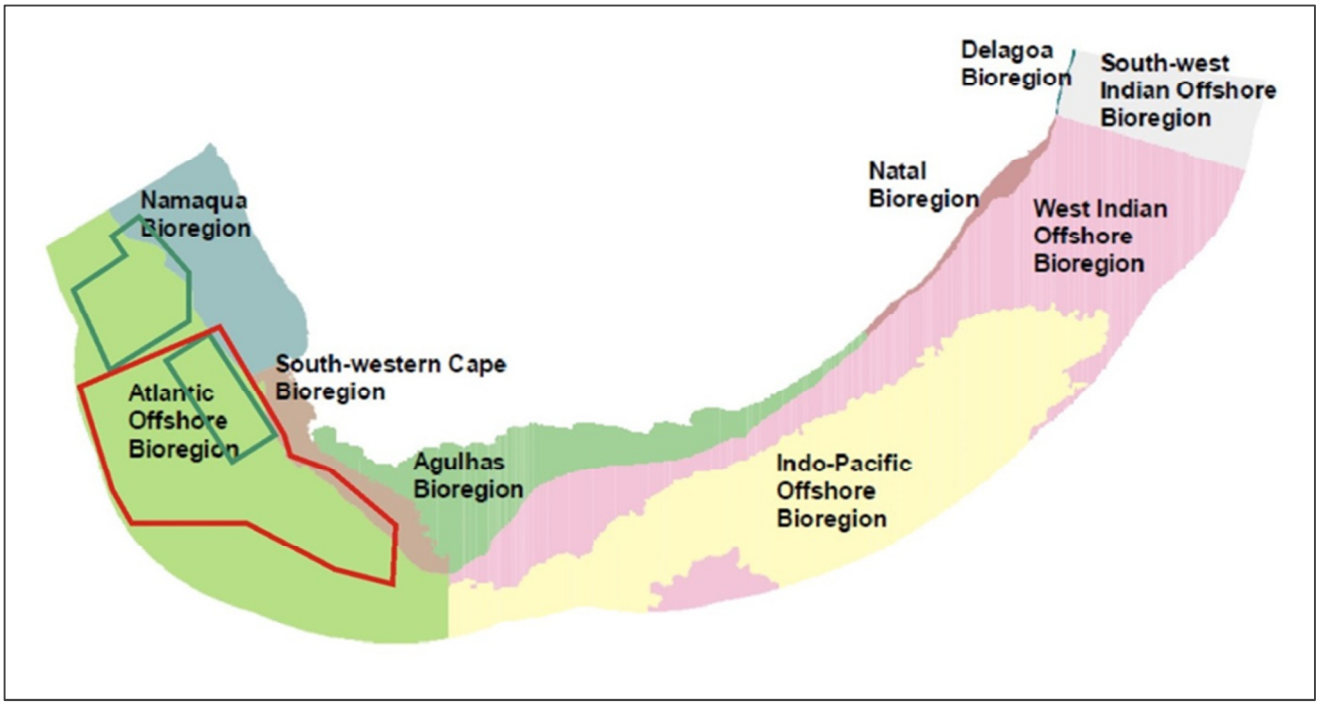


FIGURE 4-6: THE SPECULATIVE 2D (RED POLYGON) AND 3D (GREEN POLYGONS) SURVEY AREAS IN RELATION TO THE SOUTH AFRICAN INSHORE AND OFFSHORE BIOREGIONS (ADAPTED FROM LOMBARD *ET AL.* 2004).

Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments and the water column. The biological communities 'typical' of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species, which may be affected by the proposed exploration activities.

4.4.1 Demersal Communities

4.4.1.1 Benthic Invertebrate Macrofauna

The benthic biota of unconsolidated marine sediments constitute invertebrates that live on (epifauna) or burrow within (infauna) the sediments, and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm). To date very few areas on the continental slope off the West and South Coasts have been biologically surveyed, and consequently the benthic fauna of the outer shelf and continental slope (beyond depths of 450 m) are very poorly known. This is primarily due to limited opportunities for sampling as well as the lack of access to equipment for visual sampling of hard substrata.

Due to the lack of information on benthic macrofaunal communities beyond the shelf break, no description can be provided for the Reconnaissance Permit Area. Generally, however, polychaetes, crustaceans and molluscs

make up the largest proportion of individuals, biomass and species of macro-infauna communities on the west coast. Typically species richness increases from the inner-shelf across the mid-shelf and is influenced by sediment type. The distribution of species are typically inherently patchy reflecting the high natural spatial and temporal variability associated with macro-infauna of unconsolidated sediments (e.g. Kenny *et al.* 1998; Kendall & Widdicombe 1999; van Dalfsen *et al.* 2000; Zajac *et al.* 2000; Parry *et al.* 2003), with evidence of mass mortalities and substantial recruitments recorded on the South African West Coast (Steffani & Pulfrich 2004).

Despite the current lack of knowledge of the community structure and endemicity of South African macro-infauna off the edge of the continental shelf, the marine component of the 2011 National Biodiversity Assessment (Sink *et al.* 2012), rated the South Atlantic bathyal and abyssal unconsolidated habitat types that characterise depths beyond 500 m, as 'least threatened' (see Figure 4-7, left). This primarily reflects the great extent of these habitats in the South African Exclusive Economic Zone (EEZ).

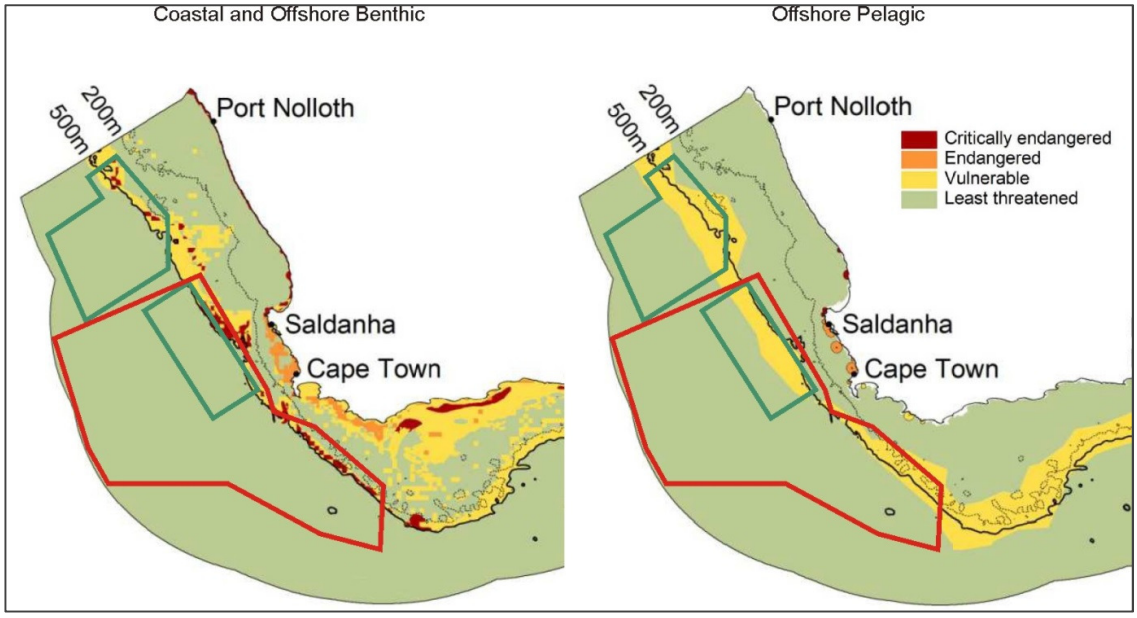


FIGURE 4-7: SPECULATIVE 2D (GREEN OUTLINE) AND 3D (RED OUTLINE) SURVEY AREAS IN RELATION TO ECOSYSTEM THREAT STATUS FOR COASTAL AND OFFSHORE BENTHIC HABITAT TYPES (LEFT), AND OFFSHORE PELAGIC HABITAT TYPES (RIGHT) ON THE SOUTH AFRICAN WEST AND SOUTH COASTS (ADAPTED FROM SINK *ET AL.* 2012).

Benthic communities are structured by the complex interplay of a large array of environmental factors. Water depth and sediment grain size are considered the two major factors that determine benthic community structure and distribution on the South African west coast (Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b). However, studies have shown that shear bed stress - a measure of the impact of current velocity on sediment – oxygen concentration (Post *et al.* 2006; Currie *et al.* 2009; Zettler *et al.* 2009), productivity (Escaravage *et al.* 2009), organic carbon and seafloor temperature may also strongly influence the structure of benthic communities. There are clearly other natural processes operating in the deepwater shelf areas of the West Coast that can override the suitability of sediments in determining benthic community structure, and it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro & van der Plas 2006; Pulfrich *et al.* 2006). In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions, or colonising

and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure.

The invertebrate macrofauna are important in the marine benthic environment as they influence major ecological processes (e.g. remineralisation and flux of organic matter deposited on the sea floor, pollutant metabolism, sediment stability) and serve as important food source for commercially valuable fish species and other higher order consumers. As a result of their comparatively limited mobility and permanence over seasons, these animals provide an indication of historical environmental conditions and provide useful indices with which to measure environmental impacts (Gray 1974; Warwick 1993; Salas *et al.* 2006).

Also associated with soft-bottom substrates are demersal communities that comprise epifauna and bottom-dwelling vertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source. According to Lange (2012) the the continental shelf on the West Coast between depths of 100 m and 250 m, contained a single epifaunal community characterised by the hermit crabs *Sympagurus dimorphus* and *Parapaguris pilosimanus*, the prawn *Funchalia woodwardi* and the sea urchin *Brisaster capensis*. Atkinson (2009) also reported numerous species of urchins and burrowing anemones beyond 300 m depth off the West Coast. Information on epifauna from beyond the shelf, and from depths corresponding to those in the Reconnaissance Permit Application area, is lacking.

4.4.1.2 Demersal Fish Species

Demersal fish are those species that live and feed on or near the seabed. As many as 110 species of bony and cartilaginous fish have been identified in the demersal communities on the continental shelf of the West Coast (Roel 1987). Changes in fish communities occur with increasing depth (Roel 1987; Smale *et al.* 1993; Macpherson & Gordoa 1992; Bianchi *et al.* 2001; Atkinson 2009), with the most substantial change in species composition occurring in the shelf break region between 300 m and 400 m depth (Roel 1987; Atkinson 2009). The shelf community (< 380 m) is dominated by the Cape hake (*M. capensis)*, and includes jacopever (*Helicolenus dactylopterus)*, izak catshark (*Holohalaelurus regain)*, soupfin shark (*Galeorhinus galeus)* and whitespotted houndshark (*Mustelus palumbes)*. The more diverse deeper water community is dominated by the deep water hake (*Merluccius paradoxus)*, monkfish (*Lophius vomerinus)*, kingklip (*Genypterus capensis)*, bronze whiptail (*Lucigadus ori)* and hairy conger (*Bassanago albescens)* and various squalid shark species. There is some degree of species overlap between the depth zones.

Roel (1987) showed seasonal variations in the distribution ranges of shelf communities, with species such as the pelagic goby (*Sufflogobius bibarbatus)*, and West Coast sole (*Austroglossus microlepis)* occurring in shallow water north of Cape Point during summer only. The deep-sea community was found to be homogenous both spatially and temporally. In a more recent study, however, Atkinson (2009) identified two long-term community shifts in demersal fish communities; the first (early to mid-1990s) being associated with an overall increase in density of many species, whilst many species decreased in density during the second shift (mid-2000s). These community shifts correspond temporally with regime shifts detected in environmental forcing variables (sea surface temperatures and upwelling anomalies) (Howard *et al.* 2007) and with the eastward shifts observed in small pelagic fish species and rock lobster populations (Coetzee *et al.* 2008, Cockcroft *et al.* 2008).

The diversity and distribution of demersal cartilagenous fishes on the West Coast over a depth range of 33 – 1 016 m is discussed by Compagno *et al.* (1991). However, as with demersal fish communities discussed above, information on cartilagenous fish beyond the shelf break, and from depths corresponding to those in the Reconnaissance Permit Area, is lacking.

4.4.2 Pelagic Communities

In contrast to demersal and benthic biota that are associated with the seabed, pelagic species live and feed in the open water column. The pelagic communities are typically divided into plankton and fish, and their main predators, namely marine mammals (seals, dolphins and whales), seabirds and turtles. It is noted that that the marine component of the 2011 National Biodiversity Assessment (Sink *et al.* 2012), rated the majority of the offshore pelagic habitat types that characterise depths beyond approximately 500 m, as 'least threatened' (see Figure 4-7, right), with only a narrow band along the shelf break of the West Coast (and on the eastern edge of the speculative survey areas being rated as 'vulnerable', primarily due to its importance as a migration pathway for various resource species (e.g. whales, tuna, billfish, turtles).

4.4.2.1 Plankton

Plankton is particularly abundant in the shelf waters off the West Coast, being associated with the upwelling characteristic of the area. Plankton range from single-celled bacteria to jellyfish of 2 m diameter, and include bacterio-plankton, phytoplankton, zooplankton and ichthyoplankton. However, further offshore in the warm, clear oceanic waters of the Reconnaissance Permit Application area, plankton abundance is likely to be limited.

Phytoplankton are the principle primary producers with mean productivity on the West Coast ranging from 2.5 - 3.5 g C/m^2/day for the midshelf region but declining inshore (Shannon & Field 1985; Mitchell-Innes & Walker 1991; Walker & Peterson 1991). The phytoplankton on the West Coast is dominated by large-celled organisms, which are adapted to the turbulent sea conditions. Red-tides are ubiquitous features of the Benguela system (see Shannon & Pillar, 1986). Most of these red-tide events occur quite close inshore although Hutchings *et al.* (1983) have recorded red-tides 30 km offshore. They are unlikely to occur in the offshore regions of the Reconnaissance Permit Application area.

The mesozooplankton (≥200 µm) along the West Coast is dominated by copepods, which are overall the most dominant and diverse group in southern African zooplankton. Most mesozooplankton occur in the phytoplankton rich upper mixed layer of the water column, although some species undertake considerable vertical migration. Standing stock estimates of mesozooplankton for the southern Benguela area range from 0.2 - 2.0 g C/m^2, with maximum values recorded during upwelling periods.

The macrozooplankton (≥1 600 µm) are dominated by euphausiids of which 18 species occur in the broader study area (Pillar *et al.* 1991). Macrozooplankton biomass ranges from 0.1 1.0 g C/m^2, with production increasing north of Cape Columbine (Pillar 1986). Although it shows no appreciable onshore-offshore gradients, standing stock is highest over the shelf, with accumulation of some continental slope biomass decreases markedly.

Zooplankton biomass varies with phytoplankton abundance and, accordingly, seasonal minima will exist during non-upwelling periods when primary production is lower (Brown 1984; Brown & Henry 1985), and during winter when predation by recruiting anchovy is high. More intense variation will occur in relation to the upwelling cycle; newly upwelled water supporting low zooplankton biomass due to paucity of food, whilst high biomasses develop in aged upwelled water subsequent to significant development of phytoplankton. Irregular pulsing of the upwelling system, combined with seasonal recruitment of pelagic fish species into West Coast shelf waters during winter, thus results in a highly variable and dynamic balance between plankton replenishment and food availability for pelagic fish species. No upwelling events are expected within the proposed survey areas.

Although ichthyoplankton (fish eggs and larvae) comprise a minor component of the overall plankton, it remains significant due to the commercial importance of the overall fishery in the region. Various pelagic and demersal fish species are known to spawn in the inshore regions of the southern Benguela, including pilchard, round herring, chub mackerel, lanternfish and hakes (see Figure 4-8), and their eggs and larvae form an important contribution to the ichthyoplankton in the region. No important fish spawning areas are expected to be found within the majority of the Reconnaissance Permit Application area, although the southern portion of the proposed 2D survey area does overlap with spawning areas on the western edge of the Agulhas Bank. Ichthyoplankton abundance in the offshore oceanic waters of the Reconnaissance Permit Application area is expected to be low.

4.4.2.2 Cephalopods

The major cephalopod resource in the southern Benguela are sepiods / cuttlefish (Lipinski 1992; Augustyn *et al.* 1995). Most of the cephalopod resource is distributed on the mid-shelf with *Sepia australis* being most abundant at depths between 60-190 m, whereas *S. hieronis* densities were higher at depths between 110-250 m. *Rossia enigmatica* occurs more commonly on the edge of the shelf to depths of 500 m. Biomass of these species was generally higher in the summer than in winter. Cuttlefish are largely epi-benthic and occur on mud and fine sediments in association with their major prey item; mantis shrimps (Augustyn *et al.* 1995). They form an important food item for demersal fish.

Pelagic invertebrates that may be encountered in the Reconnaissance Permit Application area are the colossal squid (*Mesonychoteuthis hamiltoni*) and the giant squid (*Architeuthis sp*.). Both are deep-dwelling species, with the colossal squid's distribution confined to the entire circum-Antarctic Southern Ocean while the giant squid is usually found near continental and island slopes all around the world's oceans. Both species could thus potentially occur in the Reconnaissance Permit Application area, although the likelihood of encounter is extremely low. Growing to in excess of 10 m in length, they are the principal prey of the sperm whale, and are also taken by beaked whaled, pilot whales, elephant seals and sleeper sharks. Nothing is known of their vertical distribution, but data from trawled specimens and sperm whale diving behaviour suggest they may span a depth range of 300 – 1 000 m. They lack gas-filled swim bladders and maintain neutral buoyancy through an ammonium chloride solution occurring throughout their bodies.

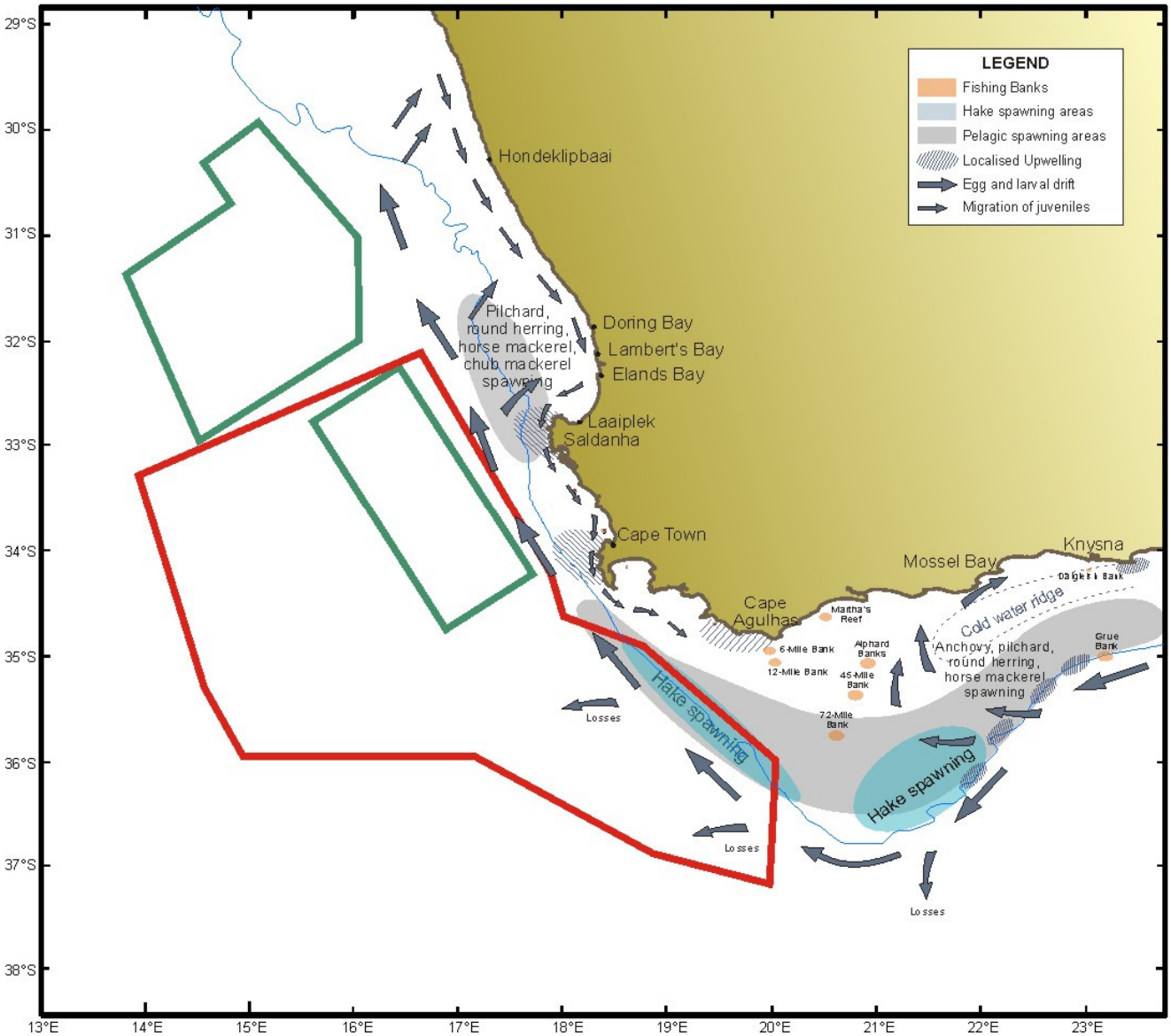


FIGURE 4-8: THE PROPOSED 2D (RED POLYGON) AND 3D (GREEN POLYGONS) SURVEY AREAS SHOWN IN RELATION TO MAJOR SPAWNING AREAS IN THE SOUTHERN BENGUELA REGION (AFTER ANDERS 1975, CRAWFORD *ET AL.* 1987, HUTCHINGS 1994). THE 200 M DEPTH CONTOUR, AREAS OF LOCALISED UPWELLING AND THE EGG AND LARVAL DRIFT AND MIGRATION OF JUVENILES ARE ALSO SHOWN.

4.4.2.3 Pelagic Fish

Small pelagic species occurring beyond the surfzone and generally within the 200 m contour include the sardine/pilchard (*Sadinops ocellatus*), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes, and exhibit similar life history patterns involving seasonal migrations between the West and South coasts. These species typically occur in mixed shoals of various sizes (Crawford *et al.* 1987), and generally occur within the 200 m contour and are thus unlikely to be encountered in the Reconnaissance Permit Application area.

The spawning areas of the major pelagic species are distributed on the continental shelf and along the shelf edge from south of St Helena Bay to Mossel Bay on the South Coast (Shannon & Pillar 1986). They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried around Cape Point and up the coast in northward flowing surface waters. The spawning areas and northward egg and larval drift thus occurs inshore of the majority of the Reconnaissance Permit Application area, although some overlap does occur in the southern portion of the proposed 2D survey area with spawning areas on the western edge of the Agulhas Bank (refer to Figure 4-8).

At the start of winter every year, juveniles of most small pelagic shoaling species recruit into coastal waters in large numbers between the Orange River and Cape Columbine. They recruit in the pelagic stage, across broad stretches of the shelf, to utilise the shallow shelf region as nursery grounds before gradually moving southwards in the inshore southerly flowing surface current, towards the major spawning grounds east of Cape Point. Recruitment success relies on the interaction of oceanographic events, and is thus subject to spatial and temporal variability. Consequently, the abundance of adults and juveniles of these small, short-lived (1-3 years) pelagic fish is highly variable both within and between species.

Two species that migrate along the West Coast following the shoals of anchovy and pilchards are snoek (*Thyrsites atun)* and chub mackerel (*Scomber japonicas)*. Their appearance along the West and South-West coasts are highly seasonal. Snoek migrating along the southern African West Coast reach the area between St Helena Bay and the Cape Peninsula between May and August. They spawn in these waters between July and October before moving offshore and commencing their return northward migration (Payne & Crawford 1989). They are voracious predators occurring throughout the water column, feeding on both demersal and pelagic invertebrates and fish. Chub mackerel similarly migrate along the southern African West Coast reaching South-Western Cape waters between April and August. They move inshore in June and July to spawn before starting the return northwards offshore migration later in the year. Their abundance and seasonal migrations are thought to be related to the availability of their shoaling prey species (Payne & Crawford 1989).

The fish most likely to be encountered in the Reconnaissance Permit Application area are the large pelagic species such as tunas, billfish and pelagic sharks, which migrate throughout the southern oceans, between surface and deep waters (> 300 m). Species occurring off western southern Africa include the albacore/longfin tuna (*Thunnus alalunga*), yellowfin (*T. albacares*), bigeye (*T. obesus*), and skipjack (*Katsuwonus pelamis*) tunas, as well as the atlantic blue marlin (*Makaira nigricans*), the white marlin (*Tetrapturus albidus*) and the broadbill swordfish (*Xiphias gladius*) (Payne & Crawford 1989). The distribution of these species is dependent on food availability in the mixed boundary layer between the Benguela and warm central Atlantic waters. Underwater features in the Reconnaissance Permit Application area include the Cape Canyon and Cape Valley, which lie on the eastern boundary of the 2D and southern 3D survey areas, and Child's Bank and Brown's Bank, which lie on the edge of the proposed northern 3D survey area, and in the south-eastern portion of the proposed 2D survey area, respectively (see Figure 4-34). The South Atlantic Seamounts lie on and adjacent to the southern boundary of the Reconnaissance Permit Area. Seasonal association with Child's Bank (off Namaqualand) and Tripp Seamount (off southern Namibia and approximately 100 km north of the northern 3D survey area) occurs between October and June, with commercial catches often peaking in March and April.

A number of species of pelagic sharks are also known to occur on the West and South Coast, including blue (*Prionace glauca)*, short-fin mako (*Isurus oxyrinchus*) and oceanic whitetip sharks (*Carcharhinus longimanus*).

Occurring throughout the world in warm temperate waters, these species are usually found further offshore on the West Coast. Great whites (*Carcharodon carcharias*) and whale sharks (*Rhincodon typus*) may also be encountered in offshore areas, although the latter occurs more frequently along the South and East coasts. Of these the blue shark is listed as "Near threatened", and the short-fin mako, whitetip and great white as "Vulnerable" and whale sharks as "Endangered" on the International Union for Conservation of Nature (IUCN).

4.4.2.4 Turtles

Three species of turtle occur along the southern African West and South Coasts, namely the leatherback (*Dermochelys coriacea*), and occasionally the loggerhead (*Caretta caretta*) and the Green (*Chelonia mydas*) turtle. Loggerhead and green turtles are expected to occur only as occasional visitors along the West and South Coasts.

The leatherback is the only turtle likely to be encountered in the offshore waters of west South Africa. The Benguela ecosystem is increasingly being recognized as a potentially important feeding area for leatherback turtles from several globally significant nesting populations in the south Atlantic (Gabon, Brazil) and southeast Indian Ocean (South Africa) (Lambardi *et al.* 2008, Elwen & Leeney 2011). Leatherback turtles from the east South Africa population have been satellite tracked swimming around the west coast of South Africa and remaining in the warmer waters west of the Benguela ecosystem (Lambardi *et al.* 2008) (see Figure 4-9).

Leatherback turtles inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey (primarily jellyfish). Their abundance in the Reconnaissance Permit Area is unknown but expected to be low. Leatherback turtles are listed as "Critically Endangered" worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species). Loggerhead and green turtles are listed as "Endangered". As a signatory of CMS, South Africa is committed to conserve these species at an international level.

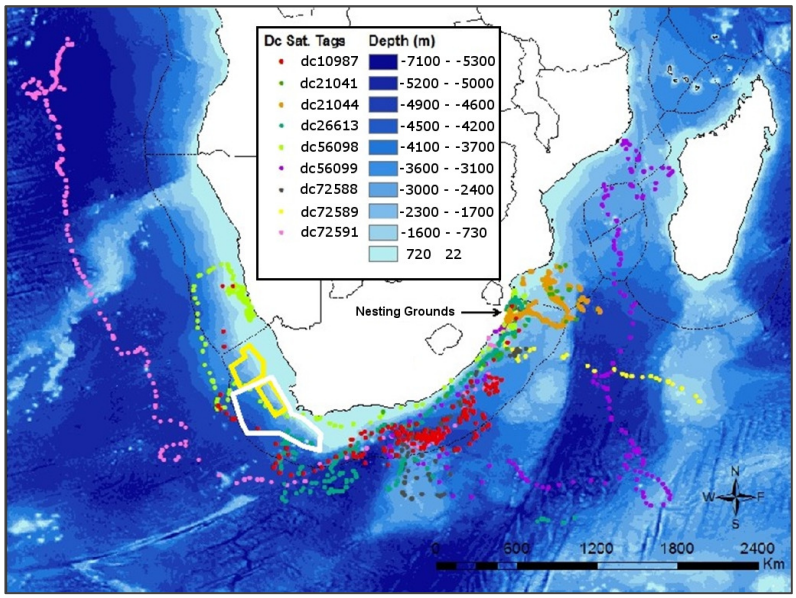


FIGURE 4-9: THE PROPOSED 2D AND 3D SURVEY AREAS IN RELATION TO THE POST-NESTING DISTRIBUTION OF NINE SATELLITE TAGGED LEATHERBACK FEMALES. (1996 – 2006; Oceans and Coast, unpublished data).

4.4.2.5 Seabirds

Large numbers of pelagic seabirds exploit the pelagic fish stocks of the Benguela system. Of the 49 species of seabirds that occur in the Benguela region, 14 are defined as resident, 10 are visitors from the northern hemisphere and 25 are migrants from the southern Ocean. The 18 species classified as being common in the southern Benguela are listed in Table 4-1. The area between Cape Point and the Orange River supports 38% and 33% of the overall population of pelagic seabirds in winter and summer, respectively. Most of the species in the region reach highest densities offshore of the shelf break (200 – 500 m depth), and would therefore expect to be encountered in the Reconnaissance Permit Application area, with highest population levels during their non-breeding season (winter). Pintado petrels and Prion spp. show the most marked variation here.

Fifteen species of seabirds breed in southern Africa: Cape Gannet, African penguin, four species of cormorant, white pelican, three gull and four tern species (Table 4-1). The breeding areas are distributed around the coast with islands being especially important. The closest breeding islands are the Saldanha Bay islands, Dassen Island off Yzerfontein, Robben Island in Table Bay and Dyer Island off Danger Point, approximately 75 km east of the eastern border of the proposed 2D survey area (Table 4-2). There is a further Cape Gannet breeding colony on Bird Island at Lambert's Bay, approximately 175 km east of the northern point of the 2D survey area. African Penguins nesting sites are at Dassen Island, Robben Island, Boulders beach in False Bay, Betty's Bay and Dyer Island.

TABLE 4-1: PELAGIC SEABIRDS COMMON IN THE SOUTHERN BENGUELA REGION (AFTER CRAWFORD *ET AL.* 1991).

Common Name	Species name	Global IUCN
Shy albatross	*Thalassarche cauta*	Near Threatened
Black browed albatross	*Thalassarche melanophrys*	Endangered[1]
Yellow nosed albatross	*Thalassarche chlororhynchos*	Endangered
Giant petrel sp.	*Macronectes halli/giganteus*	Near Threatened
Pintado petrel	*Daption capense*	Least concern
Greatwinged petrel	*Pterodroma macroptera*	Least concern
Soft plumaged petrel	*Pterodroma mollis*	Least concern
Prion spp	*Pachyptila* spp.	Least concern
White chinned petrel	*Procellaria aequinoctialis*	Vulnerable
Cory's shearwater	*Calonectris diomedea*	Least concern
Great shearwater	*Puffinus gravis*	Least concern
Sooty shearwater	*Puffinus griseus*	Near Threatened
European Storm petrel	*Hydrobates pelagicus*	Least concern
Leach's storm petrel	*Oceanodroma leucorhoa*	Least concern
Wilson's storm petrel	*Oceanites oceanicus*	Least concern
Blackbellied storm petrel	*Fregetta tropica*	Least concern
Skua spp.	*Catharacta/Stercorarius* spp.	Least concern
Sabine's gull	*Larus sabini*	Least concern

[1] May move to Critically Endangered if mortality from long-lining does not decrease.

TABLE 4-2: BREEDING RESIDENT SEABIRDS PRESENT ALONG THE WEST COAST (CCA & CMS 2001).

Common name	Species name	Global IUCN Status
African Penguin	*Spheniscus demersus*	Endangered
African Black Oystercatcher	*Haematopus moquini*	Near Threatened
White-breasted Cormorant	*Phalacrocorax carbo*	Least Concern
Cape Cormorant	*Phalacrocorax capensis*	Endangered
Bank Cormorant	*Phalacrocorax neglectus*	Endangered
Crowned Cormorant	*Phalacrocorax coronatus*	Near Threatened
White Pelican	*Pelecanus onocrotalus*	Least Concern
Cape Gannet	*Morus capensis*	Endangered
Kelp Gull	*Larus dominicanus*	Least Concern
Greyheaded Gull	*Larus cirrocephalus*	Least Concern
Hartlaub's Gull	*Larus hartlaubii*	Least Concern
Caspian Tern	*Hydroprogne caspia*	Vulnerable
Swift Tern	*Sterna bergii*	Least Concern
Roseate Tern	*Sterna dougallii*	Least Concern

The number of successfully breeding birds at the particular breeding sites varies with food abundance. Most of the breeding seabird species forage at sea with most birds being found relatively close inshore (10 - 30 km). Cape Gannets are known to forage up to 140 km offshore (Dundee 2006; Ludynia 2007), and African Penguins have been recorded as far as 60 km offshore. Penguins and gannets are thus likely to be encountered in the inshore portions of the Reconnaissance Permit Area during exploration activities.

4.4.2.6 Cetaceans (whales and dolphins)

Thirty-five species of whales and dolphins are known (based on historic sightings or strandings records) or likely (based on habitat projections of known species parameters) to occur in within the waters off the West and South coasts. The offshore areas have been particularly poorly studied with almost all available information from deeper waters (>200 m) arising from historic whaling records prior to 1970. Current information on the distribution, population sizes and trends of most cetacean species occurring on the west coast of southern Africa is lacking. Information on smaller cetaceans in deeper waters is particularly poor and the precautionary principal must be used when considering possible encounters with cetaceans in this area.

Records from stranded specimens and at-sea sightings show that the area between St Helena Bay (approximately 32° S, 18° E) and Cape Agulhas (approximately 34° S, 20° E) is an area of transition between Atlantic and Indian Ocean species, as well as those more commonly associated with colder waters of the west coast (e.g. dusky dolphins and long finned pilot whales) and those of the warmer east coast (e.g. striped and Risso's dolphins) (Findlay *et al.* 1992). The Reconnaissance Permit Area lies within and offshore of this transition zone, and the warmer waters that occur there provide an entirely different habitat, that despite the relatively high latitude may host some species associated with the more tropical and temperate parts of the Atlantic. These include, rough toothed dolphins, pan-tropical spotted dolphins and short finned pilot whales. Owing to the uncertainty of species occurrence offshore, species that may occur there have been included here for the sake of completeness.

The distribution of cetaceans can largely be split into those associated with the continental shelf and those that occur in deep, oceanic water. Importantly, species from both environments may be found on the continental slope from the shelf break (200 m to approximately 2 000 m) making this the most species rich area for cetaceans. Cetacean density on the continental shelf is usually higher than in pelagic waters as species associated with the pelagic environment tend to be wide ranging across 1 000s of km. As the Reconnaissance Permit Application area is located off the continental shelf, cetacean diversity can be expected to be relatively high, although densities will be low compared to on the shelf. The most common species within the Reconnaissance Permit Application area (in terms of likely encounter rate not total population sizes) are likely to be the Long-Finned Pilot whale and Humpback whale.

Cetaceans are comprised of two taxonomic groups, the mysticetes (filter feeders with baleen) and the odontocetes (predatory whales and dolphins with teeth). The term 'whale' is used to describe species in both groups and is taxonomically meaningless (e.g. the killer whale and pilot whale are members of the Odontoceti, family Delphinidae and are thus dolphins). Due to differences in sociality, communication abilities, ranging behaviour and acoustic behaviour, these two groups are considered separately.

The cetaceans likely to be found within the Reconnaissance Permit Application area are listed in Table 4-3, based on data sourced from: Findlay *et al.* (1992), Best (2007), Weir (2011), and unpublished records held by Sea Search / Namibian Dolphin Project. Of the 35 species listed, the Blue whale is listed as "critically endangered", the fin and sei whales are endangered and the sperm, Bryde's (inshore) and humpback (B2 population) are considered vulnerable (South African Red Data list Categories). Altogether eight species are listed as "data deficient" underlining how little is known about cetaceans, their distributions and population trends. Even historical data from commercial whaling activities dating from the 1960s, or government run cruises between 1975 and 1986 (Findlay *et al.* 1992), mostly occurred inshore of the Reconnaissance Permit Application area. Changes in the timing and distribution of migration may have occurred since these data were collected due to extirpation of populations or behaviours (e.g. migration routes may be learnt behaviours). The large whale species for which there are current data available are the humpback and southern right whale, although almost all data is limited to that collected on the continental shelf close to shore.

A review of the distribution and seasonality of the key cetacean species likely to be found within the Reconnaissance Permit Area is provided below.

(a) Mysticete (Baleen) whales

The majority of mysticetes whales fall into the family Balaenopeteridae. Those occurring in the area include the blue, fin, sei, antarctic minke, dwarf minke, humpback and bryde's whales. The southern right whale (Family Balaenidae) and pygmy right whale (Family Neobalaenidae) are from taxonomically separate groups. The majority of mysticete species occur in pelagic waters with only occasional visits to shelf waters. All of these species show some degree of migration either to or through the latitudes encompassed by the broader project area when en route between higher latitude (Antarctic or Subantarctic) feeding grounds and lower latitude breeding grounds.

Depending on the ultimate location of these feeding and breeding grounds, seasonality may be either unimodal, usually in winter months, or bimodal (e.g. May to July and October to November), reflecting a northward and southward migration through the area. Northward and southward migrations may take place

at different distances from the coast due to whales following geographic or oceanographic features, thereby influencing the seasonality of occurrence at different locations. Because of the complexities of the migration patterns, each species is discussed separately below.

Two genetically and morphologically distinct populations of Bryde's whales live off the coast of southern Africa (Best 2001; Penry 2010). The "offshore population" lives beyond the shelf (>200 m depth) off west Africa and migrates between wintering grounds off equatorial west Africa (Gabon) and summering grounds off western South Africa. Its seasonality on the west coast is thus opposite to the majority of the balaenopterids with abundance likely to be highest in the broader project area in January - March. The "inshore population" of Bryde's, which lives on the continental shelf and Agulhas Bank, is unique amongst baleen whales in the region by being non-migratory. It may move further north into the Benguela current areas of the west of coast of South Africa and Namibia, especially in the winter months (Best 2007). Only the offshore form is likely to be encountered in the survey areas.

Sei whales migrate through South African waters, where they were historically hunted in relatively high numbers, to unknown breeding grounds further north. Their migration pattern thus shows a bimodal peak with numbers west of Cape Columbine highest in May and June, and again in August, September and October. All whales were caught in waters deeper than 200 m with most caught deeper than 1 000 m (Best & Lockyer 2002). Almost all information is based on whaling records 1958-1963 and there is no current information on abundance or distribution patterns in the region. Regular sightings during seismic surveys and scientific surveys off southern Namibia suggest sei whales are likely to be amongst the most commonly seen balaenopterid in the Reconnaissance Permit Application area.

Fin whales were historically caught off the West Coast of South Africa, with a bimodal peak in the catch data suggesting animals were migrating further north during May-June to breed, before returning during August-October en route to Antarctic feeding grounds. Some juvenile animals may feed year round in deeper waters off the shelf (Best 2007). There are no recent data on abundance or distribution of fin whales off western South Africa, although a sighting in St Helena Bay in 2011 (Mammal Research Institute, unpubl. data) and several sightings in southern Namibia in 2014 and 2015 as well as a number of strandings and acoustic detections (Thomisch *et al.* 2017) in Namibia, confirm their contemporary occurrence in the region.

Antarctic and pygmy blue whales were historically caught in high numbers during commercial whaling activities, with a single peak in catch rates during July in Walvis Bay, Namibia and Namibe, Angola suggesting that in the eastern South Atlantic these latitudes are close to the northern migration limit for the species (Best 2007). The two sub-species are difficult to differentiate at sea, so are considered as one species here. Evidence of blue whale presence in the SE Atlantic is rapidly increasing. Recent acoustic detections of blue whales in the Antarctic peak between December and January (Thomisch *et al.* 2016) and in northern Namibia between May and July (Thomisch 2017) supporting observed timing from whaling records. Several recent (2014-2015) sightings of blue whales have occurred during seismic surveys off the southern part of Namibia in water >1 000 m deep confirming their current existence in the area and occurrence in Autumn months. Encounters in the Reconnaissance Permit Area may occur.

TABLE 4-3: CETACEANS OCCURRENCE OFF THE WEST COAST OF SOUTH AFRICA, THEIR SEASONALITY, LIKELY ENCOUNTER FREQUENCY WITH PROPOSED EXPLORATION ACTIVITIES AND SOUTH AFRICAN RED LIST CONSERVATION STATUS (CHILD *ET AL.* 2016).

Common Name	Species	Shelf	Offshore	Seasonality	Likely encounter frequency	IUCN Conservation Status
Delphinids						
Dusky dolphin	*Lagenorhynchus obscurus*	Yes (0- 800 m)	No	Year round	Monthly	Data Deficient
Heaviside's dolphin	*Cephalorhynchus heavisidii*	Yes (0-200 m)	No	Year round	Very rare	Least Concern
Common bottlenose dolphin	*Tursiops truncatus*	Yes	Yes	Year round	<Weekly	Least Concern
Common dolphin	*Delphinus delphis*	Yes	Yes	Year round	<Weekly	Least Concern
Southern Right whale dolphin	*Lissodelphis peronii*	Yes	Yes	Year round	Very rare	Least Concern
Striped dolphin	*Stenella coeruleoalba*	No	?	?	Very rare	Least Concern
Pantropical spotted dolphin	*Stenella attenuata*	Edge	Yes	Year round	Very rare	Least Concern
Long-finned pilot whale	*Globicephala melas*	Edge	Yes	Year round	<Weekly	Least Concern
Short-finned pilot whale	*Globicephala macrorhynchus*	?	?	?	Very rare	Least Concern
Rough-toothed dolphin	*Steno bredanensis*	?	?	?	Very rare	Least Concern
Killer whale	*Orcinus orca*	Occasional	Yes	Year round	Monthly	Least Concern
False killer whale	*Pseudorca crassidens*	Occasional	Yes	Year round	Monthly	Least Concern
Pygmy killer whale	*Feresa attenuata*	?	Yes	?	Rare	Least Concern
Risso's dolphin	*Grampus griseus*	Yes (edge)	Yes	?	Monthly	Least Concern
Sperm whales						
Pygmy sperm whale	*Kogia breviceps*	Edge	Yes	Year round	Rare	Data Deficient
Dwarf sperm whale	*Kogia sima*	Edge	?	?	Very rare	Data Deficient
Sperm whale	*Physeter macrocephalus*	Edge	Yes	Year round	Weekly	Vulnerable

Common Name	Species	Shelf	Offshore	Seasonality	Likely encounter frequency	IUCN Conservation Status
Beaked whales						
Cuvier's	*Ziphius cavirostris*	No	Yes	Year round	Rare	Least Concern
Arnoux's	*Beradius arnouxii*	No	Yes	Year round	Rare	Data Deficient
Shepherd's	*Tasmacetus sheperdi*	No	Yes	Year Round	Rare	Not Assessed
Southern bottlenose	*Hyperoodon planifrons*	No	Yes	Year round	Rare	Least Concern
Layard's	*Mesoplodon layardii*	No	Yes	Year round	Rare	Data Deficient
True's	*M. mirus*	No	Yes	Year round	Rare	Data Deficient
Gray's	*M. grayi*	No	Yes	Year round	Rare	Data Deficient
Blainville's	*M. densirostris*	No	Yes	Year round	Rare	Data Deficient
Baleen whales						
Antarctic Minke	*Balaenoptera bonaerensis*	Yes	Yes	>Winter	Monthly	Least Concern
Dwarf minke	*B. acutorostrata*	Yes	Yes	Year round	Occasional	Least Concern
Fin whale	*B. physalus*	Yes	Yes	MJJ & ON, rarely in summer	Monthly	Endangered
Blue whale (Antarctic)	*B. musculus intermedia*	No	Yes	?	Monthly	Critically Endangered
Sei whale	*B. borealis*	Yes	Yes	MJ & ASO	Monthly	Endangered
Bryde's (offshore)	*B. brydei*	Yes	Yes	Summer (JF)	Weekly	Data Deficient
Bryde's (inshore)	*B brydei (subspp)*	Yes	Yes	Year round	Rare	Vulnerable
Pygmy right	*Caperea marginata*	Yes	?	Year round	Very Rare	Least Concern
Humpback sp.	*Megaptera novaeangliae*	Yes	Yes	Year round, higher in SONDJF	Daily	Least Concern
Humpback B2 population	*Megaptera novaeangliae*	Yes	Yes	Spring Summer peak ONDJF	Daily	Vulnerable
Southern right	*Eubalaena australis*	Yes	No	Year round, higher in SONDJF	Daily*	Least Concern

Two forms of minke whale occur in the southern Hemisphere, the antarctic minke whale (*Balaenoptera bonaerensis*) and the dwarf minke whale (*B. acutorostrata subsp*.); both species occur in the Benguela (Best 2007). Antarctic minke whales range from the pack ice of Antarctica to tropical waters and are usually seen more than approximately 50 km offshore. Although adults migrate from the Southern Ocean (summer) to tropical/temperate waters (winter) to breed, some animals, especially juveniles, are known to stay in tropical/temperate waters year round. The dwarf minke whale has a more temperate distribution than the antarctic minke and they do not range further south than 60-65°S. Dwarf minkes have a similar migration pattern to antarctic minkes with at least some animals migrating to the Southern Ocean during summer. Dwarf minke whales occur closer to shore than antarctic minkes. Both species are generally solitary and densities are likely to be low in the Reconnaissance Permit Application area.

The pygmy right whale is the smallest of the baleen whales reaching only 6 m total length as an adult (Best 2007). The species is typically associated with cool temperate waters between 30°S and 55°S and records in Namibia are the northern most for the species with no confirmed records north of Walvis Bay. It's preference for cooler waters, suggests that it is likely to be restricted to the continental shelf areas within the Benguela system, and is unlikely to occur in the Reconnaissance Permit Application area.

The most abundant baleen whales in the Benguela are southern right whales and humpback whales. In the last decade, both species have been increasingly observed to remain on the West Coast of South Africa well after the 'traditional' South African whale season (June – November) into spring and early summer (October – February) where they have been observed feeding in upwelling zones, especially off Saldanha and St Helena Bay (Barendse *et al.* 2011; Mate *et al.* 2011).

The majority of humpback whales passing through the Benguela are migrating to breeding grounds off tropical west Africa, between Angola and the Gulf of Guinea (Rosenbaum *et al.* 2009; Barendse *et al.* 2010). Those breeding in this area are defined as Breeding Stock B1 (BSB1) by the International Whaling Commission (IWC), and were estimated at 9 000 individuals in 2005 (IWC 2012). Animals feeding in the southern Benguela are defined as population BSB2 by the IWC and are genetically distinct from BSB1, although there are resightings of individuals between the areas and it remains unclear exactly how animals in BSB1 and BSB2 relate to each other. BSB2 was estimated as only 500 individuals in 2001 - 2002 (Barendse *et al.* 2011) and both populations have increased since this time at least 5 % per annum (IWC 2012).

Humpback whales in the South-East Atlantic migrate north during early winter (June), meet and then follow the coast at varying places, so there is no clear migration 'corridor' on the West Coast. On the southward migration, returning from tropical West Africa, many humpbacks follow the Walvis Ridge offshore after leaving Angola then head directly to high latitude feeding grounds, while others follow a more coastal route (including the majority of mother-calf pairs), lingering in the feeding grounds off west South Africa in summer (Elwen *et al.* 2014; Rosenbaum *et al.* in 2014, Findlay *et al.* 2016). The number of humpback whales feeding in the southern Benguela has increased substantially since estimates made in the early 2000s (Barendse *et al.* 2011). Since 2011, 'supergroups' of up to 200 individual whales have been observed feeding within 10 km from shore (Findlay *et al.* 2017) with many hundred more passing through and whales are now seen in all months of the year around Cape Town. In the first half of 2017 (when numbers are expected to be at their lowest) more than 10 humpback whales were reported stranded along the Namibian and west South African coasts. The cause of these deaths is not known, but a similar event off Brazil in 2010 was linked to possible infectious disease or

malnutrition (Siciliano *et al.* 2013), which suggests the West African population may be undergoing similar stresses and caution should be taken in increasing stress through human activities.

Humpback whales are thus likely to be the most frequently encountered baleen whale in the Reconnaissance Permit Application area with year-round presence but numbers peaking in July for the northwards migration and October to February during the southward migration and when animals from the BSB2 population are feeding in the Benguela Ecosystem.

The southern African population of southern right whales historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baie dos Tigres) and is considered to be a single population within this range (Roux *et al.* 2011). In 2008, the population estimate was 4 600 individuals including all age and sex classes, which is thought to be at least 23% of the original population size (Brandaõ *et al.* 2011). Since the population is still continuing to grow at approximately 7% per year (Brandaõ *et al.* 2011), the population size in 2016 would number more than 7 300 individuals. When the population numbers crashed, the range contracted down to just the south coast of South Africa, but as the population recovers, it is repopulating its historic grounds including Namibia (Roux *et al.* 2001) and Mozambique (Banks *et al.* 2011). Southern right whales are seen regularly in the nearshore waters of the West Coast (<3 km from shore), extending north into southern Namibia (Roux *et al.* 2001, 2011). Southern right whales have been recorded off the West Coast in all months of the year, but with numbers peaking in winter (June - September).

In the last decade, deviations from the predictable and seasonal migration patterns of these two species have been reported from the Cape Columbine – Yzerfontein area (Best 2007; Barendse *et al.* 2010). High abundances of both Southern Right and Humpback whales in this area during spring and summer (September-February), indicates that the upwelling zones off Saldanha and St Helena Bay may serve as an important summer feeding area (Barendse *et al.* 2011, Mate *et al.* 2011). It was previously thought that whales feed only rarely while migrating (Best *et al.* 1995), but these localised summer concentrations suggest that these whales may in fact have more flexible foraging habits.

(b) Odontocetes (toothed) whales

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader project area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site specific to oceanic and wide ranging. Those in the region can range in size from 1.6 m long (Heaviside's dolphin) to 17 m (Bull Sperm whale).

All information about sperm whales in the southern African sub-region results from data collected during commercial whaling activities prior to 1985 (Best 2007). Sperm whales are the largest of the toothed whales and have a complex, structured social system with adult males behaving differently to younger males and female groups. They live in deep ocean waters, usually greater than 1 000 m depth, although they occasionally come onto the shelf in water 500 - 200 m deep (Best 2007). They are considered to be relatively abundant globally (Whitehead 2002), although no estimates are available for South African waters. Seasonality of catches suggests that medium and large sized males are more abundant in winter months while female groups are more abundant in autumn (March - April), although animals occur year round (Best 2007). Sperm whales are thus likely to be encountered in relatively high numbers in deeper waters (>500 m), predominantly in the

winter months (April - October). Sperm whales feed at great depths during dives in excess of 30 minutes making them difficult to detect visually, however the regular echolocation clicks made by the species when diving make them relatively easy to detect acoustically using Passive Acoustic Monitoring (PAM).

There are almost no data available on the abundance, distribution or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters (>200 m) off the shelf of the southern African West Coast. Beaked whales are all considered to be true deep water species usually being seen in waters in excess of 1 000 – 2 000 m deep (see various species accounts in Best 2007). Presence in the Reconnaissance Permit Application area may fluctuate seasonally, but insufficient data exist to define this clearly.

The genus Kogia currently contains two recognised species, the Pygmy (*K. breviceps*) and dwarf (*K. sima*) sperm whales, both of which most frequently occur in pelagic and shelf edge waters, although their seasonality is unknown. The majority of what is known about *Kogiidae* whales in the southern African subregion results from studies of stranded specimens (e.g. Ross 1979; Findlay *et al.* 1992; Plön 2004; Elwen *et al.* 2013). Dwarf sperm whales are associated with the warmer waters south and west of St Helena Bay. They are recorded from both the Benguela and Agulhas ecosystem (Best 2007) in waters deeper than approximately 1 000 m, and are thus likely to occur in the Reconnaissance Permit Application area, although abundances are likely to be very low.

Killer whales have a circum-global distribution being found in all oceans from the equator to the ice edge (Best 2007). Killer whales occur year round in low densities off western South Africa (Best *et al.* 2010), Namibia (Elwen & Leeney 2011) and in the Eastern Tropical Atlantic (Weir *et al.* 2010). Killer whales are found in all depths from the coast to deep open ocean environments and may thus be encountered in the Reconnaissance Permit Application area at low levels.

The false killer whale has a tropical to temperate distribution and most sightings off southern Africa have occurred in water deeper than 1 000 m, but with a few recorded close to shore (Findlay *et al.* 1992). They usually occur in groups ranging in size from 1 - 100 animals (Best 2007). The strong bonds and matrilineal social structure of this species makes it vulnerable to mass stranding (8 instances of 4 or more animals stranding together have occurred in the Western Cape, all between St Helena Bay and Cape Agulhas). There is no information on population numbers or conservation status and no evidence of seasonality in the region (Best 2007).

Long-finned pilot whales display a preference for temperate waters and are usually associated with the continental shelf or deep water adjacent to it (Mate *et al.* 2005; Findlay *et al.* 1992; Weir 2011). They are regularly seen associated with the shelf edge by marine mammal observers (MMOs) and fisheries observers and researchers. The distinction between long-finned and short-finned pilot whales is difficult to make at sea. As the latter are regarded as more tropical species (Best 2007), it is likely that the vast majority of pilot whales encountered in the project area will be long-finned.

The common dolphin is known to occur offshore in West Coast waters (Findlay *et al.* 1992; Best 2007), although the extent to which they occur in the project area is unknown, but likely to be low. Group sizes of common dolphins can be large, averaging 267 (± SD 287) for the South Africa region (Findlay *et al.* 1992). They

are more frequently seen in the warmer waters offshore and to the north of the country, seasonality is not known.

In water <500 m deep, Dusky dolphins are likely to be the most frequently encountered small cetacean as they are very "boat friendly" and often approach vessels to bowride. The species is resident year round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay *et al.* 1992). Although no information is available on the size of the population, they are regularly encountered in near shore waters between Cape Town and Lamberts Bay (Elwen *et al.* 2010a; NDP unpubl. data) with group sizes of up to 800 having been reported (Findlay *et al.* 1992). A hiatus in sightings (or low density area) is reported between approximately 27°S and 30°S, associated with the Lüderitz upwelling cell (Findlay *et al.* 1992). Dusky dolphins are resident year round in the Benguela.

Heaviside's dolphins are relatively abundant in the Benguela ecosystem region with 10 000 animals estimated to live in the 400 km of coast between Cape Town and Lamberts Bay (Elwen *et al.* 2009). This species occupies waters from the coast to at least 200 m depth, (Elwen *et al.* 2006; Best 2007), and may show a diurnal onshore-offshore movement pattern (Elwen *et al.* 2010b), but this varies throughout the species range. Heaviside's dolphins are resident year round.

Several other species of dolphins that might occur in deeper waters at low levels include the pygmy killer whale, Risso's dolphin, rough toothed dolphin, pan tropical spotted dolphin and striped dolphin (Findlay *et al.* 1992; Best 2007). Nothing is known about the population size or density of these species in the project area, but encounters are likely to be rare.

Beaked whales were never targeted commercially and their pelagic distribution makes them the most poorly studied group of cetaceans. With recorded dives of well over an hour and in excess of 2 km deep, beaked whales are amongst the most extreme divers of any air breathing animals (Tyack *et al.* 2011). They also appear to be particularly vulnerable to certain types of anthropogenic noise, although reasons are not yet fully understood. All the beaked whales that may be encountered in the survey areas are pelagic species that tend to occur in small groups usually less than five, although larger aggregations of some species are known (MacLeod & D'Amico 2006; Best 2007).

4.4.2.7 Pinnipeds (seals)

The Cape fur seal (*Arctocephalus pusillus pusillus*) is the only species of seal resident along the West Coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs (see Figure 4-34). Vagrant records from four other species of seal more usually associated with the subantarctic environment have also been recorded: southern elephant seal (*Mirounga leoninas*), subantarctic fur seal (*Arctocephalus tropicalis*), crabeater (*Lobodon carcinophagus*) and leopard seals (*Hydrurga leptonyx*) (David 1989).

There are a number of Cape fur seal colonies within the broader study area:

- Kleinzee (incorporating Robeiland): This colony has the highest seal population and produces the highest seal pup numbers on the South African Coast (Wickens 1994).

- Bucchu Twins near Alexander Bay, at Cliff Point (approximately 17 km north of Port Nolloth): This was formerly a non-breeding colony but has also attained breeding status (M. Meyer, SFRI, pers. comm.).
- Strandfontein Point (south of Hondeklipbaai), Bird Island at Lamberts Bay, Paternoster Point at Cape Columbine and Duikerklip in Hout Bay: These are a non-breeding colonies.
- Robbesteen near Koeberg.
- Seal Island in False Bay and Geyser Rock at Dyer Island.
- McDougall's Bay islands and Wedge Point: These sites are haul-out sites only and are not permanently occupied by seals.

These colonies all fall well inshore and to the east of the Reconnaissance Permit Application area. All have important conservation value since they are largely undisturbed at present. The timing of the annual breeding cycle is very regular, occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991). Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. Seals are therefore likely to be encountered during exploration activities in the inshore portions of the Reconnaissance Permit Application area.

4.5 HUMAN UTILISATION

4.5.1 Fisheries

The South African fishing industry consists of approximately 14 commercial sectors operating within the 200 nautical mile (nm) Exclusive Economic Zone (EEZ). The western coastal shelf is a highly productive upwelling ecosystem (Benguela current) and supports a number of fisheries.

The largest and most economically valuable of these are the demersal trawl and long-line fisheries, targeting the cape hakes *Merluccius paradoxus* and *M. capensis*, and the pelagic purse-seine fishery targeting pilchard (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus*) and red-eye round herring (*Etrumeus whitheadii*). Secondary commercial species in the hake-directed fisheries include an assemblage of demersal (bottom-dwelling) fish of which monk fish (*Lophius vomerinus*) and snoek (*Thyrsites atun*) are the most important commercial species. Other fisheries active on the West Coast are the pelagic long-line fishery for tunas and swordfish and the tuna pole and traditional linefish sectors. 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*).

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. The main landing sites for the small pelagic fleets on the West Coast are St. Helena Bay, as well as Saldanha Bay. 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 and South Coasts include Port Nolloth, Hondeklip and Laaiplek,

Hout Bay and Gansbaai harbours. There are more than 230 small-scale fishing communities on the South African coastline (DAFF, 2016). Small-scale fisheries commonly use boats but occur mainly close to the shore. Recreational fisheries comprise shore-based, estuarine and boat-based line fisheries as well as spearfishing and net fisheries, including cast, drag and hoop net techniques.

The main commercial sectors operating in the vicinity of the study area are discussed below.

4.5.1.1 Demersal Trawl

The hake-directed trawl fishery is the most valuable sector of the South African fishing industry and is split into two sub-sectors: the offshore ("deep-sea") sector which is active off both the South and West Coasts, and the much smaller inshore trawl sector which is active off the South Coast. A fleet of approximately 45 trawlers operate within the offshore sector targeting the Cape hakes (*Merluccius capensis* and *M. paradoxus*). Main by-catch species include monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*). The fishery is active year-round, with a relatively constant amount of effort expended each month.

Trawls are usually conducted along specific trawling lanes on "trawl friendly" substrate (flat, soft ground). On the West Coast, these grounds extend in a continuous band along the shelf edge between the 300 m and 1 000 m bathymetric contours. Monk-directed trawlers tend to fish shallower waters than hake-directed vessels on mostly muddy substrates. Trawl nets are generally towed along depth contours (thereby maintaining a relatively constant depth) running parallel to the depth contours in a north-westerly or south-easterly direction. Trawlers also target fish aggregations around bathymetric features, in particular seamounts and canyons (i.e. Cape Columbine and Cape Canyon), where there is an increase in seafloor slope and in these cases the direction of trawls follow the depth contours. The activity of the fishery is restricted by permit condition to operating within the confines of a historical "footprint" – an area of approximately 57 300 km^2 and 17 000 km^2 for the offshore and inshore fleets, respectively. Trawlers are prohibited from operating within 5 nm of the coastline.

The offshore fleet is segregated into wetfish and freezer vessels which differ in terms of the capacity for the processing of fish at sea and in terms of vessel size and capacity. While freezer vessels may work in an area for up to a month at a time, wetfish vessels may only remain in an area for about a week before returning to port. Wetfish vessels range between 24 m and 56 m in length while freezer vessels are usually larger, ranging up to 80 m in length. The gear configurations are similar for both freezer and wet fish vessels. Trawl gear is deployed astern of the vessel.

The towed gear typically consists of trawl warps, bridles and trawl doors, a footrope, headrope, net and codend (see Figure 4-10). The monk-directed trawlers use slightly heavier trawl gear, trawl at slower speeds and for longer periods (up to eight hours) compared to the hake-directed trawlers (60 minutes to four hours). Monk gear includes the use of "tickler" chains positioned ahead of the footrope to chase the monk off the substrate and into the net.

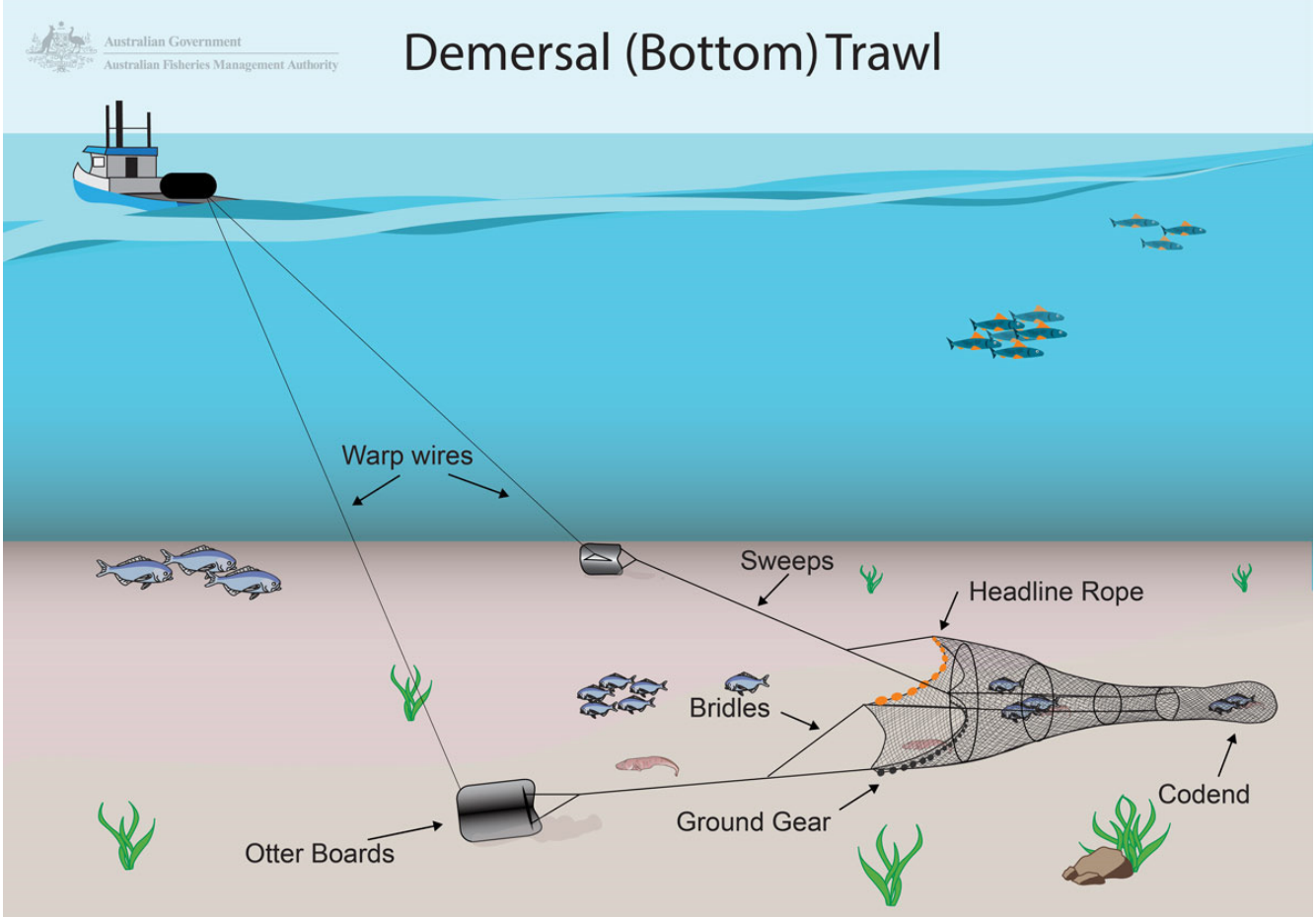


FIGURE 4-10: SCHEMATIC DIAGRAM OF TRAWL GEAR TYPICALLY USED BY THE SOUTH AFRICAN HAKE TRAWL VESSELS.
(Source: http://www.afma.gov.au/portfolio-item/trawling)

The hake-directed demersal trawl effort and catch between 2008 and 2016 in relation to the proposed survey areas is shown in Figure 4-11. The proposed 2D survey acquisition area covers approximately 16 850 km^2 of the offshore trawling ground, while the two proposed 3D seismic acquisition areas cover 7 700 km^2 of the offshore trawling ground (it is noted that the southern 3D survey area falls completely within the 2D survey footprint).

4.5.1.2 Mid-Water Trawl

Adult horse mackerel (*Trachurus trachurus capensis*) is targeted by mid-water trawl, defined 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. Mid-water trawling gear configuration is similar to that of demersal trawlers, except that the net is manoeuvred vertically through the water column (see Figure 4-12).

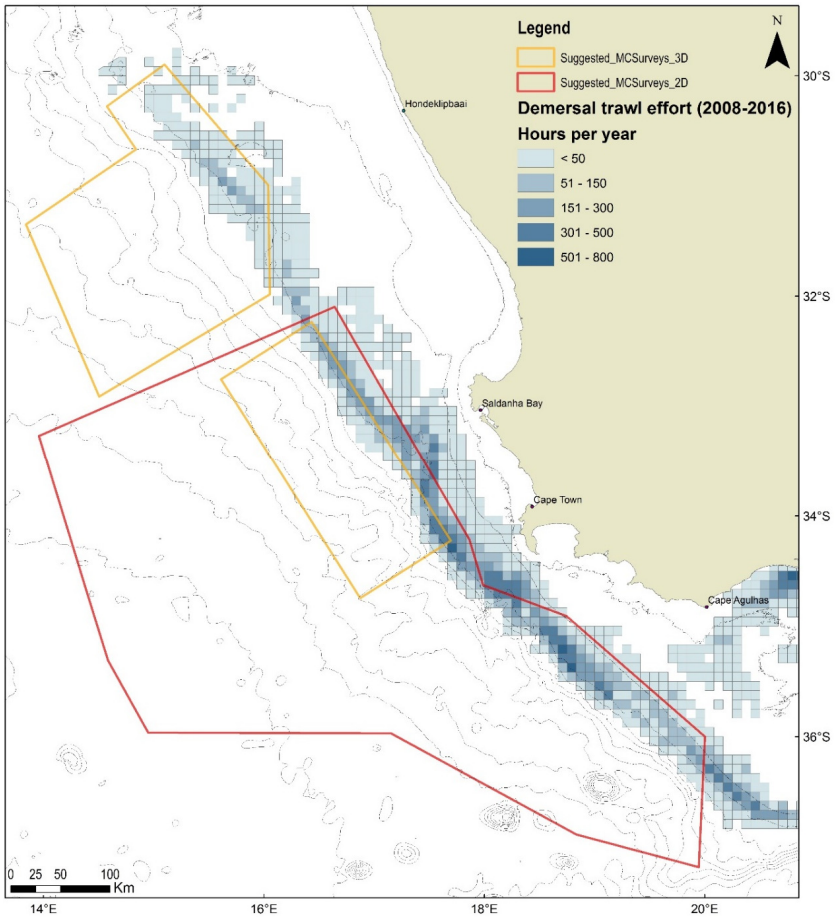


FIGURE 4-11: THE PROPOSED 2D (RED OUTLINE) AND 3D (ORANGE OUTLINE) SURVEY TARGET AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF TRAWLING EFFORT EXPENDED BY THE SOUTH AFRICAN HAKE-DIRECTED TRAWL SECTOR.

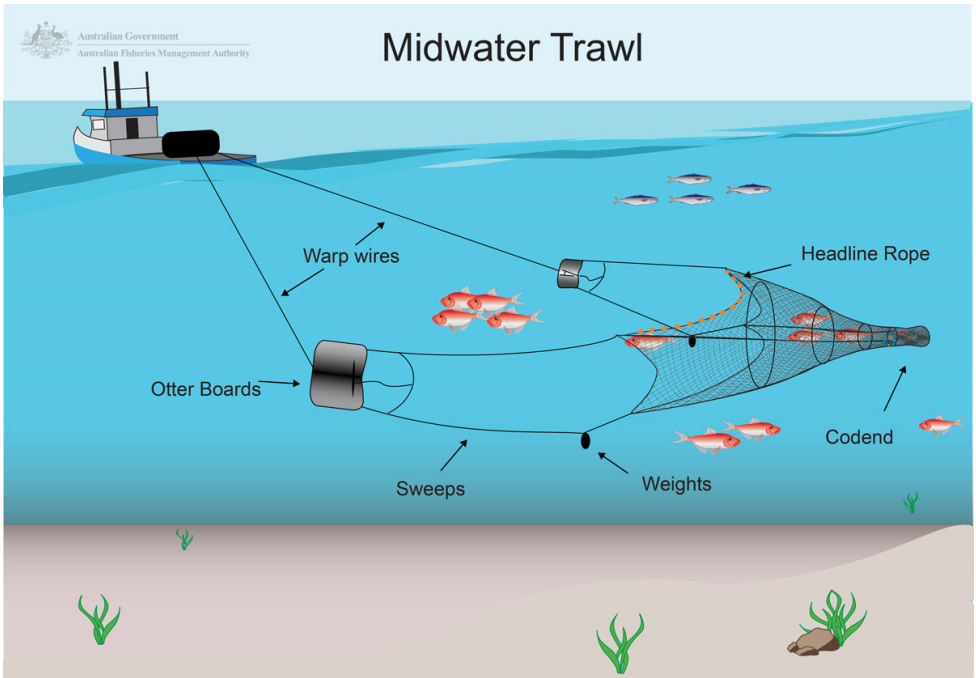


FIGURE 4-12: SCHEMATIC OF TYPICAL GEAR CONFIGURATION OF A MID-WATER TRAWLER. (Source: https://www.afma.gov.au/fisheries-management/methods-and-gear/trawling)

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.

The proposed 2D and 3D seismic survey acquisition areas in relation to the spatial extent of grounds fished by mid-water trawlers on the West and South Coasts is illustrated in Figure 4-13.

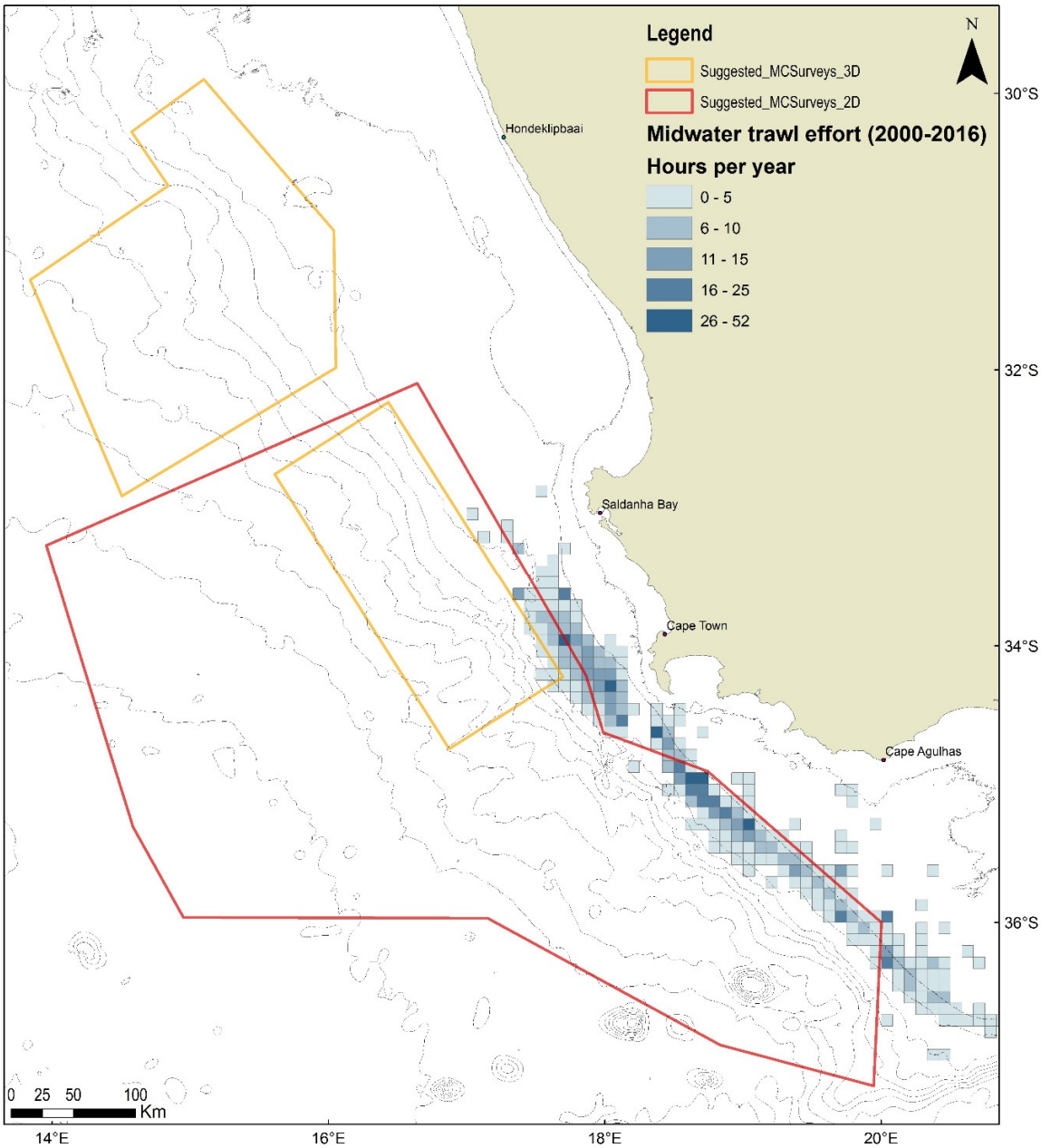


FIGURE 4-13: THE PROPOSED 2D AND 3D SEISMIC SURVEY ACQUISITION AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF FISHING EFFORT EXPENDED BY THE MID-WATER TRAWL SECTOR.

4.5.1.3 Demersal Longline

The demersal long-line fishing technique is used to target bottom-dwelling species of fish. Two fishing sectors utilize this method of capture, namely the hake long-line fishery targeting the Cape hakes (*M. capensis* and *M. paradoxus*) and the shark long-line sector targeting only demersal species of shark. The fishery operates year-round with a slight increase in activity between August and December.

A demersal long-line vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor (see Figure 4-14). Steel anchors, of 40 kg to 60 kg, are placed at the ends of each line to anchor it, and are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Lines are typically between 10 km and 20 km in length, carrying between 6 900 and 15 600 hooks each. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of between five and nine knots. Once deployed the line is left to soak for up to eight hours before it is retrieved. A line hauler is used to retrieve gear (at a speed of approximately one knot) and can take six to ten hours to complete. During hauling operations a demersal long-line vessel would be severely restricted in manoeuvrability.

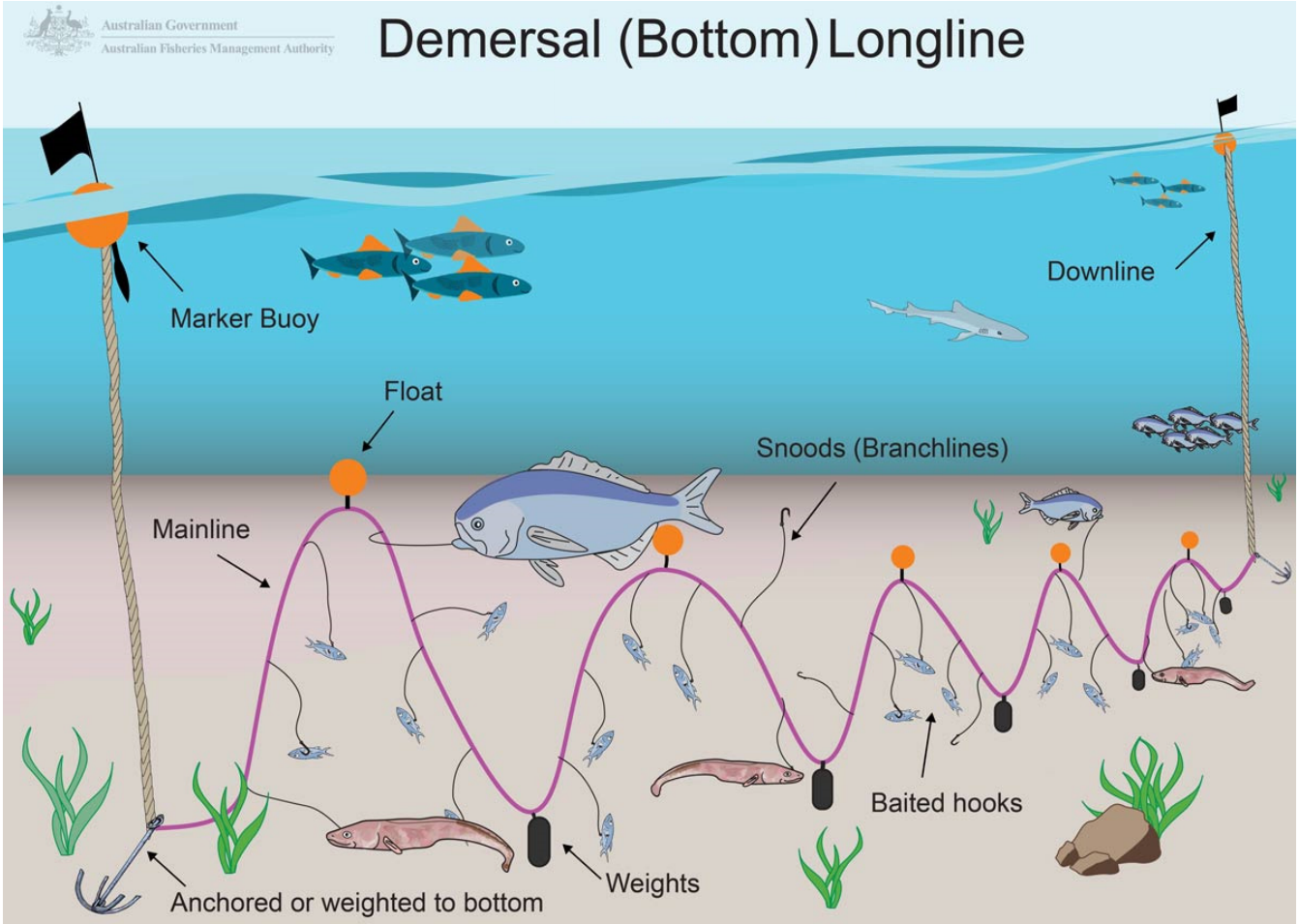


FIGURE 4-14: TYPICAL CONFIGURATION OF DEMERSAL (BOTTOM-SET) HAKE LONG-LINE GEAR. (Source: http://www.afma.gov.au/portfolio-item/longlining)

Currently 64 hake-directed vessels are active within the fishery, most of which operate from the harbours of Cape Town and Hout Bay. Fishing grounds are similar to those targeted by the hake-directed trawl fleet. The hake longline footprint extends down the west coast from approximately 150 km offshore of Port Nolloth (15°E, 29°S). It lies inshore to the south of St Helena Bay moving offshore once again as it skirts the Agulhas Bank to the south of the country (21°E, 37°S). Along the South coast the footprint of the fishery moves inshore towards Mossel Bay.

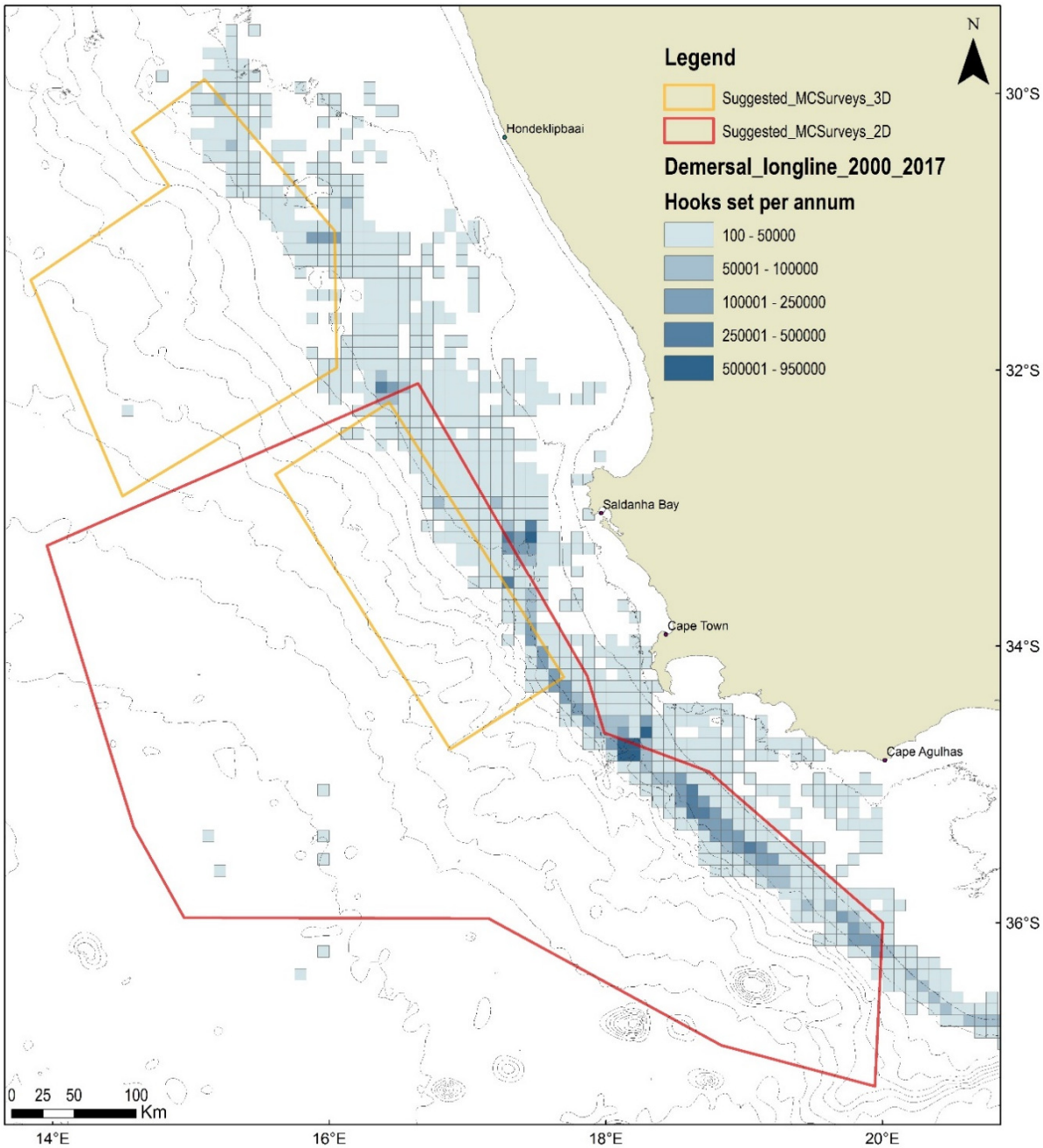


FIGURE 4-15: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF FISHING EFFORT EXPENDED BY THE DEMERSAL LONGLINE SECTOR.

4.5.1.4 Small Pelagic Purse-Seine

The South African small pelagic purse seine fishery is the largest fishery by volume and the second most important in terms of value. The pelagic purse-seine fishery targets small mid-water and surface-shoaling species such as sardine, anchovy, juvenile horse mackerel and round herring using purse-seine fishing techniques.

Once a shoal has been located the vessel steams around it and encircle it with a large net. The depth of the net is usually between 60 m and 90 m. Netting walls surround aggregated fish both from the sides and from underneath, thus preventing them from escaping by diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom (see Figure 4-16). Once the shoal has been encircled the net is pursed and hauled in and the fish are pumped onboard into the hold of the vessel. After the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered onboard, which may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

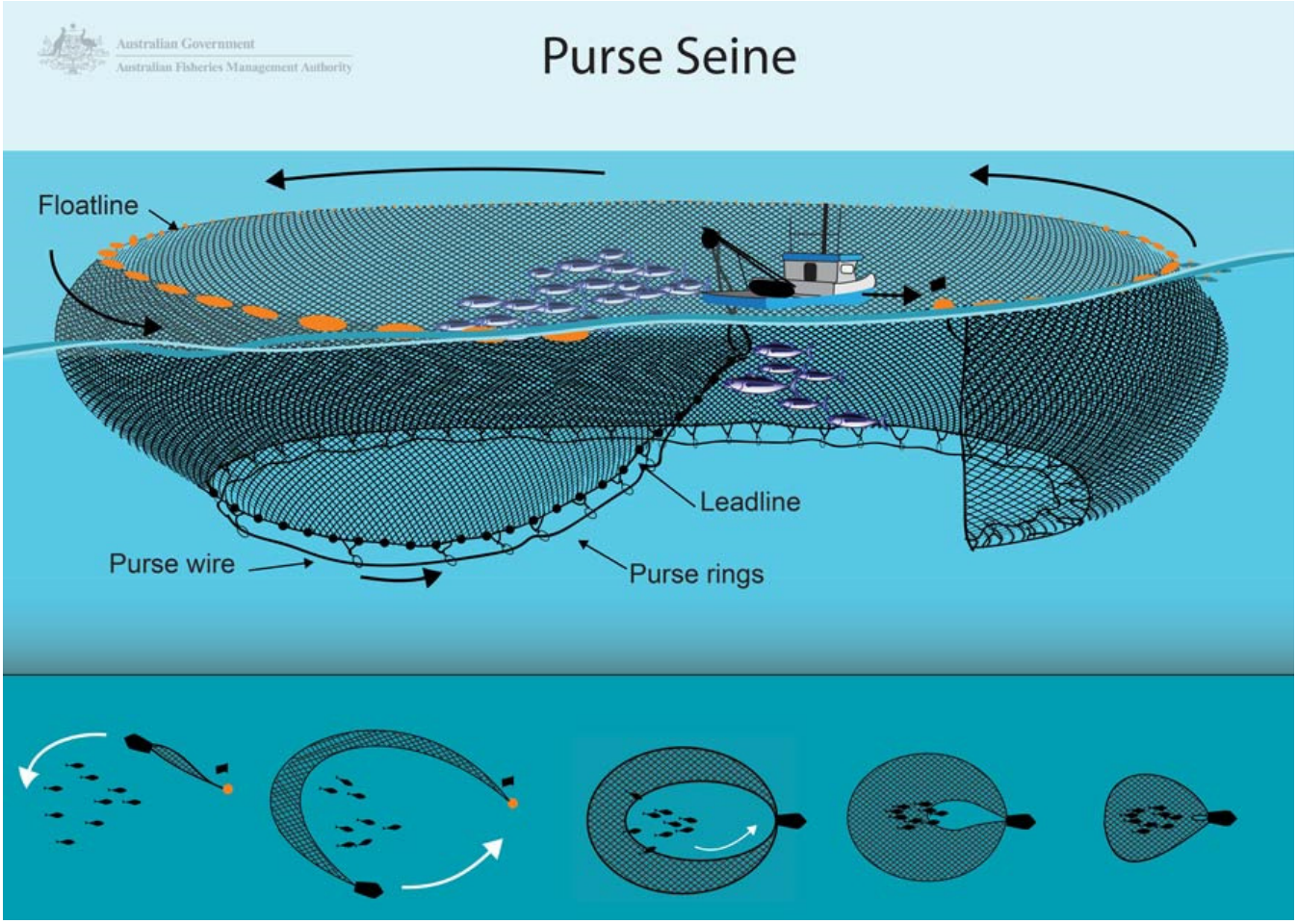


FIGURE 4-16: SCHEMATIC OF TYPICAL PURSE-SEINE GEAR DEPLOYED IN THE "SMALL" PELAGIC FISHERY. (Source: http://www.afma.gov.au/portfolio-item/purse-seine)

The South African fishery, consisting of approximately 101 vessels, is active all year round with a short break from mid-December to mid-January (to reduce impact on juvenile sardine), with seasonal trends in the specific species targeted.

The geographical distribution and intensity of the fishery is largely dependent on the seasonal fluctuation and geographical distribution of the targeted species. Fishing grounds occur primarily along the Western Cape and Eastern Cape coast up to a distance of 100 km offshore, but usually closer inshore. The sardine-directed fishery tends to concentrate effort in a broad area extending from St Helena Bay, southwards past Cape Town towards Cape Point and then eastwards along the coast to Mossel Bay and Port Elizabeth. The anchovy-directed fishery takes place predominantly on the South-West Coast from St Helena Bay to Cape Point and is most active in the period from March to September. Round herring (non-quota species) is targeted when available and specifically in the early part of the year (January to March) and is distributed South of Cape Point to St Helena Bay. The proposed 2D and 3D seismic survey areas in relation to the spatial extent of fishing grounds are illustrated in Figure 4-17.

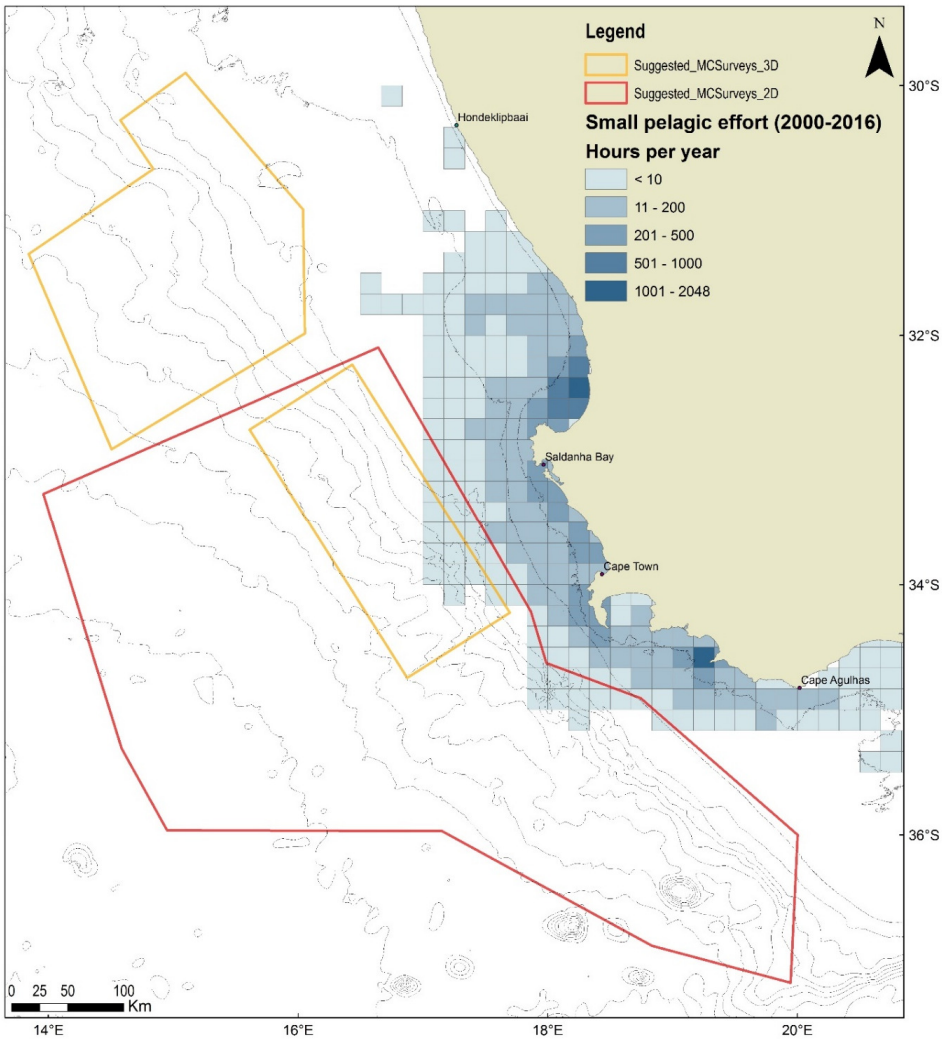


FIGURE 4-17: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF FISHING EFFORT EXPENDED BY THE SMALL PELAGIC PURSE-SEINE FISHERY.

4.5.1.5 Large Pelagic Longline

The large pelagic long-line fishery operates year-round, extensively within the South African EEZ targeting primarily tuna and swordfish. Due to the highly migratory nature of these species, stocks straddle the EEZ of a number of countries and international waters. As such they are managed as a “shared resource” amongst various countries. In 2017, 60 fishing rights were allocated for a period of 15 years. There are a total of 22 active longline vessels within South African waters, 18 of which were fishing in the Atlantic (West of 20°E)

during 2017. Three Japanese vessels were fishing exclusively in the Indian Ocean (East of 20°E) during 2017 (DAFF, 2018).

This type of long-line gear targets pelagic species and therefore extends downwards from the sea surface. A drifting long-line consists of a mainline kept near the surface or at a certain depth by means of regularly spaced floats and with relatively long snoods (short sections of monofilament line) with baited hooks, evenly spaced on the mainline (see Figure 4-18). Drifting long-lines are set vertically, each line hanging from a float at the surface. A single main line consists of twisted rope (6 to 8 mm diameter) or a thick nylon monofilament (5 to 7.5 mm diameter). The mainline of a pelagic long-line can be over 100 km long. Droppers with the hook and bait on one end are attached to the main line by clips at intervals of 20 to 30 m. A dropper can be made up of several parts and be up to 45 m long. Buoys are attached to the main line by buoy-lines at intervals to keep the mainline near 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 its position for later retrieval by the fishing vessel. A line may be left drifting for a considerable length of time and is retrieved by means of a powered hauler at a speed of approximately 1 knot. During hauling a vessel's manoeuvrability will be severely restricted and, in the event of an emergency, the line may be dropped to be hauled in at a later stage.

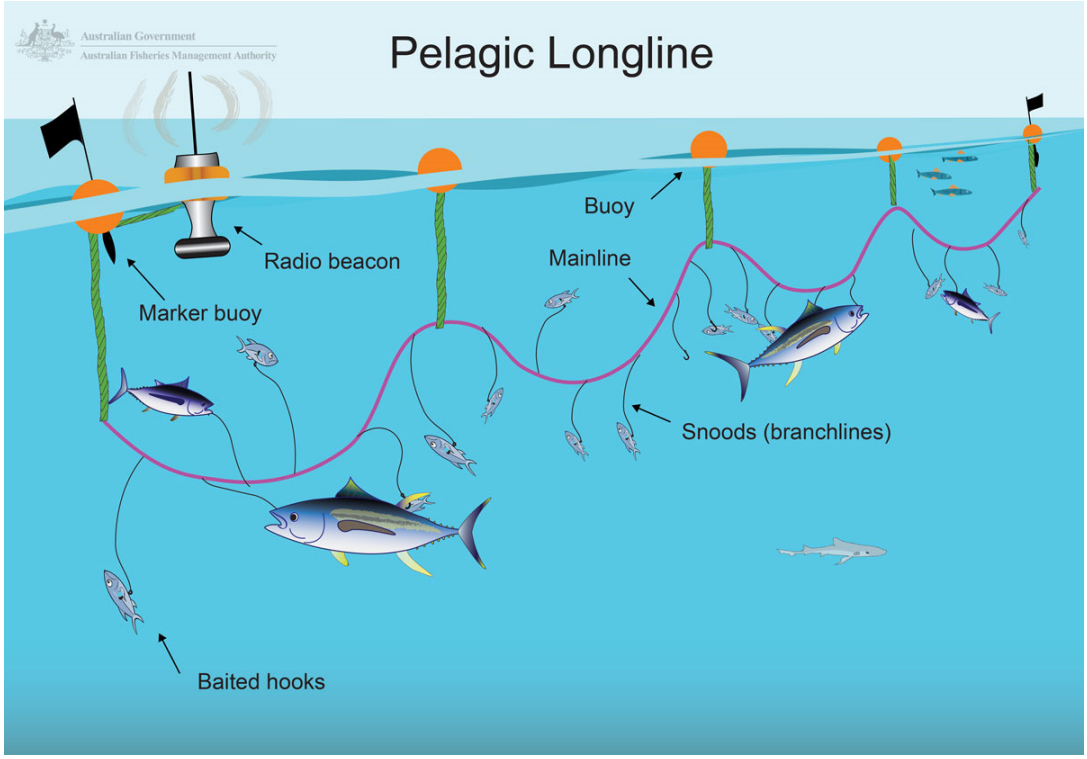


FIGURE 4-18: TYPICAL PELAGIC LONG-LINE CONFIGURATION TARGETING TUNA AND SWORDFISH SPECIES. (Source: https://www.afma.gov.au/fisheries-management/methods-and-gear/longlining)

During the period 2000 to 2014, the sector landed an average catch of 4 527 tons and set 3.55 million hooks per year. The fishery operates extensively within the South African EEZ, primarily along the continental shelf break and further offshore, and operates year-round with a relative increase in effort during winter and spring. Thus, the entire extent of the proposed 2D and 3D seismic survey acquisition areas overlaps with the spatial distribution of pelagic longline fishing effort (see Figure 4-19).

4.5.1.6 Tuna Pole

The tuna pole fishery is based on migratory species of tuna, predominantly Atlantic longfin tuna stock and a very small amount of skipjack tuna, yellowfin tuna and bigeye tuna. The South African fleet consists of approximately 128 pole-and-line vessels, which are based at the ports of Cape Town, Hout Bay and Saldanha Bay. The fishery is seasonal with vessel activity mostly 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.

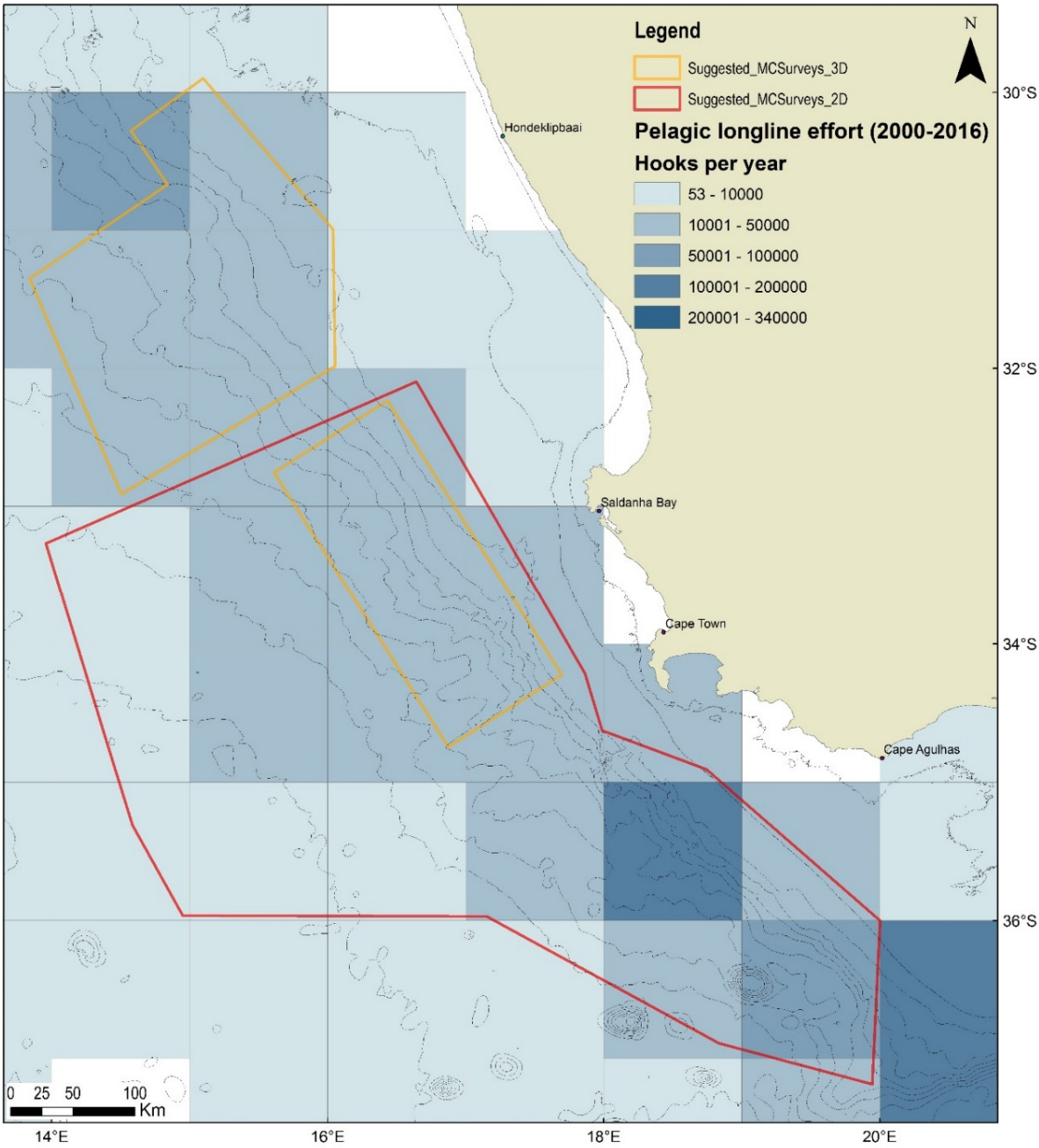


FIGURE 4-19: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF FISHING EFFORT EXPENDED BY THE LONGLINE SECTOR.

Vessels drift whilst attracting and catching shoals of pelagic tunas. Sonars and echo sounders are used to locate schools of tuna. Once a school is located, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface. Live bait is then used to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the 2 to 3 m poles are fitted with a short length of fishing line leading to a hook. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (see Figure 4-20). Vessels are relatively small (less than 25 m in length) and store catch on ice, thus staying at sea for short periods (approximately five days).

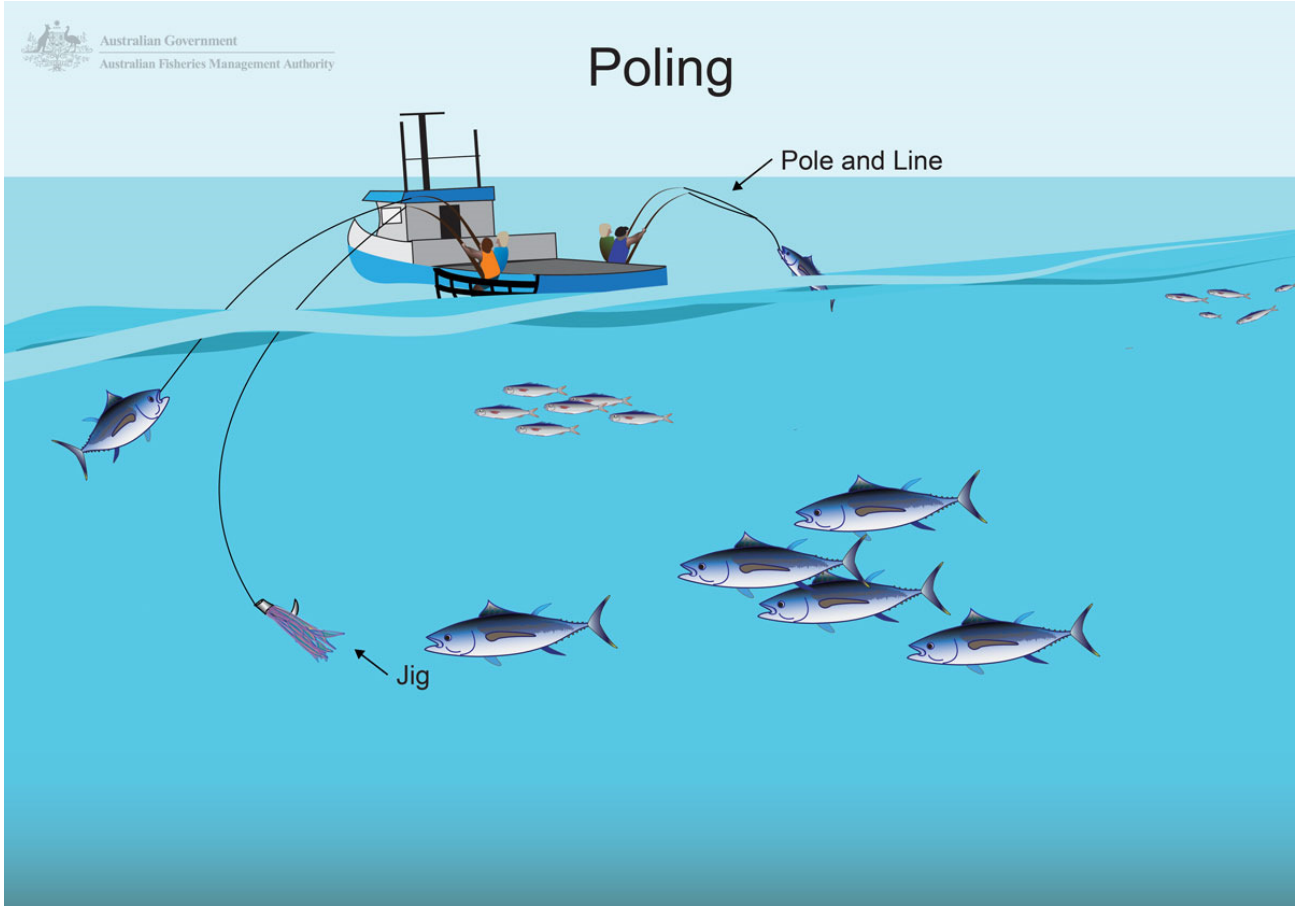


FIGURE 4-20: SCHEMATIC DIAGRAM OF POLE AND LINE OPERATION.
(Source: http://www.afma.gov.au/portfolio-item/minor-lines/)

Fishing occurs along the entire West Coast, predominantly along the shelf break. Favoured fishing areas are situated north of Cape Columbine and between 60 km and 120 km offshore from Saldanha Bay. The proposed survey areas in relation to the spatial distribution of fishing effort reported over the period 2007 to 2016 is illustrated in Figure 4-21.

4.5.1.7 Traditional Line-Fish

This fishery includes commercial, subsistence and recreational sectors. The South African commercial line fishery is the country's third most important fishery in terms of total tons landed and economic value. The bulk of the fishery catch is made up of about 35 different species of reef fish as well as pelagic and demersal species

which are mostly marketed locally as “fresh fish”. In South Africa effort is managed geographically with the spatial effort of the fishery divided into three zones.

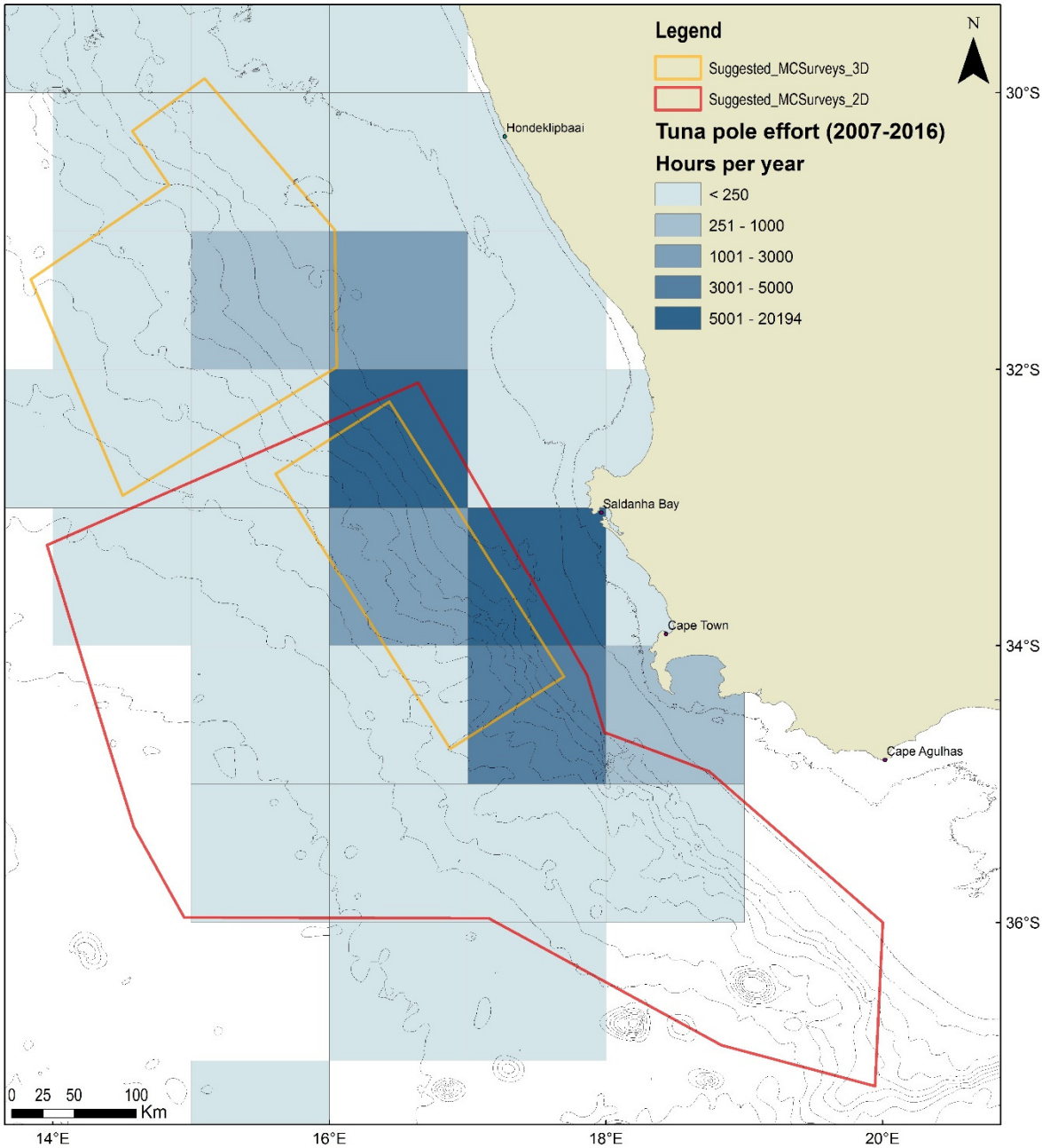


FIGURE 4-21: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF FISHING EFFORT EXPENDED BY THE TUNA POLE SECTOR.

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. Most of the catch (up to 95%) is landed by the Cape commercial fishery, which operates on the continental shelf from the Namibian border on the West Coast to the Kei River in the Eastern Cape. Vessels range in length between 4.5 m and 11 m and the offshore operational range is restricted by vessel category. Activity ranges to a maximum offshore distance of about 70 km, although fishing at this outer limit is sporadic.

Although linefish fishing vessels are able to operate far offshore, most of the activity is conducted within 15 km of a launch site. The probability of these localities falling within either of the proposed 2D and 3D surveys is considered to be relatively low but cannot be excluded. A seasonal increase in the targeting of tuna species in offshore locations e.g. Cape Point, may attract participants of this fishery and thus extend into the proposed 2D and southern-most 3D survey area (see Figure 4-22).

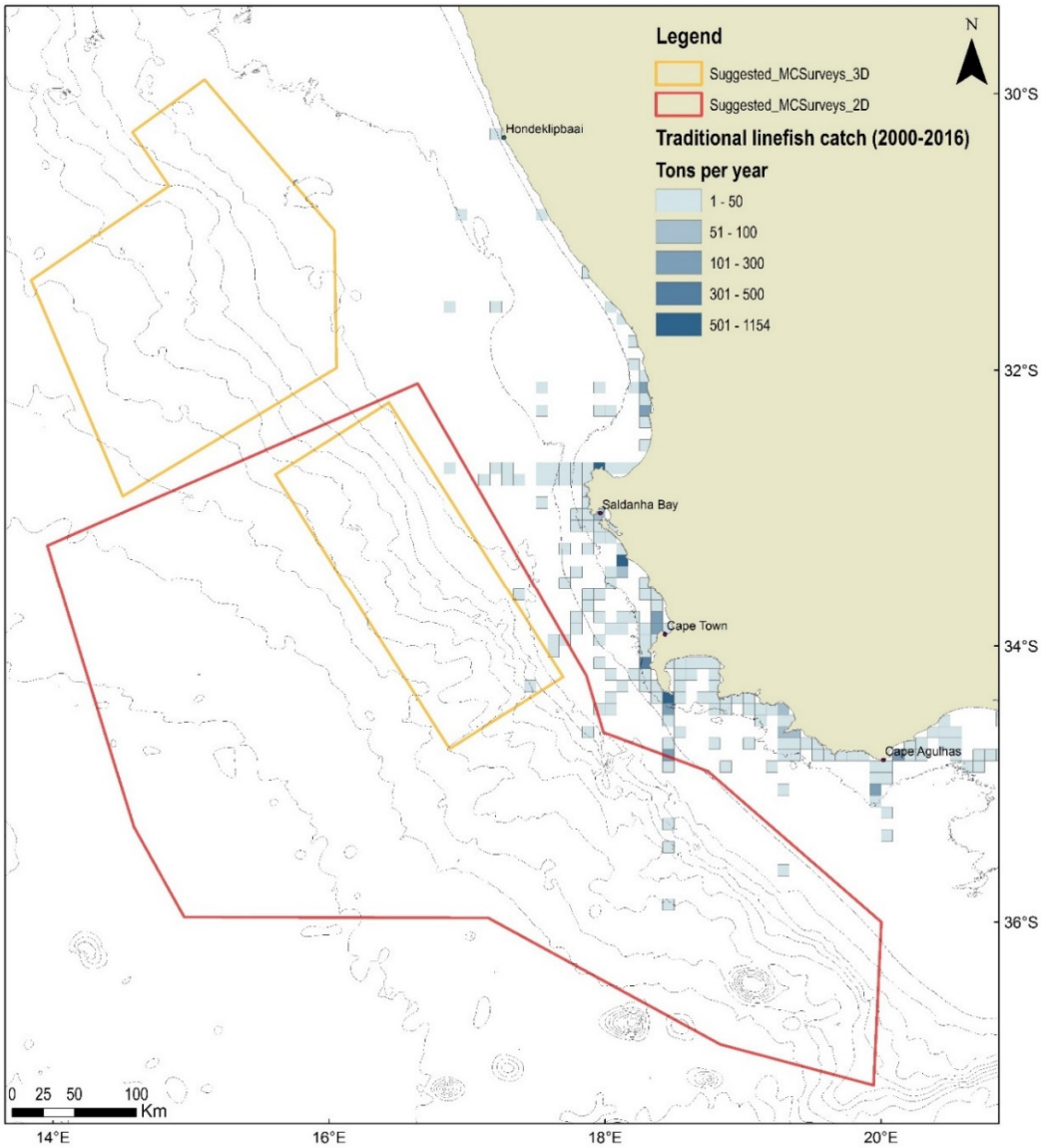


FIGURE 4-22: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF TRADITIONAL LINEFISH OPERATIONS.

4.5.1.8 West Coast Rock Lobster

The West Coast rock lobster fishery occurs inside the 200 m depth contour along the West Coast from Namibia to East London on the East Coast of South Africa. In South Africa the fishery is divided into the offshore fishery and the near-shore fishery, both directed inshore of the 100 m bathymetric contour. The offshore sector operates in a water depth range of 30 m to 100 m whilst the inshore fishery is restricted by the type of gear used to waters shallower than 30 m in depth. Thus, there is no direct overlap with the proposed survey operations (see Figure 4-23).

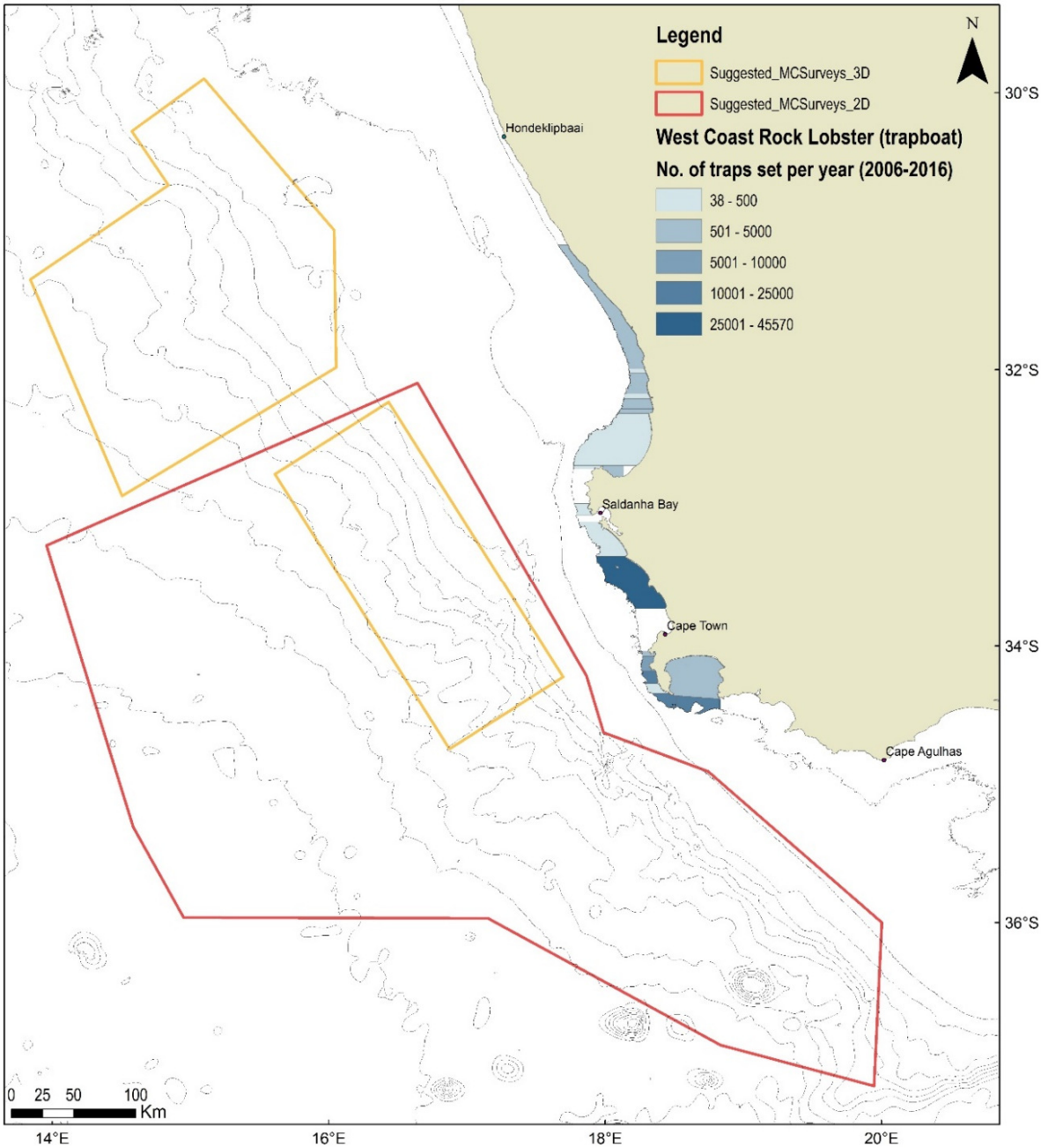


FIGURE 4-23: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE WEST COAST ROCK LOBSTER FISHING GROUNDS.

4.5.1.9 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. Vessels 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.

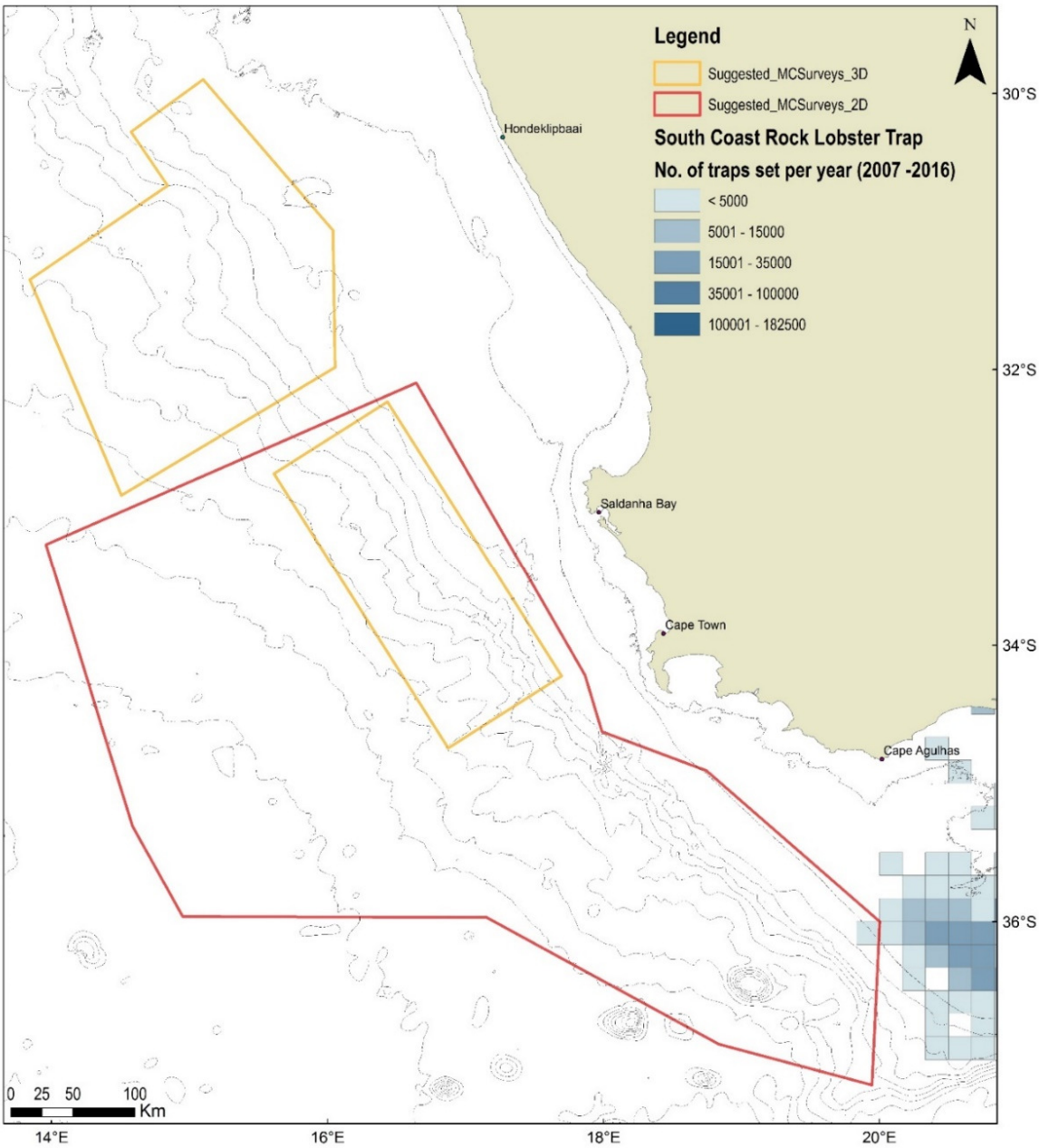


FIGURE 4-24: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF FISHING EFFORT EXPENDED BY TRAP FISHERY TARGETING SOUTH COAST ROCK LOBSTER.

There is no significant overlap between fishing grounds and either of the survey areas (see Figure 4-24), however, there is evidence of fishing ground immediately adjacent to the eastern extent of the proposed 2D survey area.

4.5.1.10 Fisheries Research Surveys

Surveys of demersal fish resources are carried out in January (West Coast survey encompassing the area between the Namibian border and Cape Agulhas) and April/May (South Coast survey encompassing the area between Cape Agulhas and Port Alfred) each year by DAFF in order to set the annual TACs for demersal fisheries. In recent correspondence received from DAFF (Durholtz, pers. comm., 5 November 2018) it is

understood that the 2019 survey is scheduled to commence from the first week of January 2019 until mid-February 2019. Stratified, 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. The gear configuration is similar to that of commercial demersal trawlers; however, nets are towed for a shorter duration of generally 30 minutes per tow. Trawl positions are randomly selected to cover specific depth strata that range from the coast to the 1 000 m bathymetric contour. Approximately 120 trawls are conducted during each survey over a period of approximately one month. Figure 4-25 shows the proposed 2D and 3D survey areas in relation to the demersal trawling effort.

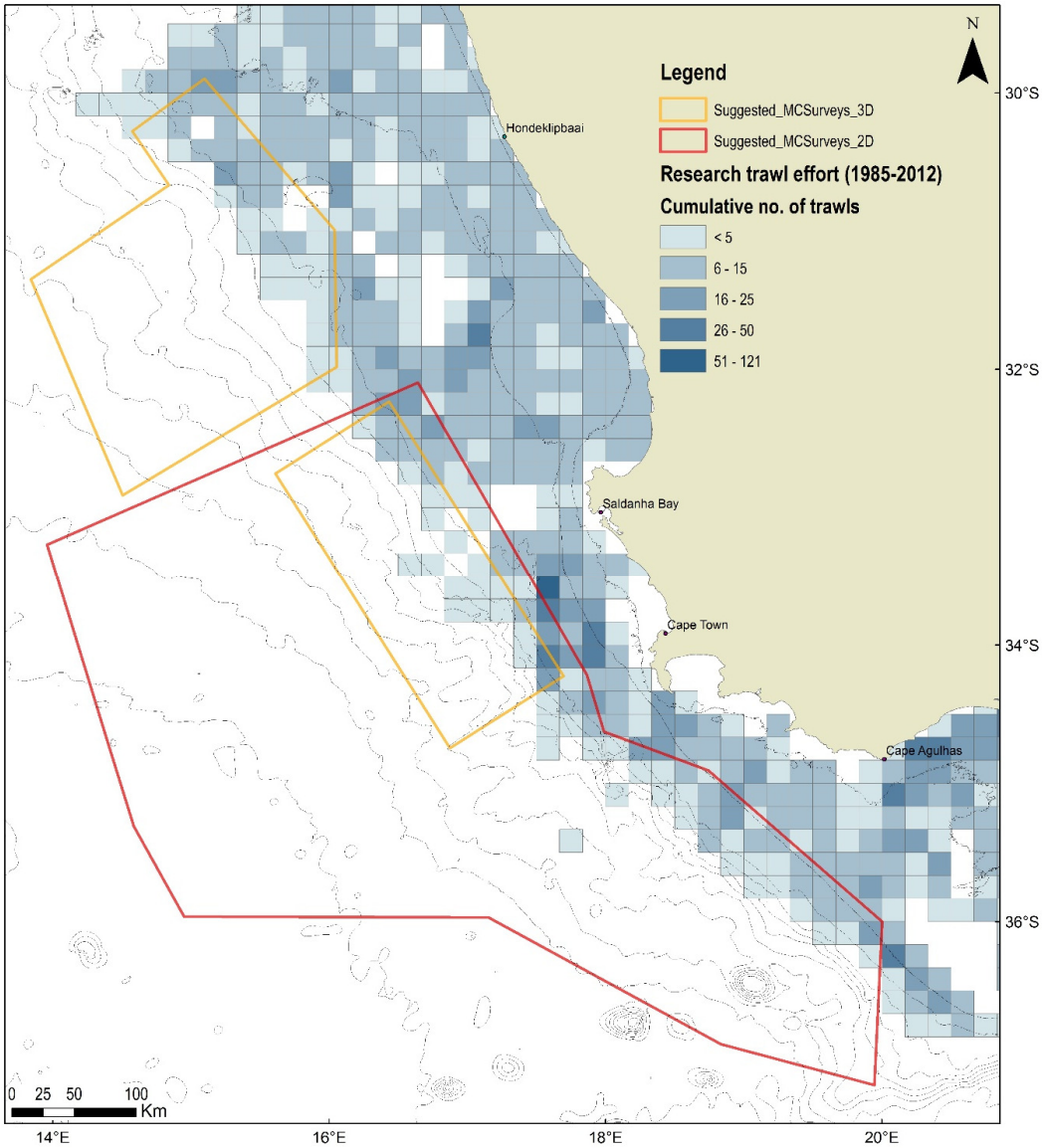


FIGURE 4-25: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE SPATIAL DISTRIBUTION OF THE NUMBER OF DEMERSAL RESEARCH TRAWLS UNDERTAKEN BY DAFF IN SOUTH AFRICAN WATERS.

The biomass of small pelagic species is also assessed bi-annually by an acoustic survey. The first of these surveys is timed to commence in mid-May to mid-June 2019 while the second starts in mid-October to mid-December 2019. During these surveys the survey vessel travels pre-determined transects (perpendicular to

bathymetric contours) running offshore from the coastline to approximately the 200 m bathymetric contour. The survey is designed to cover an extensive area from the Orange River on the West Coast to Port Alfred on the East Coast. The proposed layout of survey tracks undertaken during the 2010 and 2013 acoustic surveys is shown in Figure 4-26.

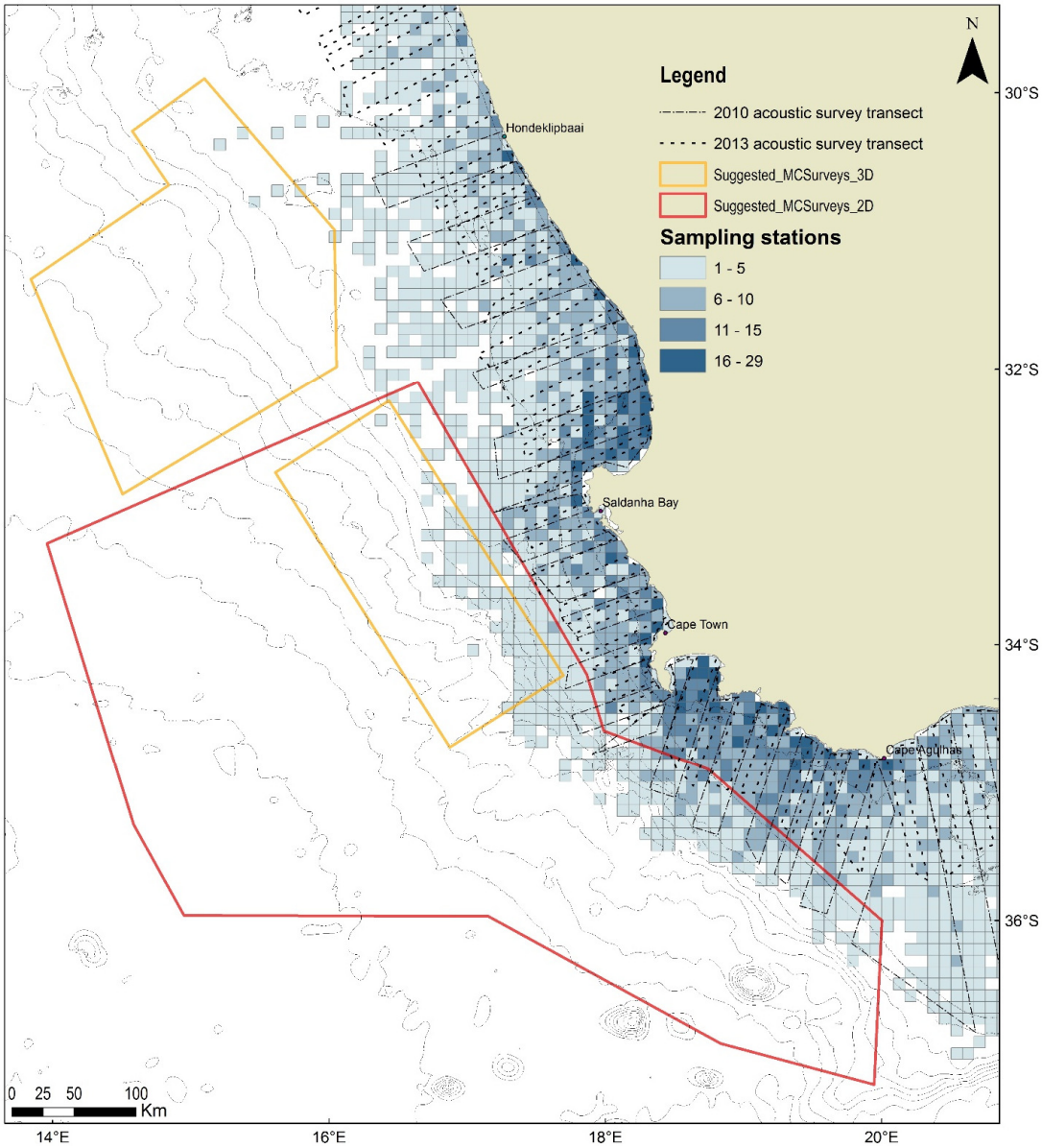


FIGURE 4-26: THE PROPOSED 2D AND 3D SEISMIC SURVEY AREAS IN RELATION TO THE SPATIAL DISTRIBUTION SAMPLING STATIONS FOR ACOUSTIC SURVEYS OF THE BIOMASS OF SMALL PELAGIC SPECIES.

4.5.2 Shipping transport

A large number of vessels navigate along the West and South coasts on their way around the southern African subcontinent. The majority of shipping traffic is located on the outer edge of the continental shelf (between 12 and 24 nm offshore) with traffic inshore of the continental shelf along the West and South Coast largely

comprising fishing vessels. The majority of the shipping traffic would pass through the proposed survey areas as shown in Figure 4-27.

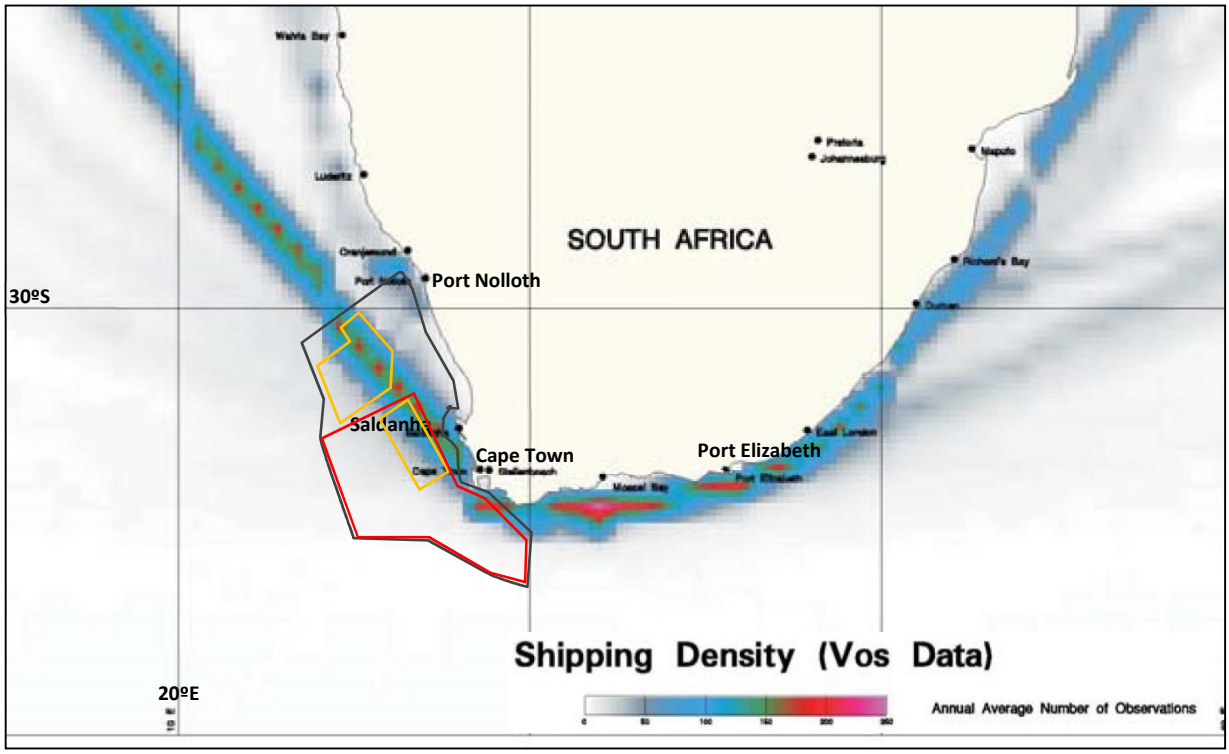


FIGURE 4-27: THE PROPOSED RECONNAISSANCE PERMIT APPLICATION AREA IN RELATION TO THE MAJOR SHIPPING ROUTES ALONG THE WEST AND SOUTH COASTS OF SOUTH AFRICA. (Data from the South African Centre for Oceanography)

4.5.3 Exploration, Production and Mining

4.5.3.1 Exploration

The South African continental shelf and economic EEZ have similarly been partitioned into Licence blocks for petroleum exploration and production activities (see Figure 4-28). Oil and gas exploration in the South African offshore commenced with seismic surveys in 1967. Since then numerous 2D and 3D seismic surveys have been undertaken on the West and South Coasts.

Approximately 40 exploration wells have been drilled since the 1960's. Prior to 1983, reliable technology was not available for removing wellheads from the seafloor. Since then, however, on completion of drilling operations, the well casing has been severed 3 m below the sea floor and removed from the seafloor together with the permanent and temporary guide bases. Of the approximately 40 wells drilled, 35 wellheads remain on the seafloor. Location and wellhead details are available from the Hydrographic office of the South African Navy (which issues the details to the public in a notice to mariners) or directly from PASA. We are not aware of any exploration well drilling planned for the immediate future in this proposed Reconnaissance Permit area.

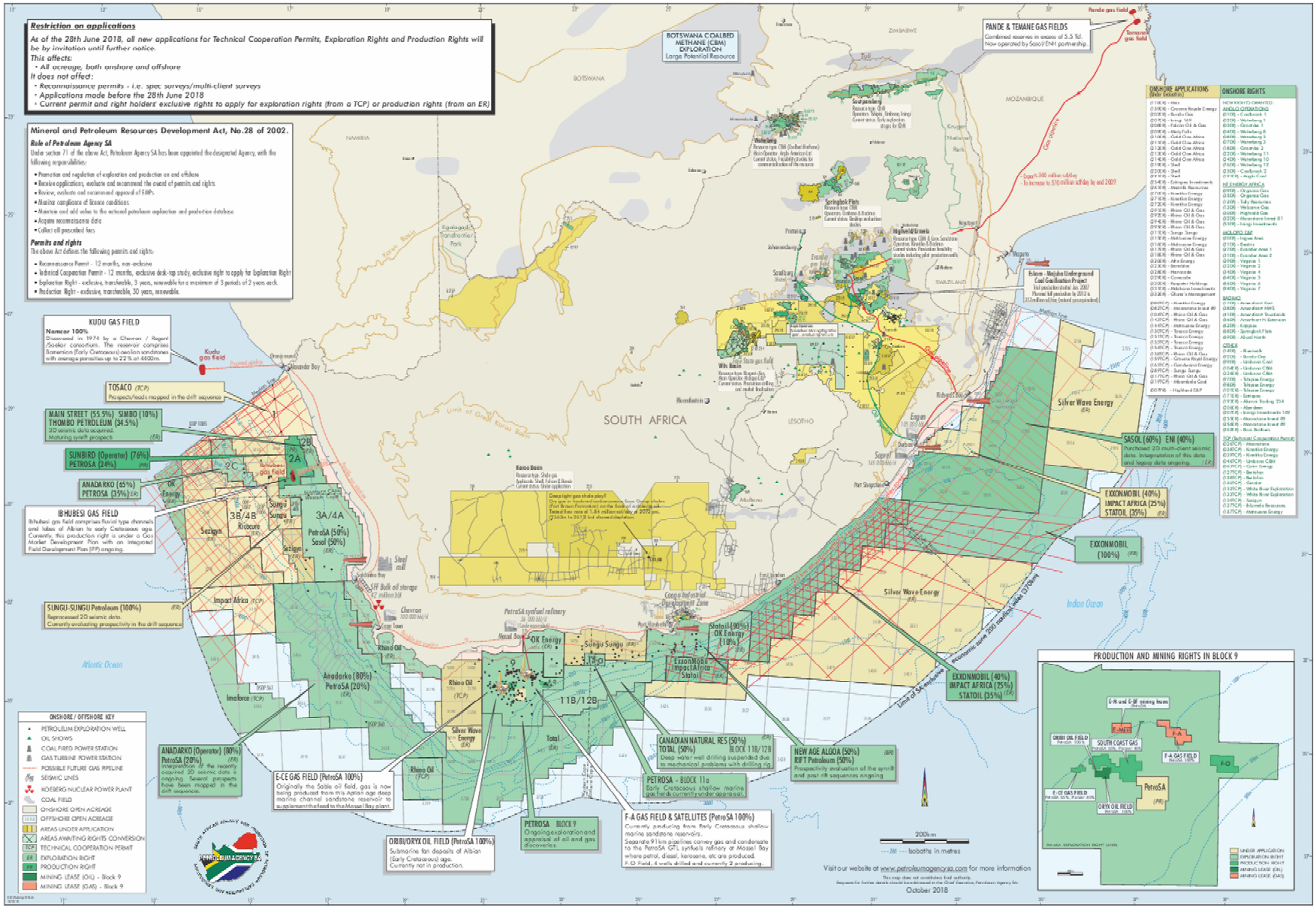


FIGURE 4-28: PETROLEUM LICENCE BLOCKS OFF THE WEST, SOUTH AND EAST COASTS OF SOUTH AFRICA (AFTER PASA, OCTOBER 2018).

4.5.3.2 Development and production

There is no current development or production from the South African west coast offshore. The Ibhubesi Gas Field (Block 2A) and Kudu Gas Field (which lies several hundred kilometres to the north-west off the coast of southern Namibia) have been identified for development. In this regard, a subsea pipeline to export gas from the Ibhubesi Gas Field to a location either on the Cape Columbine peninsula or to Ankerlig approximately 25 km north of Cape Town is currently being proposed by Sunbird South Africa.

4.5.4 Prospecting and mining

4.5.4.1 Diamonds

Twenty diamond mining concessions have been established along the West Coast. The concession areas are split into four or five zones (Surf zone and (a) to (c) or (d)-concessions), which together extend from the high water mark out to approximately 500 m depth (see Figure 4-29). The (b)-(c) boundary varies from 3 km to over 7 km from the high water mark. The proposed 2D and 3D survey areas overlap with a small portion of these marine diamond mining concession areas (see Figure 4-30).

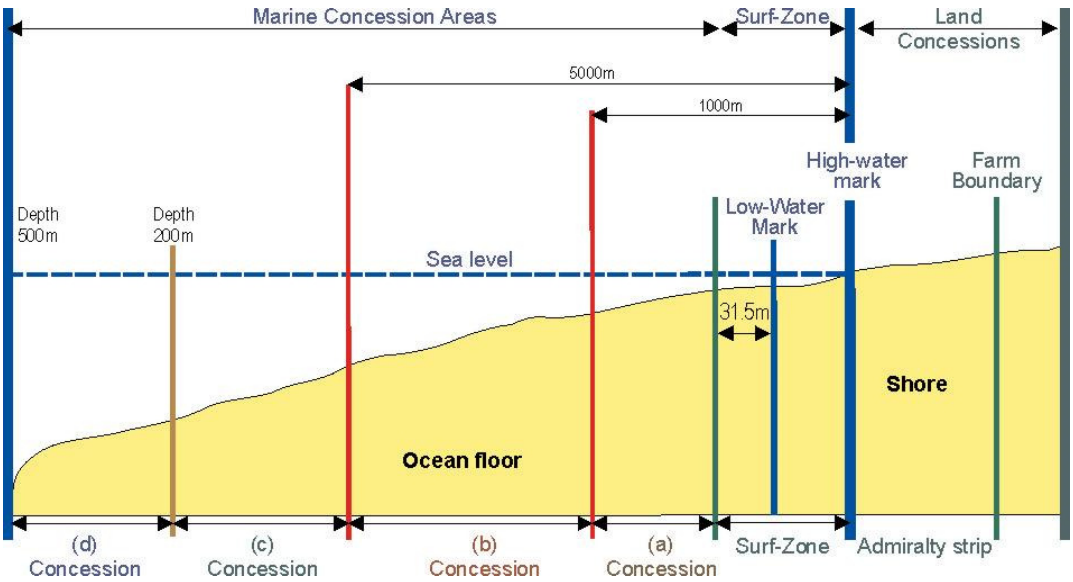


FIGURE 4-29: DIAGRAM OF THE ONSHORE AND OFFSHORE BOUNDARIES OF THE SOUTH AFRICAN (A) TO (D) MARINE DIAMOND MINING CONCESSION AREAS.

On the Namaqualand coast south of Hondeklipbaai, marine diamond mining activity is restricted to nearshore, diver-assisted operations from small, converted fishing vessels working in the a-concessions, which extend to 1 000 m offshore of the high water mark. Over the past few years there has been a substantial decline in small-scale diamond mining operations along the Namaqualand coast due to the global recession and depressed diamond prices. Some vessels still operate out of Alexander Bay and Port Nolloth, but activity out of Hondeklip Bay has all but ceased. Deep-water diamond mining is currently underway in the South African 2C and 3C offshore concession areas.

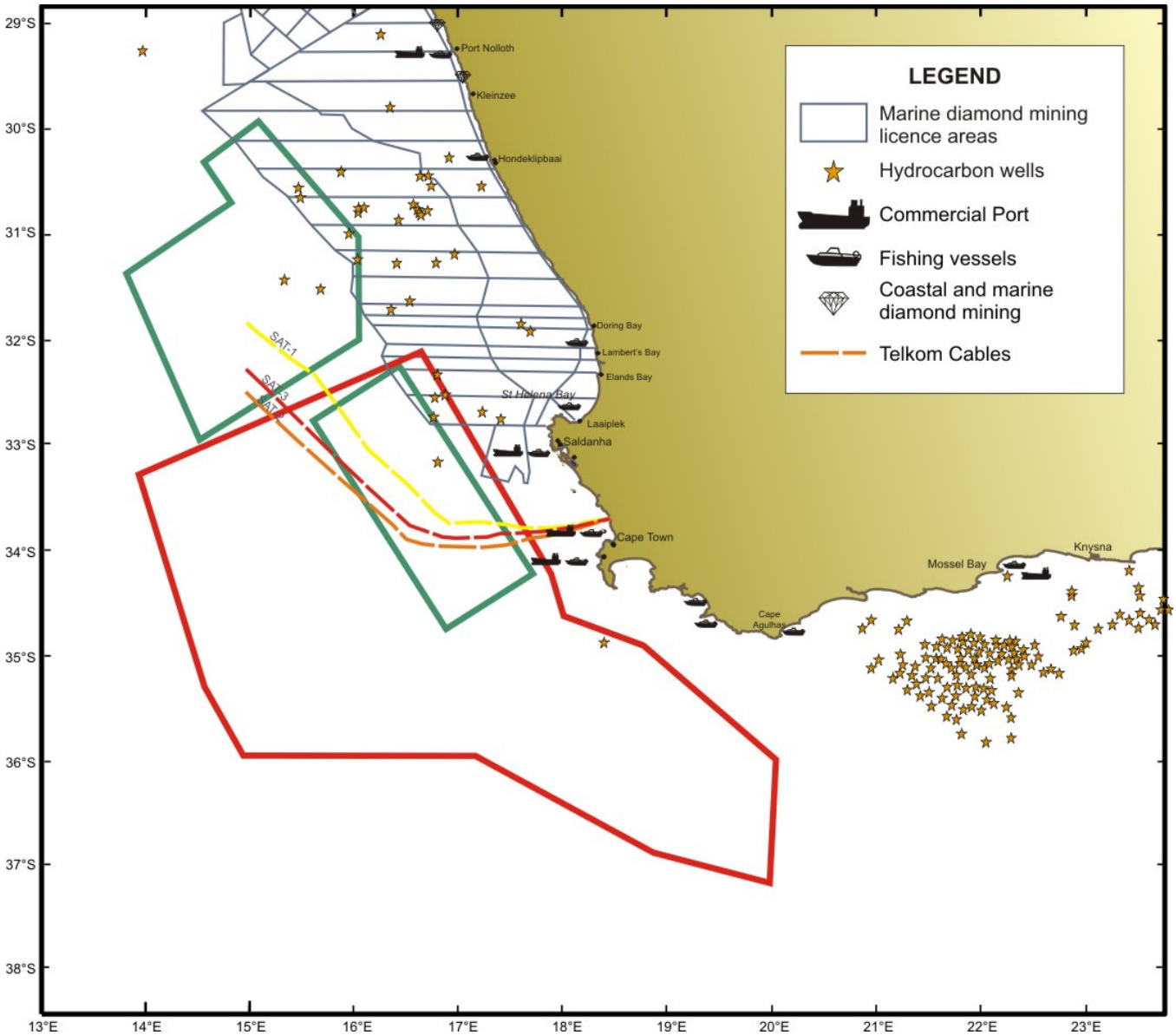


FIGURE 4-30: THE PROPOSED 2D (RED POLYGON) AND 3D (GREEN POLYGONS) SURVEY AREAS IN RELATION TO PROJECT-ENVIRONMENT INTERACTION POINTS ON THE WEST AND SOUTH COAST THE LOCATION OF EXISTING HYDROCARBON WELLS, MARINE DIAMOND MINING, PORTS FOR COMMERCIAL AND FISHING VESSELS AND ROUTES OF THE SUBSEA TELECOMMUNICATIONS CABLES (DASHED LINES) ARE ILLUSTRATED.

4.5.4.2 Heavy minerals

Heavy mineral sands containing, amongst other minerals, zircon, ilmenite, garnet and rutile may be found offshore of the West Coast. Although a literature search has not identified any published studies that detail the distribution of heavy minerals offshore, concentrations are known to exist onshore. Tronox's Namakwa Sands is currently exploiting heavy minerals from onshore deposits near Brand-se-Baai (approximately 385 km north of Cape Town).

De Beers Consolidated Mines (Pty) Ltd (DBCM) holds prospecting rights over a number of sea concessions off the West Coast for gold, heavy minerals, platinum group metals and sapphires. De Beers Marine (Pty) Ltd is, however, the operator of these prospecting areas. Applications for renewal for these rights have been granted and executed, in portions of Concessions 2C – 10C. The proposed Reconnaissance Permit Application area would overlap with these areas, however, the actual survey areas would not extend into these concession areas.

4.5.4.3 Glauconite and phosphate

Glauconite pellets (an iron and magnesium rich clay mineral) and bedded and peletal phosphorite occur on the seafloor over large areas of the continental shelf on the West Coast. These represent potentially commercial resources that could be considered for mining as a source of agricultural phosphate and potassium (Birch 1979a & b; Dingle *et al.* 1987; Rogers and Bremner 1991).

The proposed survey areas overlap with a number of prospecting areas for glauconite and phosphorite / phosphate are located off the West Coast (see in Figure 4-31). Green Flash Trading received their prospecting rights for Areas 251 and 257 in 2012/2013. The prospecting rights for Agrimin1, Agrimin2 and SOM1 have expired (Jan Briers, DMR pers. comm., December 2013).

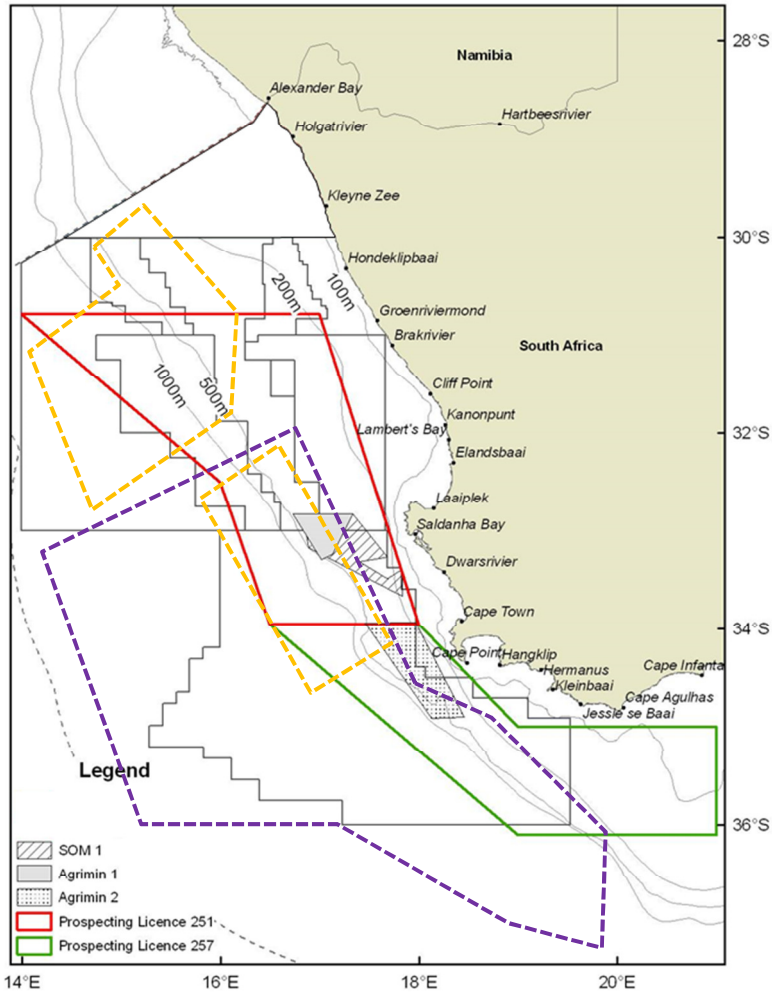


FIGURE 4-31: THE APPROXIMATE LOCATION OF THE PROPOSED 2D SURVEY (PURPLE) AND 3D SURVEYS (ORANGE) IN RELATION TO GLAUCONITE AND PHOSPHORITE PROSPECTING AREAS (AGRIMIN1, AGRIMIN2 AND SOM1).

4.5.4.4 Manganese nodules

Rogers (1995) and Rogers and Bremner (1991) report that manganese nodules enriched in valuable metals occur in ultra-deep water areas (>3 000 m) off the West Coast. The nickel, copper and cobalt contents of the nodules fall below the current mining economic cut-off grade of 2% over most of the area, but the possibility exists for mineral grade nodules in the areas north of 33°S in the Cape Basin and off northern Namaqualand.

4.5.5 Undersea Cables

There are a number of submarine telecommunications cable systems across the Atlantic and the Indian Ocean (see Figure 4-32), including *inter alia*:

- South Atlantic Telecommunications cable No.3 / West African Submarine Cable / South Africa Far East (SAT3/WASC/SAFE): This cable system is divided into two sub-systems, SAT3/WASC in the Atlantic Ocean and SAFE in the Indian Ocean. The SAT3/WASC sub-system connects Portugal (Sesimbra) with South Africa (Melkbosstrand). From Melkbosstrand the SAT-3/WASC sub-system is extended via the SAFE sub-system to Malaysia (Penang) and has intermediate landing points at Mtunzini South Africa, Saint Paul Reunion, Bale Jacot Mauritius and Cochin India (www.safe-sat3.co.za).
- Eastern Africa Submarine Cable System (EASSy): This is a high bandwidth fibre optic cable system, which connects countries of eastern Africa to the rest of the world. EASSy runs from Mtunzini (off the East Coast) in South Africa to Port Sudan in Sudan, with landing points in nine countries, and connected to at least ten landlocked countries.
- West Africa Cable System (WACS): WACS is 14 530 km in length, linking South Africa (Yzerfontein) and the United Kingdom (London). It has 14 landing points, 12 along the western coast of Africa (including Cape Verde and Canary Islands) and 2 in Europe (Portugal and England) completed on land by a cable termination station in London.
- African Coast to Europe (ACE): The ACE submarine communications cable is a 17 000 km cable system along the West Coast of Africa between France and South Africa (Yzerfontein).

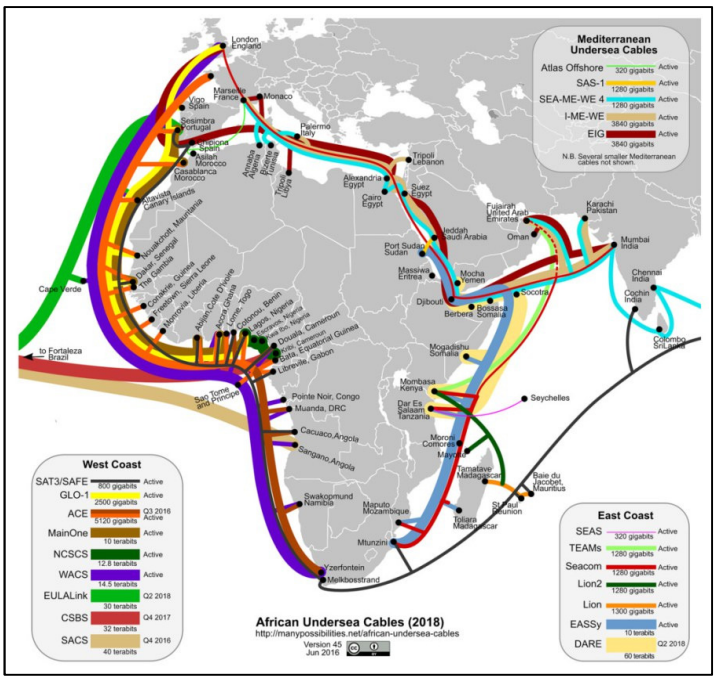


FIGURE 4-32: CONFIGURATION OF THE CURRENT AFRICAN UNDERSEA CABLE SYSTEMS. (Source: http://www.manypossibilities.net)

Where seafloor conditions permitted, the cables are buried 0.7 m below the seafloor from the landing points to 1 000 m water depth. There is an exclusion zone applicable to the telecommunication cables 1 nm (approximately 1.9 km) each side of the cable in which no anchoring is permitted.

4.5.6 Marine Archaeological Sites

4.5.6.1 Palaeontological sites

Various sites comprising fossilised forests have been found during previous marine diamond exploration and/or mining activities with Sea Concessions 2C to 5C, thus within the northern extent of the proposed Reconnaissance Permit Application area. Bamford and Corbett (1994) described various specimens of fossil wood which were recovered from the continental shelf between the mouth of the Orange River and Kleinzee in the vicinity of Sea Concessions 2C and 3C. The wood was collected in water depths of 100 to 150 m during exploration of the shelf by De Beers Marine (Pty) Ltd and the species were found to be predominately *Podocarpaceae* species.

Stevenson & Bamford (2003) describe an abundance of in-situ fossilised yellowwood tree trunks in an approximate 2 km^2 area of seabed outcrop in 136-140 m depth, about 32 km offshore in Sea Concession 4C. The fossilized wood and accompanying cold water coral colonies are considered vulnerable to any activities that could impact on the seabed (FAO 2006; Rogers *et al.* 2008; FAO 2009; Sink *et al.* 2012a,b).

Following the application of the Conservation on Biological Diversity's (CBD) Ecologically or Biologically Significant Marine Areas (EBSA) criteria, the area (referred to as the Namaqua Fossil Forest) was identified as unique, and presented at the CBD Southeast Atlantic Ocean regional workshop for consideration as an EBSA warranting formal conservation (Sink & Kirkman 2013). This area is located within the proposed Namaqua Fossil Forest Marine Protected Area (MPA) (see Section 4.6 below).

4.5.6.2 Shipwrecks

Over 2 000 shipwrecks are present along the South African coastline. The majority of known wrecks along the West Coast are located in relatively shallow water close inshore (within the 100 m isobath). Thus, shipwrecks may be encountered in the eastern inshore portions of the proposed Reconnaissance Permit Application area.

Wrecks older than 60 years are protected under the National Heritage Resources Act, 1999 (No. 25 of 1999) (NHRA). In terms of the NHRA, no person may, without a permit:

- Destroy, damage, excavate, alter, deface or otherwise disturb any wreck site;
- Destroy, damage, excavate or remove from its original position, collect or own any wreck object or artifact;
- Trade in, sell for private gain, export or attempt to export from the Republic any category of wreck object or artefact; and
- Bring onto or use at a wreck site any excavation equipment or any equipment which assists in the detection or recovery of metals or wreck objects or artefacts.

4.5.7 Anthropogenic marine hazards

Human use of the marine environment has resulted in the addition of numerous hazards on the seafloor. Readers are referred to the Annual Summary of South African Notices to Mariners No. 5 or charts from the South African Navy or Hydrographic Office for the location of different underwater hazards along the West Coast.

4.6 CONSERVATION AREAS AND MARINE PROTECTED AREAS

While there are numerous conservation areas and marine protected areas (MPAs) along the coastline of the Western Cape, the proposed Reconnaissance Permit Application is located well offshore of these areas (see Figure 4-33).

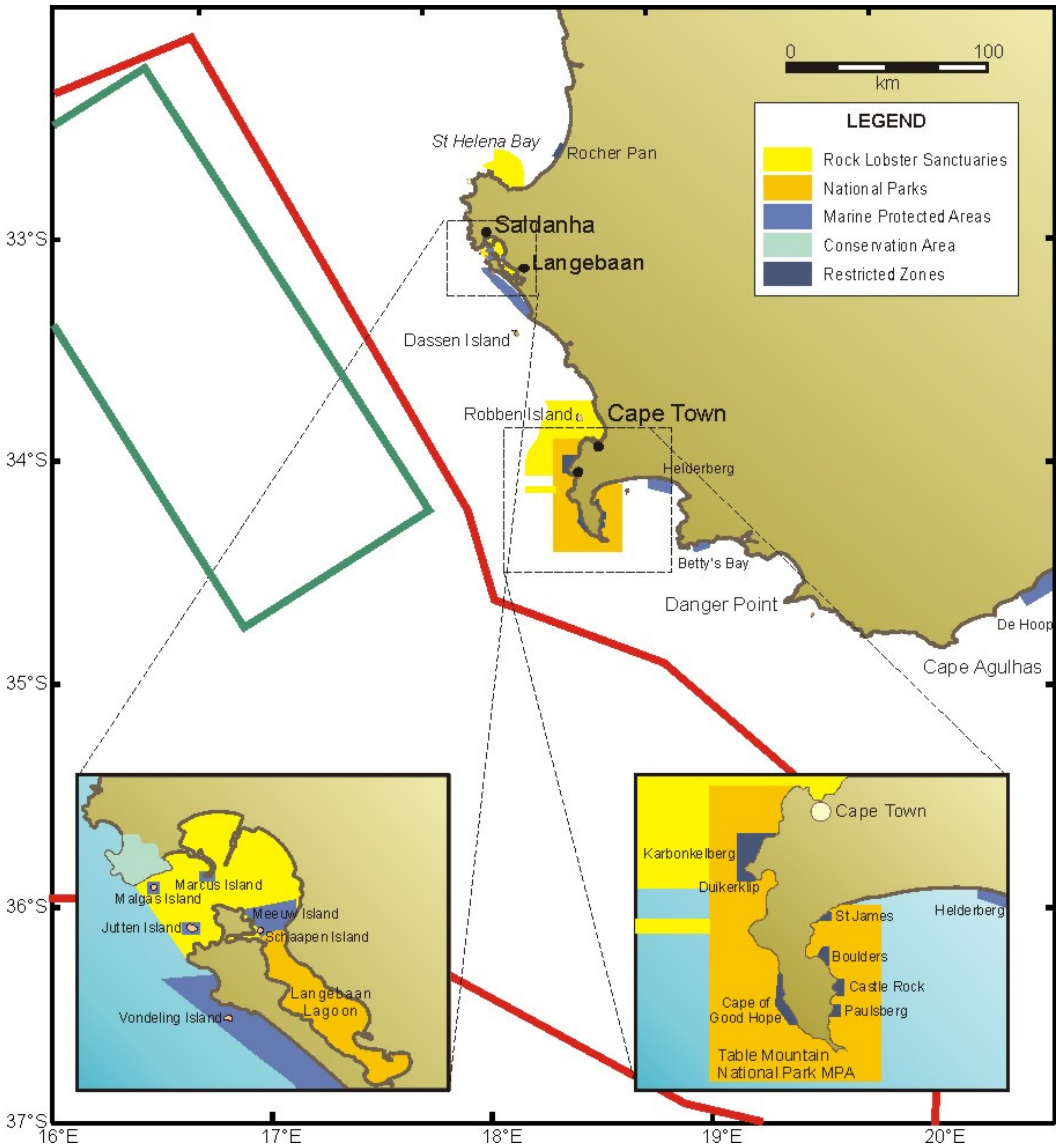


FIGURE 4-33: THE PROPOSED 2D (RED POLYGON) AND 3D (GREEN POLYGON) SURVEY AREAS IN RELATION TO RESERVES AND MARINE PROTECTED AREAS ON THE WEST AND SOUTH COASTS. THE NORTHERN 3D SURVEY AREA AND MCDOUGALL'S BAY ROCK LOBSTER SANCTUARY AT PORT NOLLOTH LIE TO THE NORTH OF THE ILLUSTRATED AREA AND ARE NOT SHOWN.

Using biodiversity data mapped for the 2004 and 2011 National Biodiversity Assessments a systematic biodiversity plan has been developed for the West Coast (Majiedt *et al.* 2013) with the objective of identifying both coastal and offshore priority areas for MPA expansion. Potentially vulnerable marine ecosystems (VMEs) that were explicitly considered during the planning included the shelf break, seamounts, submarine canyons, hard grounds, submarine banks, deep reefs and cold water coral reefs. The biodiversity data were used to identify focus areas for protection on the West Coast between Cape Agulhas and the South African – Namibian border.

The proposed 2D and 3D survey areas overlap with a number of these, namely: Orange Shelf Edge, Benguela Muds, South Atlantic Seamounts and Browns Bank Corals (see Figure 4-34). The potential MPA areas were recently presented to Government and accepted for future declaration as new MPAs. However, no formal declarations have to date been gazetted. In considering the application, should the authorities deem it necessary that these areas be avoided, PGS would adjust the planned survey lines as necessary.

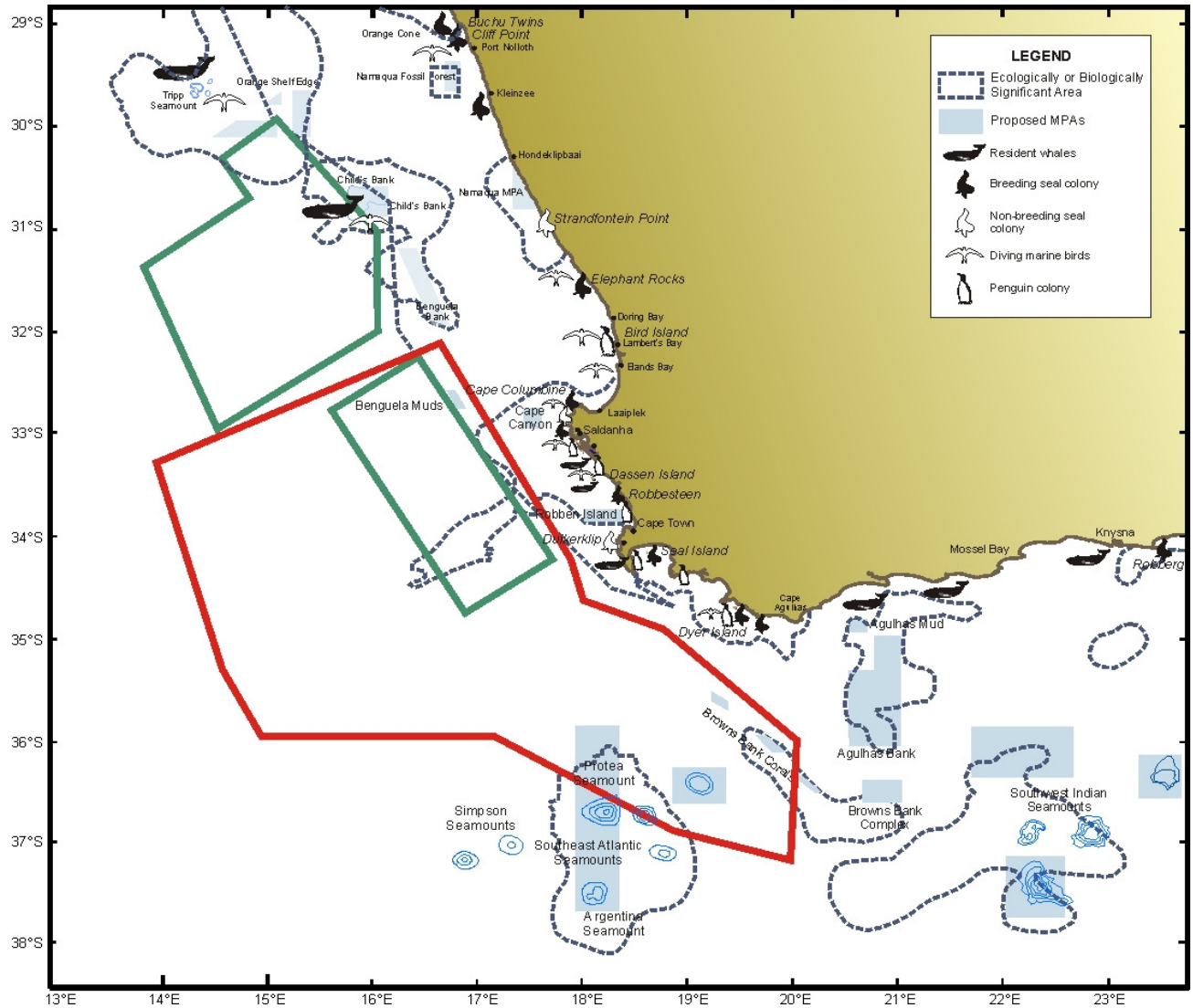


FIGURE 4-34: THE PROPOSED 2D (RED POLYGON) AND 3D (GREEN POLYGONS) SURVEY AREAS IN RELATION TO PROJECT - ENVIRONMENT INTERACTION POINTS ON THE WEST AND SOUTH COASTS, ILLUSTRATING THE LOCATION OF MPAS, SEABIRD AND SEAL COLONIES AND RESIDENT WHALE POPULATIONS.

As part of a regional Marine Spatial Management and Governance Programme (MARISMA; 2014-2020) the Benguela Current Commission (BCC) and its member states have identified a number of Ecologically or Biologically Significant Areas (EBSAs) both spanning the border between Namibia and South Africa and along the South African West and South Coasts, with the intention of implementing improved conservation and protection measures within these sites. Those areas identified as being of ecologically or biologically significant areas are shown in Figure 4-34. These EBSAs have been proposed and inscribed under the Convention of Biological Diversity (CBD). The proposed 2D and 3D survey areas overlap with a number of these EBSAs, namely: the trans-boundary Orange Shelf Edge and Benguela Upwelling System, Child's Bank, Cape Canyon and surrounds, and Brown's Bank. A further recently proposed EBSA, Protea seamount, the only named seamount within the Southeast Atlantic Seamounts cluster, lies on the southern boundary of the proposed 2D survey area.

The principal objective of these EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. No specific management actions have been formulated for the various areas at this stage.

5 ENVIRONMENTAL IMPACT ASSESSMENT

This section describes and assesses the significance of potential impacts related to the proposed speculative 2D and 3D seismic surveys off the West and South Coasts of South Africa. The potential impacts of the proposed activities are addressed in three categories, namely:

1. Seismic and support vessels operation;
2. Impacts of seismic noise on marine fauna; and
3. Impacts of seismic activities on other users of the sea.

All impacts are systematically assessed and presented according to predefined rating scales (see Appendix 2). For each potential impact a table is provided that summarises the significance level assessment for that impact. Mitigation or optimisation measures are proposed which could ameliorate the negative impacts or enhance potential benefits, respectively. The status of all impacts should be considered to be negative unless otherwise indicated. The significance of impacts with and without mitigation is also assessed.

Unless otherwise indicated, all potential impacts discussed below would be for the duration of the survey operations only, i.e. short term (five months), due to the transient nature of survey activities.

5.1 IMPACT OF NORMAL SEISMIC / SUPPORT VESSELS

5.1.1 Discharges/Disposal to the Sea

Description of impact

Discharges to the marine environment include deck drainage, machinery space drainage, sewage, galley wastes and solid wastes from the survey and/or support vessels. These discharges would result in the local reduction in water quality, which could impact marine fauna in a number of different ways:

- Physiological effects: Ingestion of hydrocarbons, detergents and other waste could have adverse effects on marine fauna, which could ultimately result in mortality;
- Increased food source: The discharge of galley waste and sewage would result in an additional food source for opportunistic feeders, speciality pelagic fish species; and
- Increased predator - prey interactions: Predatory species, such as sharks and pelagic seabirds, may be attracted to the aggregation of pelagic fish attracted by the increased food source.

Assessment

The survey and support vessels would have the necessary sewage treatment systems, oil/water separators and food waste macerators to ensure compliance with MARPOL 73/78 standards. Compliance with MARPOL 73/78 means that discharges introduce relatively small amounts of nutrients and organic material to oxygenated surface waters, which would result in only a minor contribution to local marine productivity and possibly of attracting some opportunistic feeders. The intermittent discharge of sewage is likely to contain a low level of residual chlorine following treatment, but this is expected to have a minimal effect on seawater quality given the relatively low total discharge and taking into account dilution in the surface waters.

Based on the relatively small discharge volumes, high energy sea conditions and compliance with MARPOL 73/78 requirements, the potential impact of normal discharges from the survey and support vessels would remain of low intensity across the Reconnaissance Permit Application area over the duration of the proposed surveys. Thus, the potential impact on marine fauna would remain of **VERY LOW** significance with or without mitigation (see Table 5-1).

Incineration of waste on board would also release soot as well as CO, CO_2 and dioxins (depending on the composition of the waste). In South African waters, the incineration of waste requires an Atmospheric Emission Licence in terms of the Environmental Management: Air Quality Act, 2004. Thus general waste would in all likelihood rather be stored on board for later onshore disposal, and consequently would have **no impact** on the marine environment. Waste containers would be transported to work boats for onward handling in port and removed by a waste contractor for disposal at a permitted landfill site. Recycling would occur on board and the solid waste would be sorted in separate containers before being taken to an appropriate onshore recycling facility. Specialist waste disposal contractors would dispose of hazardous waste.

Mitigation

The following measures are recommended for mitigation:

- Ensure compliance with the MARPOL 73/78 standards;
- A Shipboard Oil Pollution Emergency Plan (SOPEP) must be prepared for all vessels and be in place at all times during operation;
- Deck drainage should be routed to a separate drainage system (oily water catchment system) for treatment to ensure compliance with MARPOL 73/78 standards (i.e. 15 ppm before discharge);
- All process areas should be bunded to ensure drainage water flows into the closed drainage system;
- Undertake training and awareness of crew in spill management to minimise contamination;
- Low-toxicity biodegradable detergents and reusable absorbent cloths should be used in cleaning of all deck spillage;
- All hydraulic systems should be adequately maintained; and
- Minimise the discharge of waste material should obvious attraction of marine fauna be observed.

Cumulative Impact

Normal marine traffic offshore of the West and South Coasts would also lead to the above-mentioned discharges to the marine environment (i.e. deck drainage, machinery space drainage, sewage, galley wastes and solid wastes). As vessels are required to comply with MARPOL 73/78 requirements and the discharges occur within high energy sea conditions over a vast area, the cumulative impact is considered to be regional and of low intensity for the duration of the proposed surveys. Thus this potential impact is considered to be **VERY LOW**.

TABLE 5-1: IMPACT OF NORMAL DISCHARGES FROM THE SEISMIC AND SUPPORT VESSELS.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Consequence	Very Low	Very Low
Probability	Highly Probable	Highly Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	High	High
Nature of Cumulative impact	VERY LOW	
Degree to which impact can be reversed	Fully reversible - discharges would be quickly dispersed and diluted by the high wind and wave energy of the offshore sea environment.	
Degree to which impact may cause irreplaceable loss of resources	N/A	

5.1.2 Accidental oil spill during bunkering / refuelling

Description of impact

Accidental hydrocarbon spills of varying sizes could result from related operations, for example the bunkering of fuel oil at sea. This scenario assumes that an accidental spillage of fuel oil would occur.

Assessment

Spillages and leakages during bunkering operations are a primary source of oil pollution from ships. Many of the spillages that occur can be attributed to human error. Thus all bunkering operations should be carefully planned and executed in accordance with MARPOL 73/78 standards.

Spillages and leakages during bunkering operations are generally relatively small (< 1 000 litres). Bunkering operations are expected to take place within the port of operation or at sea during the survey. Bunkering within the port limits would be less likely to be affected by environmental factors (e.g. sea state and wind) and any accidental spills would be easier to contain and remediate. Any spill within the port limits would be managed in accordance with the port's local oil spill contingency plan. The impact associated with an oil spill within the port limits is considered to be **INSIGNIFICANT**.

Accidental spillages from offshore bunkering operations would be more difficult to contain. However, since no bunkering is permitted to take place within 50 nm from the coast, a small spill would most likely disappear before reaching the shore due to evaporative processes and the high energy marine environment off the South and West coasts. Any spills would be managed in accordance with procedures specified in the project specific Emergency Response Plan and Shipboard Oil Pollution Emergency Plan. Since a small spill would most likely never reach the coast, the potential impact on the biophysical environment is expected to be localised, of medium to high intensity over the short-term, and is therefore considered to be of **VERY LOW** significance without and with mitigation (see Table 5-2).

Mitigation

- PGS and/or the appointed survey contractor, as applicable, must prepare a project specific Emergency Response Plan and SOPEP for the each of the proposed survey operations, which defines their organisational structure and protocols that would be implemented to respond to any incident (including accidental oil / fuel spills) in a safe, rapid, effective and efficient manner;
- Offshore bunkering should not be undertaken in the following circumstances:
  - > Within 50 nm of the coast;
  - > Wind force and sea state conditions of 6 or above on the Beaufort Wind Scale;
  - > During any workboat or mobilisation boat operations;
  - > During helicopter operations;
  - > During the transfer of in-sea equipment; and
  - > At night or times of low visibility.
- Support vessels must have the necessary spill response capability to deal with accidental spills in a safe, rapid, effective and efficient manner; and
- Crew must be trained in spill management.

Cumulative Impact

There are very few other activities that currently take place offshore the West and South coasts which require bunkering at sea. However, in the event that there are any concurrent spillages from offshore bunkering operations, the cumulative impact would be of medium to high intensity and regional extent for the duration of the proposed surveys. Thus, this potential impact is considered to be of **VERY LOW to LOW** significance.

TABLE 5-2: IMPACT OF AN ACCIDENTAL OIL SPILL DURING BUNKERING OPERATIONS.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Accidental spillages related to offshore bunkering operations		
Intensity	Zero	Zero
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Medium	Medium
Accidental spillages related to offshore bunkering operations		
Intensity	Medium to High	Medium
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low to Low	Low
Probability	Improbable	Improbable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Confidence	Medium	Medium
Nature of Cumulative impact	VERY LOW to LOW	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

5.1.3 Noise from Vessel and Helicopter Operations

5.1.3.1 Noise from survey and support vessel operations

Impact description

The noise from seismic and support vessels could result in localised disturbance of marine fauna (note: noise from actual survey activities is assessed in Section 5.2).

Impact assessment

Noise from the operation of the seismic and support vessels is likely to be no higher than that from other shipping vessels in the region. The potential impact of noise from seismic and support vessel operations on marine fauna is expected to be limited to the survey area (but localised at any one time) and of low intensity in the short-term. The significance of this impact is therefore assessed to be **VERY LOW** with and without mitigation (Table 5-3).

Mitigation measures

No measures are deemed necessary to mitigate noise impacts from the survey and support vessel operations.

Cumulative Impact

The cumulative impact of vessel noise is likely to be highly localised and transient. The intensity of these impacts is anticipated to be higher along well established vessel traffic routes within the proposed Reconnaissance Permit Application are for the duration of the proposed surveys. This potential impact is considered to be of **LOW** significance.

TABLE 5-3: IMPACT OF NOISE FROM SURVEY AND SUPPORT VESSEL OPERATIONS.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Confidence	Medium	Medium
Nature of Cumulative impact	LOW	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

5.1.3.2 Noise from helicopter operations

Impact description

Although no crew changes are anticipated during the proposed surveys, helicopters could (although highly unlikely) be utilised in an emergency situation to transfer crew between the seismic vessel and the mainland, which could result in localised disturbance of marine fauna.

Impact assessment

Low altitude flight paths over bird breeding colonies could result in temporary abandonment of nests and exposure of eggs and chicks leading to increased predation risk. The closest breeding islands are the Saldanha Bay islands, Dassen Island off Yzerfontein, Robben Island in Table Bay and Dyer Island off Danger Point, approximately 75 km east of the eastern border of the proposed 2D survey area. There is a further Cape Gannet breeding colony on Bird Island at Lambert's Bay, approximately 175 km east of the northern point of the 2D survey area. African Penguins nesting sites are at Dassen Island, Robben Island, Boulders beach in False Bay, Betty's Bay and Dyer Island.

In addition, low altitude flight paths over seal colonies can cause stampedes of animals to sea resulting in trampling of pups and nesting seabirds within seal colonies. There are a number of Cape fur seal breeding colonies located within the broader study area (see Section 4.4.2.7). The timing of the annual breeding cycle is very regular occurring between November and January.

In terms of the Marine Living Resources Act, 1998 (No. 18 of 1998) it is illegal for any vessel, including aircraft, to approach to within 300 m of whales within South African waters without a permit or exemption. Disturbance of cetaceans by helicopter would depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence of helicopter noise to the water surface) and the prevailing sea conditions.

Indiscriminate or direct flying over seabird or seal colonies (or flying low level parallel to the coast) and cetaceans could have a significant disturbance impact on breeding success or mortalities of juveniles. Although such impacts would be local in the area of the colony, they may have wider ramifications over the range of affected species and are deemed to range from low to high intensity. The significance of the potential impact is considered to range from **insignificant to very low** significance, if helicopter flight paths cross any of these areas at an altitude of less than 500 m. With the implementation of the suggested mitigation measures, this impact is expected to be **INSIGNIFICANT** (see Table 5-4).

Mitigation measures

- Flight paths must be pre-planned to ensure that no flying occurs over MPAs (Marcus Island, Malgas Island, Jutten Island, Langebaan Lagoon, Sixteen Mile Beach, Table Mountain National Park, Helderberg, and Betty's Bay), seal (Kleinzee, Robberg Bucchu Twins, Strandfontein Point, Bird Island, Paternoster Point, Duikerklip, Robbesteen, Seal Island and Geyser Rock) and seabird colonies (Saldanha Bay islands, Dassen Island, Robben Island, Dyer Island, Bird Island, Boulders beach, and Betty's Bay);
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) must be avoided. There is a restriction of coastal flights (parallel to the coast within 1 nautical mile of the shore) on the South Coast between the months of June and November to avoid Southern Right whale breeding areas;
- Aircraft may not approach to within 300 m of whales in terms of the Marine Living Resources Act, 1998 without a permit;
- The operator must comply with the Seabirds and Seals Protection Act, 1973, which prohibits the wilful disturbance of seals on the coast or on offshore islands;
- The contractor should comply fully with aviation and authority guidelines and rules; and
- All pilots must be briefed on ecological risks associated with flying at a low level parallel to the coast.

Cumulative Impact

As for the cumulative impact of vessel noise, the cumulative impact of helicopter noise for the duration of the proposed surveys is likely to be highly localised and transient and generally of higher intensity along established flight paths. This potential impact is considered to be of **LOW** significance.

TABLE 5-4: IMPACT OF NOISE FROM HELICOPTER OPERATIONS.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Intensity	Low to High	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low to Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant to Very Low**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Medium	Medium
Nature of Cumulative impact	LOW	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

5.2 IMPACTS OF 2D/3D SEISMIC NOISE ON MARINE FAUNA

This section assesses the potential impacts related to 2D and 3D seismic survey noise on marine fauna.

5.2.1 Potential Impacts on Plankton

Plankton, which are species that are unable to determine their direction of travel within the water column, comprise bacterioplankton (bacterial component of plankton), phytoplankton (floral plankton) and zooplankton (faunal plankton). Zooplankton includes ichthyoplankton (planktonic larval stages of fish and invertebrates and eggs) as well as holoplankton (species that spend their entire life-cycle as plankton).

Description of impact

Potential impacts of seismic pulses on plankton could include physiological injury and/or mortality. No behavioural avoidance of the seismic survey area by plankton or invertebrates would occur. Limited indirect impacts may arise from effects on predators or prey.

Assessment

Review of the literature suggests that mortality or injury to plankton would occur in the immediate vicinity of the airgun sound source within metres of the firing airguns. Impacts would thus be of high intensity at very close range (< 5 m from the airguns), but this would be no more significant than the effect of the wash from ships propellers and bow waves.

Offshore areas are characterised by diminished phytoplankton biomass due to the predominance of nutrient-poor oceanic waters. A deficiency of phytoplankton results in poor feeding conditions for micro-, meso- and macrozooplankton, and for ichthyoplankton. As the proposed Reconnaissance Permit Application area lies well offshore of the Cape Peninsula and Cape Columbine upwelling cells (see Figure 4-8), phytoplankton, zooplankton and ichthyoplankton abundances are expected to be extremely low.

With the exception of the eastern boundary, the majority of the proposed Reconnaissance Permit Application area also does not overlap with the spawning areas or the northward egg and larval drift of commercially important species. Thus, ichthyoplankton abundance in the Reconnaissance Permit Application area is also expected to be negligible.

As the survey is scheduled over a six month period, commencing in summer, there will be some temporal overlap with the spawning periods of commercially important species. However, as plankton distribution is naturally temporally and spatially variable and natural mortality rates are high, any impacts would be of low to negligible intensity across the survey area and for the duration of the survey (short-term). The potential impact of seismic noise on plankton is thus deemed to be of **VERY LOW** significance both with and without mitigation. No mitigation measures for potential impacts on plankton and fish egg and larval stages are feasible or deemed necessary (see Table 5-5).

Mitigation

No mitigation measures are deemed necessary.

Cumulative Impact

In addition to the overlap of the proposed 2D survey area and the southern 3D survey area, other activities that may contribute to the cumulative impact on plankton are other seismic surveys offshore of the West and South coasts of South Africa. Where there is spatial overlap of survey areas, mortality or injury to plankton would occur in the immediate vicinity of the airgun sound sources in these areas of overlap. However, this is deemed to be no more significant than the effect of the wash from ships propellers and bow waves travelling through these areas.

As noted above, phytoplankton, zooplankton and ichthyoplankton abundances are expected to be extremely low in areas located offshore of the Cape Peninsula and Cape Columbine upwelling cells. Given the anticipated low abundance of plankton in these offshore areas, the overall natural variable temporal and spatial distribution, as well as the high natural mortality rate of plankton (as noted above), the overall potential cumulative impact of seismic noise on plankton is considered to be localised and of low intensity in the short-term. Thus the potential cumulative impact is considered to be of **VERY LOW** significance.

TABLE 5-5: IMPACT OF SEISMIC NOISE ON PLANKTON.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Loca	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Nature of Cumulative impact	VERY LOW	
Degree to which impact can be reversed	Fully reversible – any reduction in plankton abundance as a result of survey noise would be temporary.	
Degree to which impact may cause irreplaceable loss of resources	Negligible	

5.2.2 Potential Impacts to Marine Invertebrates

Description of impact

Most marine invertebrates do not possess hearing organs that perceive sound pressure, although many have mechanoreceptors or statocyst organs that are sensitive to hydroacoustic disturbances. Potential impacts of seismic pulses on invertebrates could include physiological injury and behavioural avoidance of the proposed Reconnaissance Permit Application area. Masking of environmental sounds and indirect impacts due to effects on predators or prey have not been documented and are highly unlikely.

Assessment

Physiological injury and mortality

There is little published information on the effects of seismic surveys on invertebrate fauna. It has been postulated, however, that shellfish, crustaceans and most other invertebrates can only hear seismic survey sounds at very close range (< 15 m away). This implies that only surveys conducted in very shallow water would have any detrimental effects on invertebrates associated with the seabed.

As the proposed surveys would be conducted in excess of 200 m depth, the received noise at the seabed would be within the far-field range and outside of distances at which physiological injury of benthic invertebrates would be expected. Thus, the potential physiological injury or mortality of invertebrates is consequently deemed of low to negligible intensity across the proposed Reconnaissance Permit Application area for duration of the proposed surveys. The impact is considered to be of **VERY LOW** significance with and without mitigation (see Table 5-6).

Pelagic invertebrates that may be encountered in the proposed exploration licence area include the colossal squid and the giant squid, although the likelihood of encounter is extremely low. Both are deep dwelling species, with the colossal squid's distribution confined to the entire circum-Antarctic Southern Ocean, while the giant squid is usually found near continental and island slopes all around the world's oceans. Although a causative link to seismic surveys has not been established with certainty, giant squid strandings coincident with seismic surveys have been reported, the animals all having severe internal injuries indicative of having ascended from depth too quickly. The potential impact of seismic noise on physiological injury or mortality of pelagic cephalopods could thus potentially be of high intensity across the Reconnaissance Permit Application area and for the survey duration. However, as the probability of an encounter is considered low, the impact is deemed to be of **VERY LOW** significance both without and with mitigation.

Behavioural avoidance of seismic survey areas

There is also little published information on the effects of seismic surveys on the response of invertebrate fauna to seismic impulses. Limited avoidance of airgun sounds may occur in mobile neritic and pelagic invertebrates and is deemed to be of low intensity. As noted above, as the proposed survey would be conducted in water depths in excess of 200 m, the received noise at the seabed would be within the far-field range and outside of distances at which avoidance by benthic invertebrates would be expected. The potential impact of seismic noise on invertebrate behaviour is deemed to be of low intensity across the proposed Reconnaissance Permit Application area for the survey duration. Thus this potential impact is considered to be **INSIGNIFICANT** with and without mitigation (see Table 5-6).

As indicated previously, there is potential for encountering giant and/or colossal squid within the Reconnaissance Permit Application Area. While the avoidance of airgun sounds by mobile neritic and pelagic squid may occur, recent research suggests that a gradual increase in signal intensity and prior exposure to air gun noise would decrease the severity of the alarm responses. Furthermore, as distribution of mobile neritic and pelagic squid is naturally spatially highly variable, any avoidance impacts would be deemed of low intensity across the Reconnaissance Permit Application area and for the duration of the survey (short-term). The impacts for cephalopods in general is considered to be of **very low** significance without mitigation, reducing to **INSIGNIFICANT** with the implementation of the typical 'soft-starts'.

Mitigation

Implement soft-start procedures as set out in Section 5.2.3 below.

Cumulative Impact

As previously indicated, there would be spatial and temporal overlap between the proposed 2D survey and survey activities within the southern 3D survey area. However, as the majority of each survey would be conducted in water depths in excess of 200 m, the received noise at the seabed would be within the far-field range, and outside of distances at which physiological injury or behavioural avoidance of benthic invertebrates would be expected. This implies that only surveys conducted in very shallow water would have any detrimental effects on invertebrates associated with the seabed. Any direct impacts on pelagic squid would be at individual level rather than species level. Thus, the overall potential cumulative impact of seismic noise on marine invertebrates is considered to be localised and of low intensity in the short-term. Thus this potential impact is considered to be of **VERY LOW** significance.

TABLE 5-6: IMPACT OF SEISMIC NOISE ON MARINE INVERTEBRATES.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Physiological injury		
Intensity	Low (benthic invertebrates) – High (squid)	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low (benthic invertebrates) – Low (squid)	Very Low
Probability	Probable (benthic invertebrates) – Improbable (squid)	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Behavioural avoidance		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable (benthic invertebrates) – Probable (squid)	Improbable
Significance	**Insignificant (benthic invertebrates) - Very Low (squid)**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Medium	Medium
Nature of Cumulative impact	VERY LOW	
Degree to which impact can be reversed	Partially reversible	

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Degree to which impact may cause irreplaceable loss of resources	Negligible	

5.2.3 Potential Impacts on Fish

The potential impact of seismic noise on fish larvae is discussed under Section 5.2.1 above and this section discusses the impact on adult fish only.

Description of impact

A review of the available literature suggests that potential impacts of seismic pulses to fish species (including sharks) could include physiological injury / mortality, behavioural avoidance of seismic survey area, masking of environmental sounds and communication, and indirect impacts due to effects on predators or prey.

Assessment

Impacts on fish are summarised in Table 5-7.

Physiological injury and mortality

The greatest risk of physiological injury or mortality from seismic sound sources is for species that establish home ranges on shallow-water reefs or congregate in inshore waters to spawn, and those displaying an instinctive alarm response to hide on the seabed or in the reef rather than flee. Large demersal or reef-fish species with swim-bladders are also more susceptible than those without this organ. Such species may suffer severe hearing damage and the adverse effect may intensify and last for a considerable time after the termination of the sound source. However, as the proposed surveys would be located in water depths in excess of 200 m, the received noise by demersal species at the seabed would be within the far-field range, and outside of distances at which physiological injury or avoidance would be expected.

Given the high mobility of most fish that occur offshore of the 200 m isobath, particularly the highly migratory pelagic species likely to be encountered in deeper water associated with the offshore portions of the Reconnaissance Permit Application area, it is assumed that the majority of the pelagic species would avoid seismic noise at levels below those where physiological injury or mortality would result. Furthermore, in many of the large pelagic species, the swim-bladders are either underdeveloped or absent, and the risk of physiological injury through damage of this organ is therefore lower. Possible injury or mortality in pelagic species could occur on initiation of a sound source at full pressure in the immediate vicinity of fish, or where reproductive or feeding behaviour override a flight response to seismic survey sounds.

There are various seamounts and important fishing banks in close proximity to the Reconnaissance Permit Application area, however, as the proposed 2D and 3D survey areas occur outside these areas the likelihood of encountering feeding aggregations of large pelagic species is considered to be low. Should an encounter occur, the potential physiological impact on migratory pelagic species, would be of high intensity, but the duration of the impact on the population would be limited to the short-term. The impact is therefore considered to be of **low** significance without the implementation of mitigation measures, and of **VERY LOW** significance with mitigation measures (see Table 5-7).

Behavioural avoidance of seismic survey areas

Behavioural responses to seismic sounds have been documented at received levels of about 160 dB re 1 µPa @ 1m. Responses are varied and include avoidance of seismic survey areas, changes in depth distribution and schooling behaviour, startle response and changes in feeding behaviours of some fish. Behavioural effects are generally short-term with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound.

The potential impact on fish behaviour could be of high intensity (particularly in the near-field of the airgun array), over the short-term (with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound), but limited to the immediate survey areas. Any observed effects are unlikely to persist for more than a few days after termination of airgun use. Consequently it is considered to be of **low** significance without mitigation and **VERY LOW** significance with mitigation.

Spawning and reproductive success

Fish populations could be further impacted if behavioural responses result in deflection from migration paths or disturbance of spawning. If fish on their migration paths or spawning grounds are exposed to powerful external forces, they may be disturbed or even cease spawning altogether thereby affecting recruitment to fish stocks. The magnitude of effect in these cases would depend on the biology of the species and the extent of the dispersion or deflection. Studies undertaken experimentally exposing the eggs and larvae of various fish species to airgun sources, however, identified mortalities and physiological injuries at very close range (< 5 m) only. Considering the wide range over which the potentially affected species occur, the relatively short duration of the seismic surveys and that migration routes do not constitute narrow restricted paths, the impact is considered to be of **VERY LOW** significance with and without mitigation measures.

Masking of environmental sounds and communication

Fish deliberately produce sounds by three processes, including by stridulation (caused by friction of adjacent skeletal components), by vibration of the swimbladder, or by rapid head movement. Chorus sounds range across frequencies higher than the majority of produced seismic survey energy, but some frequency overlap may occur.

Communication and the use of environmental sounds by fish in the offshore environment off the West and South Coasts of South Africa are unknown. However, impacts arising from masking of sounds are expected to be of low intensity due to the duty cycle of seismic surveys (one firing every 10 to 15 seconds) in relation to the more continuous biological noise. Furthermore, as the proposed surveys would be conducted more than 40 km off the coast in excess of 200 m depth, any effects on demersal fish species would be in the far field. Such impacts would occur across the Reconnaissance Permit area in the short-term, and are consequently considered to be **INSIGNIFICANT** with and without mitigation.

Indirect impacts due to effects on predators or prey

The assessment of indirect effects of seismic surveys on fish is limited by the complexity of trophic pathways in the marine environment. The impacts are difficult to determine and would depend on the diet make-up of the fish species concerned and the effect of seismic surveys on the diet species. Indirect impacts of seismic surveying could include attraction of predatory species such as sharks to small pelagic fish species stunned by seismic noise. In such cases where feeding behaviour overrides a flight response to seismic survey sounds, injury or mortality could result if the seismic sound source is initiated at full power in the immediate vicinity of the feeding predators. Little information is available on the feeding success of large migratory species in association with seismic survey noise. Although large pelagic species are known to aggregate around seamounts to feed, these seamounts are located outside of the proposed survey areas. Furthermore, considering the extensive range over which large pelagic fish species feed in relation to the proposed Reconnaissance Permit Application area and the low abundance of pelagic shoaling species that constitute their main prey, the impact is likely to be of low intensity in the short-term. The significance of impact is consequently deemed **VERY LOW** with or without mitigation.

Mitigation

- Implement a "soft-start" procedure of a minimum of 20 minutes' duration when initiating airgun tests (a single or a number of airguns at full power)[6][7]and / or seismic surveying. This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response to outside the zone of injury or avoidance. Such a "soft-start" procedure would allow fish to move out of the survey areas and thus avoid potential physiological injury as a result of seismic noise;
- All breaks in airgun firing of longer than 20 minutes must be followed by a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. Breaks of shorter than 20 minutes should be followed by a "soft-start" of similar duration; and
- Airgun firing should be terminated if mass mortalities of fish as a direct result of shooting are observed.

Cumulative Impact

As the proposed survey areas are located offshore in water depths in excess of 200 m, it is not anticipated to have any effect on demersal species. As noted above, large pelagic species are highly mobile and are anticipated to avoid seismic noise at levels below those where physiological injury or mortality would result. While there is a degree of spatial overlap between the proposed 2D and southern 3D survey areas, due to the generally low significance effect on fish (as described below) the cumulative impact is similarly expected to be **LOW**.

TABLE 5-7: IMPACT OF SEISMIC NOISE ON FISH.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Physiological injury		
Intensity	High	Low to Medium
Duration	Short-term	Short-term
Extent	Local	Local

[6] Note: If the intention is to test a single airgun on low power then a "soft-start" is not required.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Consequence	Low	Very Low
Probability	Probable	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Behavioural avoidance		
Intensity	High	Low to Medium
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Probable	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Spawning and reproductive success		
Intensity	High	Low to Medium
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Improbable	Improbable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Masking of environmental sounds and communication		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Low	Low
Indirect impacts		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Very Low**	**VERY LOW**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Status	Negative	Negative
Confidence	Low	Low
Nature of Cumulative impact	LOW	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

5.2.4 Potential Impacts on Seabirds

Description of effect

Among the marine avifauna occurring along the South and West Coasts, it is only the species that feed by plunge-diving or that rest on the sea surface (non-diving), which may be affected by the underwater noise of seismic surveys. Potential impacts of seismic pulses to seabirds could include physiological injury, behavioural avoidance of the seismic survey area and indirect impacts due to effects on predators or prey.

Assessment

Impacts on seabirds are summarised in Table 5-8 (diving seabirds) and Table 5-9 (non-diving seabirds).

Physiological injury and mortality

African Penguins and other diving seabirds are all highly mobile and would be expected to flee from approaching sound sources at distances well beyond those that could cause physiological injury, although initiation of a sound source at full power in the vicinity of diving seabirds could result in injury or mortality where feeding behaviour override a flight response to seismic survey sounds.

Of the plunge diving species that occur along the West and South Coasts, the Cape Gannet regularly feeds as far offshore as 100 km, the rest foraging in nearshore areas up to 40 km from the coast, although Cape Cormorants have been reported up to 80 km from their colonies. The nearest Cape Gannet nesting grounds are at the Saldanha Bay islands and at Bird Island in Lambert's Bay, approximately 50 km and 150 km to the east of the Reconnaissance Permit Application area, respectively. Thus, there is a high likelihood of encountering gannets, particularly in the inshore portions of the Reconnaissance Permit Application area.

The nearest African Penguin nesting sites are located at the Saldanha Bay Islands, Dassen Island, Robben Island, False Bay, Betty's Bay and Dyer Island, all more than 50 km inshore of the proposed 2D survey area and >80 km inshore of the southern 3D survey area. Thus, encounters with African penguins can be expected within the inshore portions of the proposed 2D and southern 3D survey areas. In the offshore environment, pelagic seabirds that dive for their prey may also be encountered.

A single airgun could typically produce sound levels of the order of 220-230 dB re 1µPa at 1 m, while arrays produce sounds typically in the region of 250 dB re 1µPa at 1m. The majority of energy produced is in the 0 to 120 Hz bandwidth, although energy at much higher frequencies is also recorded. As the amplitude of sound

waves generally declines (attenuates) with distance from the source, the attenuation being frequency dependent, with stronger attenuation at higher frequencies. The decay of a sound wave will further be dependent on local conditions such as water temperature, water depth, bottom conditions and depth at which the signal is generated. The transmission loss (TL) due to spherical spreading (TL = 20 log r, where r is the distance from the sound source) results in the sound intensity falling by 6 dB for each doubling of the range. A source level of 250 dB re 1µPa at 1 m could thus result in a 60 dB drop in sound level over a distance of approximately 1 km (i.e. at approximately 1 km from the source the level would drop to 190 dB and at 50 km from the source the level would drop to less than 157 dB). The transmission loss over a distance of 50 km would suggest that the sound intensity would most likely be well below threshold levels of penguins and Cape Gannets in the immediate vicinity of the above-mentioned breeding areas located approximately 50 km from the closest point of the proposed 2D and southern 3D survey areas.

Given the high mobility of diving sea birds, and the attenuation of the sounds over at least a 50 km distance, the seismic noise perceived by the birds would be at levels below those where physiological injury or mortality would result. To put this into context in relation to other ambient marine noise levels, large commercial vessels typically produce sounds with source levels in the 180 - 195 dB re 1 µPa @ 1 m range with peak levels in the 10 – 50 Hz frequency band. These vessels may travel closer to the shore than the proposed survey acquisition areas. As such the proposed seismic surveys would generate sound levels that could be lower than the ambient sounds levels generated by other commercial vessels. It is also important to consider the surveying speed (4-6 kn) would ensure the duration of the potential impact would only be a few hours in the closest proximity to the penguin and Cape Gannet colonies.

The potential for physiological impact of seismic noise on diving birds (especially Cape Gannets and African penguins) could be of high intensity but would be limited to the immediate survey area and survey duration (short-term). The potential physiological impact on diving species is considered to be of **low** significance without mitigation and **VERY LOW** significance with mitigation.

No physiological injury or mortality impacts would occur in non-diving seabirds, as flying seabirds are highly mobile and would be expected to flee from approaching seismic noise sources at distances well outside of that that could cause physiological injury. The potential physiological impact on non-diving species is considered to be **INSIGNIFICANT**.

Behavioural avoidance of seismic survey area

Diving birds would be expected to hear seismic sounds at considerable distances, as they have good hearing at low frequencies (which coincide with seismic shots). Response distances are, however, speculative as no empirical evidence is available. It would be expected that these bird species would hear seismic sounds linked to the proposed 2D and 3D survey operations as they have good hearing at low frequencies (which coincide with seismic shots). However, following the discussion provided above, any behavioural avoidance by diving seabirds would be limited to within the long range of the operating airgun and over very short periods only.

The impact is likely to be of medium to high intensity in the short-term, as avoidance behaviour would only last for as long as the seismic noise continues (but only a couple of hours in any one location). The potential impact

on the behaviour of diving seabirds is considered to be of **low** significance without mitigation and of **VERY LOW** significance with mitigation.

The behavioural impact of seismic noise on non-diving seabirds is considered to be **INSIGNIFICANT**.

Indirect impacts due to effects on predators or prey

The assessment of indirect effects of seismic surveys on diving seabirds is limited by the complexity of trophic pathways in the marine environment and depends on the diet make-up of the bird species concerned and the effect of seismic surveys on the diet species. No information is available on the feeding success of seabirds in association with seismic survey noise. With few exceptions, most plunge-diving birds forage on small shoaling fish prey species relatively close to the shore and are unlikely to feed extensively in offshore waters that would be targeted during the proposed seismic surveys.

The broad ranges of potential fish prey species (in relation to potential avoidance patterns of seismic surveys of such prey species), the low likelihood of encountering diving birds and extensive ranges over which most seabirds feed suggest that indirect impacts would be of **INSIGNIFICANT** significance with and without mitigation.

Mitigation

Recommendations to mitigate the potential impacts on seabirds are the same as recommended for fish (see Section 5.2.3). In addition, the following is recommended:

- An area with a radius of 500 m be scanned (visually during the day) by an independent on-board observer or Marine Mammal Observer (MMO) for the presence of diving seabirds prior to the commencement of "soft-starts". During the commencement of night-time operations, the pre-watch should be undertaken using night-vision/infra-red binoculars. "Soft-start" procedures must only commence once it has been confirmed that there is no significant diving seabird activity within 500 m of the vessel;
- Daylight observations of the survey area should be carried out by an independent on-board observer or MMO. Seabird incidence and behaviour should be recorded. Any attraction of predatory seabirds by mass disorientation and stunning of fish as a result of seismic survey activities, and incidents of feeding behaviour near the hydrophone streamer, should be recorded;
- If obvious mortality or injuries to seabirds are observed, the survey should be terminated temporarily until such time as the MMO confirms that the risk to diving seabirds has been significantly reduced. It is important that the MMOs' decisions to terminate firing are made confidently and expediently. In this light it is suggested that MMOs advise when the survey is to be terminated and a log of all termination decisions is kept (for inclusion in both daily and close out reports);
- Lighting on-board the survey vessel should be reduced to minimum safety levels to minimise stranding of pelagic seabirds on the survey vessels at night. All stranded seabirds must be retrieved and released during daylight hours; and
- All data recorded by the MMO should form part of a survey close-out report. Furthermore, daily reports should be forwarded to the key stakeholders to ensure compliance with the mitigation measures.

Cumulative Impact

As noted above, the nearest seabird colonies (specifically African Penguin and Cape Gannet colonies) are located more than 50 km of the proposed 2D survey area and approximately 80 km from the southern 3D survey area. Although the total combined extent of the proposed 2D and 3D survey areas is large, the potential impact of the seismic noise associated with each survey would be limited to the vicinity of the operating airgun at the time of operation. Thus, there would be a sufficiently large enough area available for diving seabirds to avoid and move away from seismic noise sources. Given the above and the generally low significance effect on seabirds, the cumulative impact is similarly expected to be **LOW**.

TABLE 5-8: IMPACT OF SEISMIC NOISE ON DIVING SEABIRDS.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Physiological injury		
Intensity	High	Low to Medium
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Probable	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Behavioural avoidance		
Intensity	Medium to High	Low to Medium
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Probable	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Masking of environmental sounds and communication		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Low	Low
Nature of Cumulative impact	LOW	
Degree to which impact can be	Fully reversible	

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
reversed		
Degree to which impact may cause irreplaceable loss of resources	Low	

TABLE 5-9: IMPACT OF SEISMIC NOISE ON NON-DIVING SEABIRDS.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Physiological injury		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Low	Low
Behavioural avoidance		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Low	Low
Masking of environmental sounds and communication		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Low	Low
Nature of Cumulative impact	Other activities that may contribute to the cumulative impact on non-diving seabirds include other exploration activities off the South and West Coast. Cumulative impact is considered to be of LOW significance.	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

5.2.5 Potential Impacts on Turtles

Description of impact

The most likely impacts on turtles from seismic survey operations include physiological injury (including disorientation) or mortality from seismic noise and collision with or entanglement in towed seismic apparatus, behavioural avoidance of seismic survey areas and indirect effects due to the effects of seismic sounds on prey species.

Assessment

Three species of turtle occur along the West and South Coasts of South Africa (see Section 4.4.2.4), namely the leatherback (*Dermochelys coriacea*), and occasionally the loggerhead (*Caretta caretta*) and the Green (*Chelonia mydas*) turtle. The leatherback turtle is likely to be encountered in deeper waters of the Reconnaissance Permit Application area, however their abundance is expected to be low. Loggerhead and green turtles are expected to occur only as occasional visitors along the West and South Coasts.

Impacts on turtles are summarised in Table 5-10.

Physiological injury and mortality

The overlap of turtle hearing sensitivity with the higher frequencies produced by airguns suggest that turtles may be considerably affected by seismic noise. Recent evidence, however, suggests that turtles only detect airguns at close range (<10 m) or are not sufficiently mobile to move away from approaching airgun arrays (particularly if basking). Initiation of a sound source at full power in the immediate vicinity of a swimming or basking turtle would be expected to result in physiological injury. The potential impact could therefore be of high intensity, but remain within the short-term.

There is also the potential for collision between adult turtles and the seismic vessels or entanglement of turtles in the towed seismic equipment and surface floats. The potential impact on turtles is highly dependent on the abundance and behaviour of turtles in the Reconnaissance Permit Application area at the time of the surveys. As the breeding areas for Leatherback turtles occur over 3 000 km to north-west of the survey area (in the Republic of Congo and Gabon), turtles encountered during the survey are likely to be migrating vagrants. Impacts through collision or entanglement would be of high intensity and short-term. However, the likelihood of encounter is low. Thus, the potential physiological impact on turtles and the potential for mortality through collision or entanglement is considered to be of **low** significance without mitigation, and **VERY LOW** significance with mitigation.

Behavioural avoidance of seismic survey areas

Behavioural changes by turtles in response to seismic sounds range from startle response and avoidance by fleeing an operating sound source, through to apparent lack of movement away from active airgun arrays. The impact of seismic sounds on turtle behaviour is of high intensity, but would persist only for the duration of the survey, and be restricted to the survey areas.

Given the general extent of turtle migrations relative to seismic survey target areas and the low abundance of turtles in the area, the impact of seismic noise on turtle migrations is deemed to be of **low** significance without mitigation and **VERY LOW** with mitigation.

Reproductive success

Although three species of turtles occur along the West Coast, it is only the Leatherback turtle which is likely to be encountered in deeper waters. As the breeding areas for Leatherback turtles occur over 3 000 km to north-west of the survey area (in Republic of Congo and Gabon), abundances of turtles in the Reconnaissance Permit Application area during the survey are likely to be low, comprising occasional migrating vagrants. Any effects on recruitment success would thus be indirect, through entanglement and mortality of adults rather than through direct impacts to hatchlings.

Should collisions or entanglements occur, the indirect impacts on recruitment success would be of low intensity over the short term. The likely low encounter rates would result in the impact of seismic noise or potential collision on hatchling survival to be of **low** significance without mitigation and **VERY LOW** with mitigation.

Masking of environmental sounds and communication

As noted above, breeding adults of sea turtles undertake large migrations between distant foraging areas and their nesting sites, which are located over 3 000 km to the north-west of the Reconnaissance Permit Application area. Although it is speculated that turtles may use acoustic cues for navigation during migrations, information on turtle communication and the effect of seismic noise is lacking. However, their low abundance in the survey area would suggest that the significance of this potential impact (should it occur) would be **INSIGNIFICANT**.

Indirect impacts due to effects on predators or prey

The diets of the common South African turtle species are remarkably diverse. As their prey lack gas-filled organs the effects of seismic surveys on their major food source is expected to be negligible. The effects of seismic surveys on the feeding behaviour of turtles is thus expected to be **INSIGNIFICANT** both with and without mitigation.

<u>Mitigation</u>

Recommendations to mitigate the potential impacts on turtles are the same as recommended for seabirds (refer to Section 5.2.4). In addition, the following is recommended:

- The MMO should record incidence of turtles and their responses to seismic shooting, including position, distance from the vessel, swimming speed and direction and obvious changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns, etc.). It is important that the identification and behaviour of the animals are recorded accurately along with sound levels. MMOs should therefore have experience in identification and differentiation of marine species, as well as observation techniques. The observer should also record (1) all “soft-starts” and pre-firing observation regimes, (2) incidence of feeding behaviour of predators within the hydrophone streamers, and (3) sightings of any injured or dead protected species, regardless of whether the injury or death was caused by the seismic vessel itself. If the injury or death was caused by a collision with the seismic vessel, the date and location (coordinates) of the strike and the species or a description of the animal should be recorded;
- ‘Turtle-friendly’ tail buoys should be used by the survey contractor or existing tail buoys should be fitted with either exclusion or deflector 'turtle guards'; and
- Seismic shooting must be terminated temporarily when obvious negative changes to turtle behaviour is

observed, if animals are observed within 500 m of the operating airgun and appear to be approaching the firing airgun or there is mortality or injuries to turtles as a direct result of the survey. The survey should be terminated until such time the MMO confirms that:

> Turtle/s has moved to a point that is more than 500 m from the source;
> Despite continuous observation, 30 minutes has elapsed since the last sighting of the turtle/s within 500 m of the source; and
> Risk to turtles has been significantly reduced.

Cumulative Impact

As noted above, the abundance of turtles in the Reconnaissance Permit Application area during the survey is likely to be low. As the potential impact of seismic noise on turtles would be limited to the near vicinity of the operating airgun, the area of impact would be relatively small when compared to the total extent of the proposed 2D and 3D survey areas. Thus, although it is anticipated that the surveys could affect vagrant individuals within the survey areas, this is limited by the small immediate area of impact. Accordingly, the cumulative impact of both surveys is anticipated to be **LOW**.

TABLE 5-10: IMPACT OF SEISMIC NOISE ON TURTLES.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Physiological injury		
Intensity	High	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Probable to Highly Probably	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Behavioural avoidance		
Intensity	High	Low to Medium
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Probable to Highly Probable	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Reproductive success		
Intensity	High	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Improbable	Improbable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	High	High
Masking of environmental sounds and communication		
Intensity	Very Low	Very Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Low	Low
Indirect impacts		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Low	Low
Nature of Cumulative impact	LOW	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

5.2.6 Potential Impacts on Seals

Description of impact

Review of the available literature suggests that potential impacts of seismic pulses on Cape fur seals could include physiological injury, behavioural avoidance of the proposed survey areas, masking of environmental sounds and underwater communication and indirect impacts due to effects on predators or prey.

Assessment

The Cape fur seal is known to forage up to 220 km offshore, thus the inshore portions of the proposed survey areas fall within the foraging range of seals from all of the West and South Coast colonies (see Section 4.4.2.7). Impacts on seals are summarised in Table 5-11.

Physiological injury and mortality

The potential for physiological injury to seals from seismic noise is expected to be low as it is assumed that highly mobile creatures such as fur seals would avoid severe sound sources at levels below those at which discomfort occurs, although Cape fur seals have been recorded to approach operational seismic survey gear. Their tendency to swim at or near the surface would expose them to reduced sound levels when in close proximity to an operating airgun array.

The potential impact of physiological injury to seals as a result of seismic noise is therefore deemed to be of medium intensity and would be limited to the proposed Reconnaissance Permit area, although injury could extend beyond the survey duration. As the survey area is located within the foraging range of seals, encounters are considered to be likely and the significance of the impact is thus rated as **VERY LOW** with and without mitigation.

Behavioural avoidance of seismic survey areas

Although partial avoidance (to less than 250 m) of operating airguns has been recorded for some seal species, Cape fur seals appear to be relatively tolerant to loud noise pulses and, despite an initial startle reaction, individuals quickly revert back to normal behaviour.

The potential avoidance of seismic survey areas is thus considered to be of low to medium intensity and limited to the survey area and duration. The potential impact of seal behaviour in response to seismic surveys is considered to be of **VERY LOW** significance with or without mitigation.

Masking of environmental sounds and communication

The fact that seals have acute underwater directional hearing suggests that sound is used in orientating underwater. True seals have been shown to use underwater vocalisation in both orientation and communication. The use of underwater sounds for environmental interpretation and communication by Cape fur seals is unknown, although masking is likely to be limited by the low duty cycle of seismic pulses (one pulse every 10 to 15 seconds). The impact of masking is considered to be of **VERY LOW** significance with and without mitigation.

Indirect impacts due to effects on predators or prey.

The assessment of indirect effects of seismic surveys on Cape fur seals is limited by the complexity of trophic pathways in the marine environment and depends on the diet make-up of the species (and the flexibility of the diet) and the effect of seismic surveys on the diet species. The broad ranges of fish prey species (in relation to the avoidance patterns of seismic surveys of such prey species) and the extended foraging ranges of Cape fur seals suggest that indirect impacts due to effects on predators or prey in the proposed Reconnaissance Permit Application area would **INSIGNIFICANT** with and without mitigation.

Mitigation

Recommendations to mitigate the potential impacts on seals are similar to that recommended for turtles (refer to Section 5.2.5), except that:

- "Soft-start" procedures should be allowed to commence for at least a 20-minute duration if, after a period of 30 minutes, seals are still within 500 m of the airguns;
- Airgun firing should be terminated temporarily if any obvious negative changes to seal behaviour is observed in close proximity to firing airguns or there is any obvious mortality or injuries to seals as a direct result of the survey; and
- The MMO's daily report should record general seal activity, numbers and any noticeable change in behaviour.

Cumulative Impact

As noted above, seals are known to forage up to 220 km offshore and thus could be expected within the inshore portions of the proposed 2D and 3D survey areas. However, as for turtles described above, the potential impact of seismic noise on seals would be limited to the near vicinity of the operating airgun, the extent of the potential impact would be relatively small when compared to the total extent of the proposed 2D and 3D survey areas. Thus, although it is anticipated that the surveys could affect individuals within the survey areas, this is limited by the small immediate area of impact. Accordingly, the cumulative impact of both surveys is anticipated to be **LOW**.

TABLE 5-11: IMPACT OF SEISMIC NOISE ON SEALS.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Physiological injury		
Intensity	Medium	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Behavioural avoidance		
Intensity	Low to Medium	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	High	High

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Masking of environmental sounds and communication		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Indirect impacts		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	High	High
Nature of Cumulative impact	LOW	
Degree to which impact can be reversed	Fully reversible – the range over which seals can potentially feed is extensive in relation to the survey area.	
Degree to which impact may cause irreplaceable loss of resources	Negligible	

5.2.7 Potential Impact on Cetaceans (Whales and Dolphins)

Description of impact

Review of the available literature suggests that potential impacts of seismic pulses on cetaceans (whales and dolphins) could include physiological injury, behavioural avoidance of seismic survey areas, masking of environmental sounds and communication, and indirect impacts due to effects on predators or prey.

Assessment

A wide diversity of cetaceans (35 species) may be encountered within the proposed Reconnaissance Permit Application area, with varying likelihood of being encountered (see Section 4.4.2.6). The terms “whales” and “dolphins” relate to the size of cetacean species, but the group can best be divided into odontocete (toothed whales and dolphins) that are resident or migratory and mysticete (filter-feeding baleen whales) that are largely migratory. Marked differences occur in the hearing of odontocete cetaceans and mysticete cetaceans, with mysticete hearing centred at below 1 kHz, while odontocete hearing is centred at frequencies of between 10 and 100 kHz. These species may react to seismic shots at long ranges, but hearing damage from seismic shots is only likely to occur at close range.

Impacts on mysticete cetaceans and odontocete cetaceans are summarised in Table 5-12 and Table 5-13, respectively.

Physiological injury

Physiological injury to cetaceans can result from exposure to high sound levels through a number of avenues, including trauma to both auditory and non-auditory tissues as shifts of hearing threshold (as permanent (PTS) or temporary threshold shifts (TTS)), direct tissue damage, acoustically induced decompression sickness or other non-auditory physiological effects.

Typical sound source levels of 243-249 dB re 1 µPa @1 m exceed the source levels required for hearing damage (PTS and TTS) in cetaceans. Available information suggests that the animal would need to be in close proximity to operating airguns to suffer physiological injury, and being highly mobile it is assumed that they would avoid sound sources at distances well beyond those at which injury is likely to occur. However, avoidance may be complicated by the multipath nature of sound in the ocean. Mitigation involving a "soft-start" procedure would help alert cetaceans to the increasing sound level and promote movement away from the sound source. Deep-diving cetacean species may, however, be more susceptible to acoustic injury, particularly in the case of seafloor-focussed seismic surveys, where the downward focussed impulses could trap deep diving cetaceans within the survey pulse, as escaping towards the surface would result in exposure to higher sound level pulses.

Available information also suggests that baleen whales and the larger toothed whales would be very receptive to the sound produced by seismic airgun arrays and consequently these groups may be more affected by this type of disturbance than smaller toothed whales. Cetaceans likely to be encountered within the proposed Reconnaissance Permit Application area, include those migrating through the area to mate and breed.

The majority of baleen whales migrate to the southern African subcontinent to breed during winter months. humpback whales migrating north strike the coast at varying places mostly north of St Helena Bay around May, continuing through to September/October when the southern migration begins and continues through to December. Southern right whales arrive in coastal waters in June, building up to a maximum in September/October and departing again in December. The proposed survey areas thus lie within the migration paths of humpback and southern right whales, albeit offshore of areas frequented by southern right whales for mating and breeding.

As the surveys are proposed for the summer months (December to May) encounters with migrating whales should be minimal, although some humpbacks on their return journey in November/December may still be encountered, particularly in the northern portions of the Reconnaissance Permit Area. However, the surveys are likely to frequently encounter resident odontocetes such as common dolphins and pilot whales, which are present year-round, and may encounter sperm whales in offshore areas.

The potential impact of physiological injury to both mysticetes and resident odontocetes as a result of high-amplitude seismic sounds is deemed to be of high intensity, but would be limited to the immediate vicinity of operating airguns within the proposed Reconnaissance Permit Application area. The impact is therefore considered to be of **low** significance without mitigation for resident odontocetes, and for mysticetes (mainly resident species and Humpbacks in November/December). However, although the significance of this impact is

rated as low due to the low probability of it occurring, should the impact occur it would be deemed to be of **Medium** significance. With the implementation of mitigation, the significance would reduce to **VERY LOW** for mysticetes.

Behavioural avoidance of seismic survey areas

Mysticete cetaceans appear to avoid impulsive sounds of received levels greater than 150 to 180 dB, while subtle behavioural responses have been noted at levels of above 120 dB. Although behavioural avoidance of seismic noise by baleen whales is highly likely, such avoidance is generally considered of minimal impact in relation to the distances of migrations of the majority of mysticete cetaceans. As noted above, the survey area overlaps with the migration route of both humpback and southern right whales. However, if the survey is scheduled to occur outside of the main winter migration periods (June - November), interactions with migrating whales should be low. Interaction with the offshore population of Bryde's whale is, however, likely as their seasonality on the West Coast is opposite to the majority of the balaenopterids with abundance highest in the broader Reconnaissance Permit Application area in January through to March.

Of greater concern than general avoidance of migrating whales is avoidance of critical feeding or breeding habitats. Displacement from a critical habitat is particularly important if the sound source is located at an optimal feeding or breeding ground or areas where mating, calving or nursing occurs. Southern right whales mostly remain in the coastal area south of Lambert's Bay, but are seen regularly along the northern Namaqualand coast and in southern Namibia, and are increasingly expanding their range as the population grows. As the proposed 3D survey areas are located far offshore, there is no overlap with the nearshore West and South Coast regions typically utilised by southern rights as a mating, calving, or nursery grounds.

Similarly, the proposed 2D and southern 3D survey areas are located more than 70 km and 100 km, respectively, offshore of the West Coast feeding ground around Cape Columbine, where local abundances of temporary resident humpback and southern right whales occur during summer months. Thus, interaction between the near-shore portions of the proposed surveys and the summer feeding aggregations is likely.

For other species, the paucity of fine scale data from offshore waters on the distribution and seasonal occurrence of most cetacean species prevents prediction where such critical habitat might be with any certainty. Other baleen whale species are also found year round or have seasonal occurrences that are not well known, but existing data shows year-round presence of mysticetes.

The potential impact of behavioural avoidance of seismic survey target areas by mysticete cetaceans is considered to be of high intensity and for the duration of the survey operations. Considering the distribution ranges of most species of cetaceans, the impact of seismic surveying is considered of **low** (before the mitigation period for migrating mysticetes, namely southern rights and humpbacks) to **medium** (for resident whales and offshore Bryde's whales) significance before mitigation. Limiting seismic surveys to outside of the June to December migration would reduce the intensity of potential impacts to low resulting in **VERY LOW** (for migrating species) to **LOW** (for resident whales and offshore Bryde's whales) significance after mitigation.

There is very limited information on the response of odontocete cetaceans to seismic surveys. No seasonal patterns of abundance are known for odontocetes that may occur in the proposed Reconnaissance Permit

Application area but several species are considered to be year-round residents. Furthermore, a number of toothed whale species have a more pelagic distribution thus occurring further offshore, with species diversity and encounter rates likely to be highest on the shelf slope. As much of the survey will take place in offshore waters, Sperm whales are likely to be encountered. The potential impact of behavioural avoidance of the proposed survey areas by odontocetes is considered to be of medium to high intensity across the Reconnaissance Permit area and for the duration of the surveys. Although the overall significance varies between species, it is considered to be of **very low to low** significance before mitigation and **VERY LOW** with mitigation.

Masking of environmental sounds and communication

Mysticete cetaceans appear to vocalise almost exclusively within the frequency range of the maximum energy of seismic survey noise, while odontocete cetaceans vocalise at frequencies higher than these. Since noise in the mid-frequency range can travel far, masking of communication sounds produced by whistling dolphins and blackfish[8] is likely. In the migratory baleen whale species, vocalisation increases once they reach the breeding grounds and on the return journey in November / December when accompanied by calves, so for those species migrating southwards through the area (Humpback and Southern Right whales) vocalisation is likely to be high in the survey areas during the December period, reducing thereafter.

Vocalisation would also be expected in those resident species present year round in the area (Dwarf Minke, Bryde's (offshore) and Pygmy Right). However, masking of communication signals is likely to be limited by the low duty cycle of seismic pulses. Consequently, the intensity of impact on migratory baleen whales is likely to be low over the survey area and duration, but of medium intensity for resident mysticetes or those lingering on the summer feeding grounds. In the case of toothed whales the intensity would be high. For the migratory mysticetes the significance is rated as **VERY LOW,** both without and with mitigation, for odontocetes and resident mysticetes it is rated as **low** without mitigation and **VERY LOW** with mitigation.

Indirect impacts due to effects on predators or prey.

Although the fish and cephalopod prey of toothed whales and dolphins may be affected by seismic surveys, impacts will be highly localised and small in relation to the feeding ranges of cetacean species. The majority of mysticete cetaceans would undertake little feeding within breeding ground waters on the West and South Coasts and rely on blubber reserves for the migrations from the feeding grounds. Although the upwelling zones off Saldanha and St Helena Bay have become important summer feeding areas for Southern Right and Humpback whales, baleen whales have not been reported to feed while in the location of the Reconnaissance Permit Application area, thus any indirect effects on their food source is deemed to be **INSIGNIFICANT**.

The assessment of indirect effects of seismic surveys on resident odontocete cetaceans is limited by the complexity of trophic pathways in the marine environment and depends on the diet make-up of the species (and their flexibility in their diet) and the effect of seismic surveys on the diet species. However, it is expected that both fish and cephalopod prey of toothed whales and dolphins may be affected over limited areas. The

[8] The term blackfish refers to the delphinids: Melon-headed whale, Killer whale, Pygmy Killer Whale, False Killer Whale, Long-finned Pilot Whale and Short-finned Pilot Whale.

broad ranges of prey species (in relation to the avoidance patterns of seismic surveys of such prey species) suggest that indirect impacts due to effects on prey would be **VERY LOW** before and after mitigation.

Mitigation

Recommendations to mitigate potential impacts on cetaceans are similar to that recommended for turtles (refer to Section 4.4.2.4). In addition, the following is recommended:

- The seismic survey should be undertaken outside of the key cetacean migration and breeding period which extends from the beginning of June to the end of November.
- As no seasonal patterns of abundance are known for odontocetes occupying the proposed study area, a precautionary approach to avoiding impacts throughout the year is recommended;
- Survey operations can occur between January to end of May (subject to permit award date and vessel availability);
- For the inshore portions of the proposed survey areas, the following is recommended:
  - As several of the large whale species would be abundant on the West Coast between September and February, the inshore portions between Cape Point (approximately 34° 21'S) and Strandfontein (approximately 31° 45'S) of the seismic operations should be planned to be undertaken in late summer and early winter (February - May).
  - Survey operations should, if possible, commence in the western portions of the proposed survey areas to avoid disruption of the planned demersal research trawl survey in January to mid-February 2019. For the portions of the of the survey areas inshore of the 1 000 m depth contour, there must be simultaneous operational planning in place to avoid disruption of the planned small pelagic acoustic research surveys.
- The survey vessels must be fitted with Passive Acoustic Monitoring (PAM) technology, which detects animals through their vocalisations. As the survey is taking place in waters deeper than 1 000 m depth where sperm whales and other deep-diving odontocetes are likely to be encountered, the use of PAM 24-hours a day is highly recommended. As a minimum, PAM technology must be used during the 30-minute pre-watch period and when surveying at night or during adverse weather conditions and thick fog. The hydrophone streamer should ideally be towed behind the airgun array to minimise the interference of vessel noise, and be fitted with two hydrophones to allow directional detection of cetaceans;
- "Soft-start" procedures must only commence once it has been confirmed (visually and using PAM technology during the day and using only PAM technology at night or during periods of poor visibility) that there is no cetacean activity within 500 m of the vessel. This pre-watch period should be for at least 30 minutes prior to the commencement of the "soft-start" procedures, so that deep- or long-diving species can be detected;
- In the case of small cetacean (<3 m in overall length), which are often attracted to survey vessels, "soft-start" procedures should, if possible, only commence once it has been confirmed that there is no small cetacean activity within 500 m of the air-guns. If after a period of 30 minutes small cetaceans are still within 500 m of the air-guns, the normal "soft-start" procedure should be allowed to commence for at least a 20-minutes duration. The MMO should monitor small cetacean behaviour during "soft-starts" to determine if the animals display any obvious negative responses to the air-guns and gear or if there are any signs of injury or mortality as a direct result of seismic shooting operations.
- The implementation of "soft-start" procedures of a minimum of 20 minutes' duration on initiation of

seismic surveying would mitigate any extent of physiological injury in most mobile vertebrate species as a result of seismic noise and is consequently considered a mandatory management measure for the implementation of the proposed seismic survey;

- If cetaceans are observed within 500 m of the airguns during the pre-watch period, the "soft-start" procedure should be delayed until such time as this area is clear of cetaceans, and should not begin until after the animals depart the 500 m exclusion zone or 30 minutes after they are last seen;
- All breaks in airgun firing of longer than 20 minutes must be followed by a 30-minute pre-shoot watch and a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. Breaks of shorter than 20 minutes should be followed by a visual assessment for marine mammals within the 500 m mitigation zone (not a 30-minute pre-shoot watch) and a "soft-start" of similar duration;
- During night-time line changes low level warning airgun discharges should be fired at regular intervals in order to keep animals away from the survey operation while the vessel is repositioned for the next survey line;
- The use of the lowest practicable airgun volume should be defined by the operator and enforced;
- In terms of the Marine Living Resources Act, 1998 (No. 18 of 1998) it is illegal for any vessel to approach or remain within 300 m of whales within South African waters without a permit or exemption. If the operator or seismic contractor are not able to comply with this restriction, it is recommended that an application be made to DEA for a permit or exemption; and
- Marine mammal incidence data and seismic source output data arising from the survey should be made available, if requested, to the Marine Mammal Institute, DEA, DAFF and PASA for analyses of survey impacts in local waters.

Cumulative Impact

As noted above, as the proposed 2D and 3D survey areas some distance away from the nearshore West and South Coast regions typically utilised by Southern Right whales as a mating, calving, or nursery grounds. However, potential impacts on resident whales and offshore Bryde's whales could be possible. Should there be surveys that overlap temporally, the intensity of the above-mentioned identified impacts would likely be of higher intensity, for the duration of the surveys over the combined extent of the survey areas. As such, the cumulative impact of both surveys on cetaceans is expected to be **LOW**.

TABLE 5-12: IMPACT OF SEISMIC NOISE ON MYSTICETE CETACEANS (BALEEN WHALES).

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Physiological injury		
Intensity	High	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Probable	Probable
Significance	**Medium**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Behavioural avoidance		

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Intensity	High	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low – Medium	Very Low – Low
Probability	Probable	Probable
Significance	**Low – Medium**	**VERY LOW – LOW**
Status	Negative	Negative
Confidence	High	High
Masking of environmental sounds and communication		
Intensity	Low – Medium	Very Low – Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low - Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Indirect Impacts		
Intensity	Very Low	Very Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Neutral	Neutral
Confidence	High	High
Nature of Cumulative impact	LOW	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

TABLE 5-13: IMPACT OF SEISMIC NOISE ON ODONTOCETE CETACEANS (TOOTHED WHALES AND DOLPHINS).

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Physiological injury		
Intensity	High	Low - Medium
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Probable	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	High	High
Behavioural avoidance		
Intensity	Medium - High	Low - Medium
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low – Low	Very Low
VERY LOW	Probable	Probable
Fully reversible	**Very Low – Low**	**VERY LOW**
Low	Negative	Negative
Confidence	High	High
Masking of environmental sounds and communication		
Intensity	High	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Very Low
Probability	Probable	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Indirect impacts		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	High	High
Nature of Cumulative impact	LOW	

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

5.3 IMPACT ON OTHER USERS OF THE SEA

5.3.1 Potential Impact on Fishing Industry

5.3.1.1 Potential impact on fishing sectors

Description of impact

The proposed surveys could result in impacts on fishing as a result of the 500 m safety zones around the survey vessels. In addition to the statutory 500 m safety zone, a seismic contractor would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond. Typical safe operational limits for 2D and 3D surveys are illustrated in Figure 3-3. The operator would commission support / chase vessels equipped with appropriate radar and communications to patrol the area during the seismic survey to ensure that other vessels adhere to the safe operational limits. The estimated 3 km turning circle radius would also make the effective area of operation slightly larger than the actual survey acquisition areas.

Studies have demonstrated that seismic surveys may also to lead to reduces catch rates not only in the immediate vicinity of the airgun but also in a wider area due to fish avoidance of the seismic survey area and changes in feeding behaviour. Estimates of the distance from the airgun at which a decline in catch rates has been observed, the duration of that impact and the magnitude of the impact (percentage reduction in catch rate) varied considerably between studies.

The potential impacts on the various potentially affected fishing sectors operating off the West and South Coasts of South Africa are presented below.

Assessment

Of the ten fishing sectors that operate off the South and East Coasts (see Section 4.5.1), eight could be affected by the proposed surveys. These include: demersal trawl, mid-water trawl, demersal long-line, small pelagic purse seine, large pelagic long-line, tuna pole, traditional line-fish, and South Coast rock lobster fishery. The potential impacts on these fisheries are described and assessed below.

It is noted that the proposed survey areas do not overlap with the West Coast rock lobster fishing grounds and are situated at least 40 km away. With respect to the netfish (beach-seine and gill net) fisheries, these are typically restricted to the near-shore with beach-seines and gill-nets and unlikely to be set in waters deeper than 50 m, i.e. well outside of the proposed survey target areas. Thus, no impact is expected on either of these fisheries.

Demersal trawl

The overlap of the proposed seismic survey areas with the demersal trawl fishery is illustrated in Figure 5-1. Over the period 2008 to 2016 within the proposed 2D survey area, 33 087 trawling hours within the area yielded 48 309 tons of hake which is equivalent to 37% and 49% of the overall effort and catch recorded annually by the sector. The fishery operates continuously throughout the year, with no significant seasonal patterns in fishing effort. Over the same period, the effort and catch recorded within both proposed 3D surveys areas amounted to 10 566 hours and 16 385 tons per year, respectively. This is equivalent to 12% of the total national effort and 17 % of the total national landings reported by the demersal trawl sector over this period.

The impact of exclusion from fishing grounds on the demersal trawl sector is considered to be regional and of high intensity in the short-term. The overall significance is expected to be **MEDIUM** both with and without mitigation).

Mid-water trawl

The mid-water trawl fishery targets adult horse mackerel. In relation to the proposed 2D and 3D survey areas, mid-water trawling fishing effort is largely restricted across the inshore extent of the proposed 2D seismic survey area. There is limited effort recorded within the eastern corner of the southern 3D survey area and no effort in the northern 3D survey area (see Figure 5-1 below). Over the period 2008 to 2016, 738 trawling hours yielded 3 110 tons of horse mackerels. This is equivalent to 40% and 16%, respectively, of the overall effort and catch recorded annually by the sector. The fishery operates continuously throughout the year, with no significant seasonal patterns in fishing effort.

The potential impact of temporary exclusion from fishing grounds on the mid-water trawl fishery in the survey areas is considered to be of local extent and of high intensity in the short-term. The overall impact is considered to be **LOW** with and without mitigation. It should be noted that trawl vessels are restricted in manoeuvrability when gear is deployed. Therefore, direct communication from the survey vessel would be required in order to request trawl vessels to keep clear of the survey vessel.

Demersal long-line

Demersal longline activity occurs across the entire eastern extent of the proposed 2D and 3D survey areas shoreward of the 1 000 m bathymetric contour (see Figure 5-1). Over the period 2000 to 2017, 15.8 million hooks were set within the 2D survey area yielding 3 765 tons of hake which is equivalent to 46% and 47%, respectively, of the overall effort and catch recorded annually by the sector.

Effort and catch recorded within both of the proposed 3D acquisition areas amounted to 3.3 million hooks and 734 tons per year, respectively (over the period 2000 to 2017). This is equivalent to 10% of the total national effort and 9% of the total national landings reported by the demersal trawl sector over this period. The fishery operates year-round with a slight increase in activity between August and December.

The potential impact of temporary exclusion from fishing grounds for the demersal long-line fishery in the proposed survey areas is of regional extent and of high intensity in the short-term. The overall impact is considered to be of **MEDIUM** significance with and without mitigation.

Small pelagic purse seine

There is limited overlap with between the proposed 2D and 3D survey areas and the fishing grounds of the small pelagic purse seine fishery (see Figure 5-1). Where fishing does take place within the proposed survey areas, it is only sporadic. The fishery operates throughout the year with a short seasonal break from mid-December to mid-January.

The potential impact of temporary exclusion from fishing grounds for the small pelagic purse seine fishery in the proposed survey areas is of local extent and of low intensity in the short-term. The overall impact is considered to be of **VERY LOW** significance with and without mitigation.

Large pelagic long-line

This sector utilises surface long-lines to target migratory pelagic species including albacore tuna, yellowfin tuna, bigeye tuna, swordfish and various shark species. The fishery operates year-round and the spatial distribution is extensive from the continental shelf break into deeper waters and occurs across the entire proposed Reconnaissance Permit and survey areas (see Figure 5-1).

Within the proposed 2D and 3D survey areas, over the period 2000 to 2016, 668 500 hooks were set yielding 612 tons of large pelagic species which is equivalent to 17% and 21% of the overall effort and catch recorded annually by the sector. On average, 500 lines per year were set within the area, with an increase in effort during Autumn and Winter (April - July). The impact of temporary exclusion from fishing grounds for the large pelagic long-line sector is considered to be regional in extent and of high intensity in the short-term. Based on the on the high number of vessels operating within the sector and the location of favoured fishing grounds within the proposed survey areas, the probability of the impact occurring is considered to be definite. The overall significance is expected to be **MEDIUM** both with and without mitigation.

Tuna Pole

The tuna pole 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.

The proposed 2D and 3D survey areas overlap with the large majority of the grounds fished by the tuna pole fleet (see Figure 5-1). Over the period 2007 to 2016, the effort and catch reported amounted to 34 770 fishing hours and 2 908 tons per year, respectively. Survey operations within the northern extent of the 2D survey area and southern 3D survey area should be avoided between November and January, if possible, to avoid disruption during peak fishing months.

The impact of temporary exclusion from fishing grounds for the tuna pole sector is considered to be of regional extent, high intensity and of short duration. Based on the on the high number of vessels operating within the sector and the location of favoured fishing grounds within the proposed survey areas, the probability of the impact occurring is considered to be definite. The overall significance is expected to be **MEDIUM** both with and without mitigation.

Traditional linefish

Although traditional linefish vessels are able to operate far offshore (up to a maximum range of about 70 km), most of the activity is conducted within 15 km of a launch site. A seasonal increase in the targeting of tuna species in offshore locations e.g. Cape Point, may attract participants of this fishery and thus extend into the proposed 2D and southern 3D survey areas.

The proposed 2D and 3D survey areas in relation to the traditional linefish catch between 2000 and 2016 is shown in Figure 5-1. Due to the limited overlap expected between the fishery and proposed survey operations, the potential short duration impact on the traditional linefish fishery would be of local extent and medium intensity. The potential impact on the fishery is considered to be **INSIGNIFICANT** with and without mitigation.

South Coast rock lobster

The fishing grounds for this fishery are located between 20° E and 28° E. The nature of this fishery entails the deployment of traps on the seafloor which are difficult to remove at short notice. While there is no significant overlap between fishing grounds and any the proposed survey areas (see Figure 5-1), there is evidence of fishing grounds immediately adjacent to the eastern extent of the proposed 2D survey area. Thus, it is possible the survey vessel could encounter deployed rock lobster trap gear within this area during survey line changes outside of the acquisition area.

Due to the location of fishing grounds immediately adjacent to the proposed 2D survey area and the fact that fishing operations would only be affected if the survey vessel moves into this area, the potential short duration impact would be of low intensity and local extent. Thus, the potential impact on the fishery is considered to be of **VERY LOW** significance with and without mitigation.

Reduced catch rates – all fisheries

Due to the transient nature of the proposed seismic survey operations, the possible effect of reduced catches for all fisheries due to seismic noise in the wider vicinity of the proposed survey areas is considered to be of overall **low** significance without mitigation and **VERY LOW** significance with mitigation (see Table 5-15).

<u>Mitigation</u>

The mitigation measures recommended for fish (refer to Section 5.2.3) would reduce the significance of potential impacts on some of the above-mentioned fisheries. In addition, the following mitigation measures would minimise disruptions to survey and fishing operations.

- Survey operations within the northern portion of the 2D survey area and the overlapping southern 3D survey area should be avoided between November and January, if possible, to avoid disruption of the tuna pole sector during this peak fishing period.
- Prior to survey commencement the following key stakeholders should be consulted and informed of the proposed survey activity (including navigational co-ordinates of the survey area, timing and duration of proposed activities) and the likely implications thereof:

> Fishing industry / associations: SA Tuna Association, SA Deep-Sea Trawling Industry Association (SADSTIA), Fresh Tuna Exporters Association, SA Hake Longline Association (SAHALLA), South African Tuna Long-Line Association (SATLA), South African Pelagic Fishing Industry Association (SAPFIA), SA Commercial Linefish Association and South Coast Rock Lobster Association.
> Other key stakeholders: DAFF, Transnet National Ports, SAMSA and South African Navy Hydrographic office.

These stakeholders should again be notified at the completion of surveying when the survey vessel and support vessels are off location.

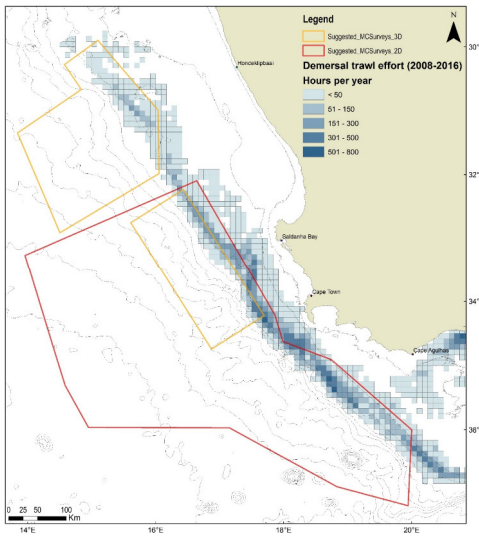
- The operator must request, in writing, that the South African Navy Hydrographic office release Radio Navigation Warnings and Notices to Mariners throughout the survey periods. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey areas, (2) an indication of the proposed survey timeframes and day-to-day location of the survey vessel, and (3) an indication of the 500 m safety zones and the proposed safe operational limits of the survey vessel. These Notices to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible;
- An independent onboard Fisheries Liaison Officer (FLO) who is familiar with fisheries operational in the area must be appointed for the duration of the survey. The FLO should provide a fisheries facilitation role to identify and communicate with fishing vessels in the area to reduce the risk of gear interaction between fishing and survey activities. The FLO should:
  > report on vessel activity daily;
  > advise on actions to be taken in the event of encountering fishing gear; and
  > set up a daily electronic reporting routine to keep key stakeholders informed of survey activity and progress and fisheries and environmental issues.

  In addition to the above, the FLO should assist in the identification of current fishing target areas to, where possible, allow for the adjustment of the survey plan to accommodate fishing.
- The survey vessel should be accompanied by a chase boat;

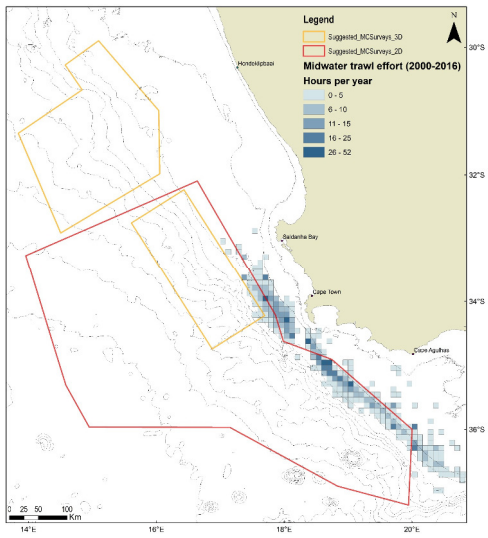
Any fishing vessel targets at a radar range of 12 nm from the survey vessels should be called via radio and informed of the navigational safety requirements around the survey vessels.

<u>Cumulative Impact</u>

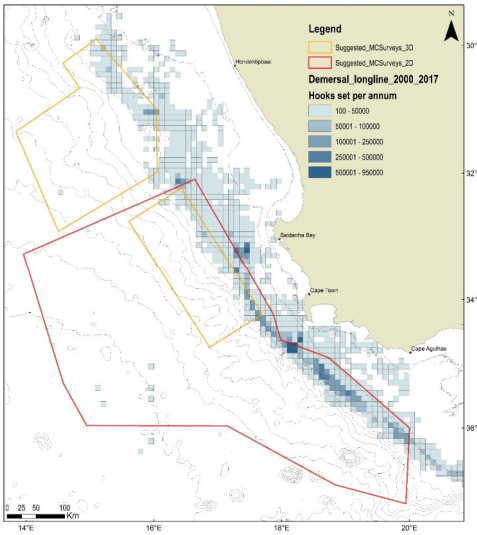
The assessment above considers the cumulative impact of the proposed 2D and southern 3D surveys on each of the above-mentioned fishing sectors. In the event that other seismic surveys overlap both spatially and temporally with the proposed 2D and 3D surveys, it is anticipated that fishing operations could continue in a modified way in the balance of the area outside of the immediate seismic survey operations. Thus, the cumulative impact of additional surveys on fisheries, for the duration of the surveys, is expected to be **MEDIUM**.



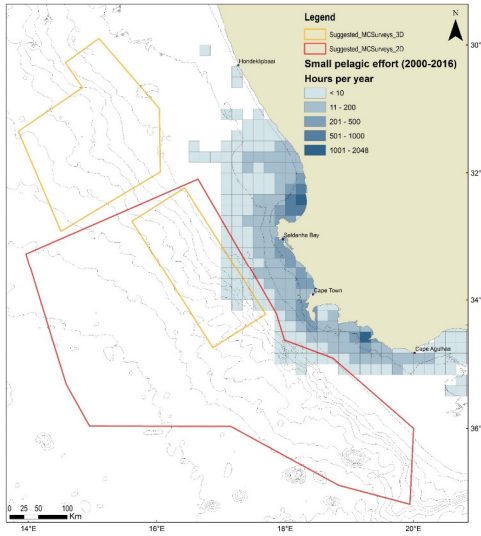
Demersal Trawl



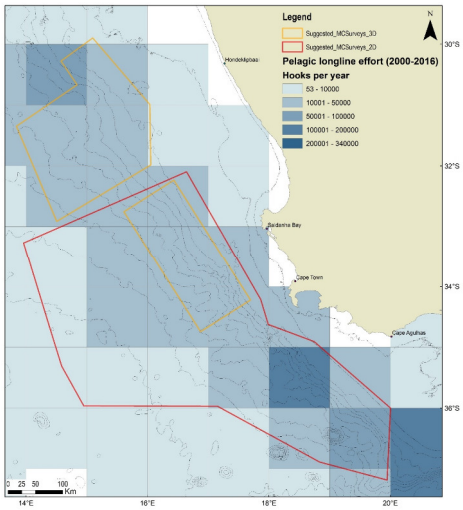
Midwater Trawl



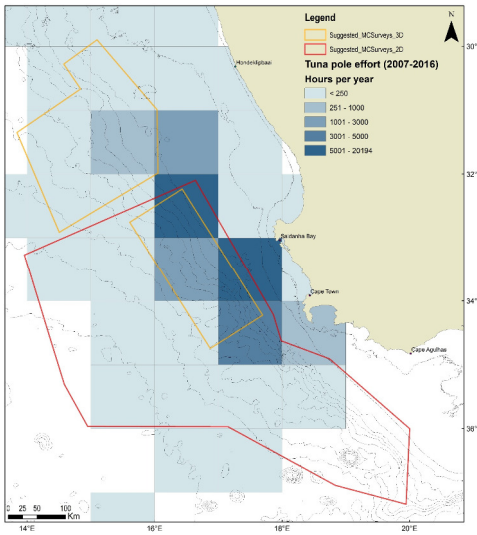
Demersal Longline



Small Pelagic Purse-Seine Fishery

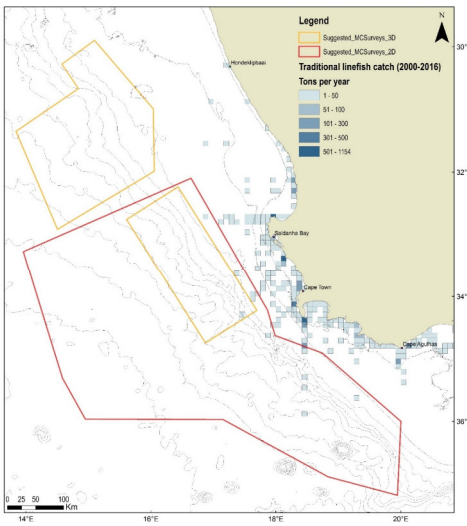


Large Pelagic Longline

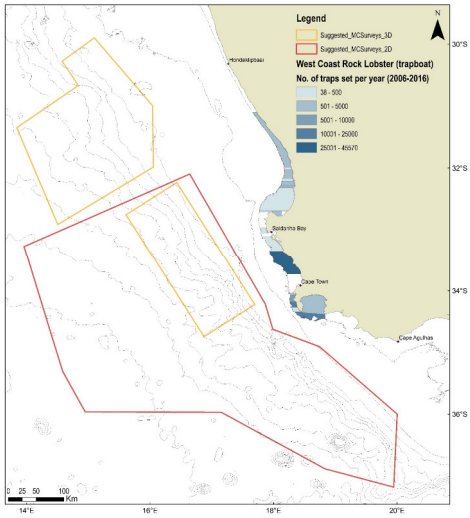


Tuna Pole

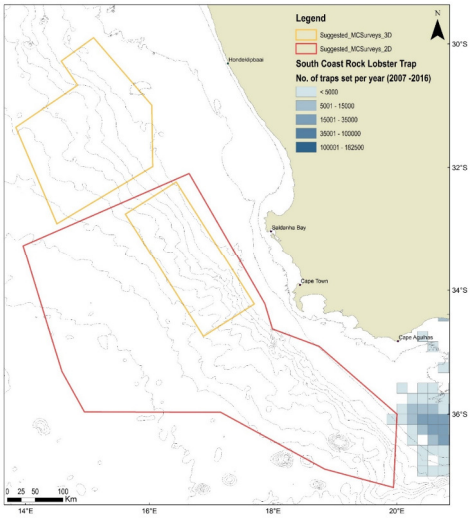
FIGURE 5-1: SUMMARY OF THE PROPOSED 2D AND 3D SURVEY AREAS IN RELATION TO THE FISHING EFFORT FOR DIFFERENT FISHERIES OPERATING OFF THE WESTS SOUTH COASTS.



Traditional Line-Fish



West Coast Rock Lobster



South Coast Rock Lobster

FIGURE 5-1: SUMMARY OF THE PROPOSED 2D AND 3D SURVEY AREAS IN RELATION TO THE FISHING EFFORT FOR DIFFERENT FISHERIES OPERATING OFF THE WESTS SOUTH COASTS (CONTINUED).

TABLE 5-14: POTENTIAL IMPACT ON FISHING SECTORS OPERATING OFF THE SOUTH AND WEST COAST.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Demersal Trawl		
Intensity	High	High
Duration	Short-term	Short-term
Extent	Regional	Regional
Consequence	Medium	Medium
Probability	Definite	Definite
Significance	**Medium**	**MEDIUM**
Status	Negative	Negative
Confidence	High	High

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Mid-water Trawl		
Intensity	High	High
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Low
Probability	Definite	Definite
Significance	**Low**	**LOW**
Status	Negative	Negative
Confidence	High	High
Demersal long-line		
Intensity	High	High
Duration	Short-term	Short-term
Extent	Regional	Regional
Consequence	Medium	Medium
Probability	Definite	Definite
Significance	**Medium**	**MEDIUM**
Status	Negative	Negative
Confidence	High	High
Small pelagic purse seine		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	High	High
Large pelagic long-line		
Intensity	High	High
Duration	Short-term	Short-term
Extent	Regional	Regional
Consequence	Medium	Medium
Probability	Definite	Definite
Significance	**Medium**	**MEDIUM**
Status	Negative	Negative
Confidence	High	High

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Tuna Pole		
Intensity	High	High
Duration	Short-term	Short-term
Extent	Regional	Regional
Consequence	Medium	Medium
Probability	Definite	Definite
Significance	**Medium**	**MEDIUM**
Status	Negative	Negative
Confidence	High	High
Traditional linefish		
Intensity	Very Low	Very Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Improbable	Improbable
Significance	**Insignificant**	**INSIGNIFICANT**
Status	Negative	Negative
Confidence	Medium	Medium
South Coast rock lobster		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Nature of Cumulative impact	MEDIUM	
Degree to which impact can be reversed	Fully reversible – any exclusion of fishing activities would be temporary.	
Degree to which impact may cause irreplaceable loss of resources	Low	

TABLE 5-15: POTENTIAL IMPACT OF REDUCED CATCH RATES ON FISHING SECTORS (ALL FISHERIES).

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Demersal Trawl		
Intensity	High	Low to Medium
Duration	Short-term	Short-term
Extent	Local	Local

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Consequence	Low	Very Low
Probability	Probable	Probable
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Nature of Cumulative impact	VERY LOW	
Degree to which impact can be reversed	Fully reversible – any reduction in catch rates due to disturbance of fish behaviour would be temporary.	
Degree to which impact may cause irreplaceable loss of resources	Negligible	

5.3.1.2 Potential Impact on Fisheries Research

Description of impact

Fisheries research on demersal and small pelagic fish resources are undertaken by DAFF off the South African coastline on a bi-annual basis in order to set the annual TAC. The presence of the survey vessel, and associated 500 m safety zone and proposed safe operational limits, could interfere with these research surveys should they occur in similar areas at the same time. In addition, fish could temporarily avoid the survey area while the seismic source array is active. There are potentially two research surveys that could take place in the proposed Reconnaissance Permit area, namely: a demersal trawling and an acoustic survey for small pelagic species.

Assessment

The demersal trawl survey off the West Coast extends from Cape Agulhas (20°E) to the Namibian maritime boarder and is planned to take place from the first week of January 2019 until mid-February 2019. 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. As the survey site selection is random, the location of each survey cannot be predicted until the planning stages prior to survey commencement. Demersal trawling for research purposes would take place within the proposed 3D survey areas between the 200 m and 1 300 m depth contours. In 2014, 20 trawls were recorded within these areas during February and March. Within the proposed 2D survey area, 27 trawls were recorded across a depth range of 170 m to 1 300 m in 2014.

The biomass of small pelagic species is assessed bi-annually by an acoustic survey. The first of these surveys is timed to commence in from mid-May to mid-June 2019 while the second starts in mid-October and runs until mid-December. The timing of the demersal and acoustic surveys is not flexible, due to restrictions with availability of the research vessel as well as scientific requirements. During these surveys the survey vessels travel pre-determined transects (perpendicular to bathymetric contours) running offshore from the coastline to approximately the 200 m isobath. The inshore portions of the proposed 2D and southern 3D survey areas coincide with the offshore extent of many of the survey transects that are conducted between Saldanha Bay and Cape Agulhas. Here, the proposed exclusion zone may directly affect operations conducted by research vessels if operating times of these vessels coincide with the survey.

The fish stock biomass assessments from the above-mentioned trawls and acoustic surveys undertaken by DAFF could be influenced if sampling is undertaken within 33 km (estimate) of active airguns. If the two activities occur simultaneously, the significance of the potential impact of the sound generated during the seismic operations on fisheries research surveys would be of high intensity. However, the extent would be local and short term. The overall significance of the impact on the research surveys would be considered **low** without mitigation, reducing to **VERY LOW** with mitigation (see Table 5-16).

Mitigation

In addition to the mitigation for the fishing industry described above, it is recommended that survey operations should, if possible, commence in the western portions of the proposed survey areas to avoid disruption of the planned demersal research trawl survey in January to mid-February 2019. The portions of the survey areas inshore of the 1 000 depth contour should be surveyed from mid-February to May to avoid disruption of the planned small pelagic acoustic research surveys.

TABLE 5-16: POTENTIAL IMPACT ON FISHING RESEARCH OFF THE SOUTH AND WEST COASTS.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Intensity	High	High
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Low
Probability	Probable	Possible
Significance	**Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Nature of Cumulative impact	None expected	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Negligible	

5.3.2 Potential Impact on Marine Transport Routes

Description of impact

The acquisition of high quality data requires that the position of the survey vessel is accurately known and that the survey vessel would need to travel in uninterrupted lines. For this reason the survey vessel (together with the towed array and hydrophone streamers) is considered to be restricted in its ability to manoeuvre and under COLREGS, 1972 (Part A, Rule 10) requires that power-driven and sailing vessels give way to a vessel restricted in its ability to manoeuvre. Vessels engaged in fishing are also required to, so far as possible, keep out of the way of a vessel restricted in its ability to manoeuvre. Furthermore, under the Marine Traffic Act, 1981, a vessel (including array of airguns and hydrophones) used for the purpose of exploiting the seabed falls under the definition of an “offshore installation” and as such it is protected by a 500 m safety zone. It is an

offence for an unauthorised vessel to enter the safety zone. In addition to a statutory 500 m safety zone, a seismic contractor would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond. Typical safe operational limits are illustrated in Figure 3-3.

The presence of the survey vessels with the associated 500 m safety zone and proposed safe operational limits could interfere with shipping in the area.

Assessment

A large number of vessels navigate along the South and West Coasts on their way around the southern African subcontinent. The majority of shipping traffic is located on the outer edge of the continental shelf (see Figure 4-27). Thus, a high degree of shipping traffic is expected to occur in, and pass through, the proposed 2D and 3D survey areas.

Although the safety zone around the survey vessel would be relatively small, all vessels would be prohibited from entering this area resulting in disruptions and/or delays. The displacement of shipping would thus be limited to within the extreme near vicinity of the survey vessel. This is normally mitigated by a notice to mariners and regular communication through daily notifications.

The potential impact on shipping traffic in the proposed Reconnaissance Permit area is considered to be regional in extent and of high intensity in the short-term. The significance of this potential impact is therefore assessed to be **medium** without mitigation and **LOW** with mitigation (see Table 5-17).

Mitigation

Recommendations to mitigate the potential impacts on marine transport routes are similar to that recommended for fishing (refer to Section 5.3.1.1). In addition, the following is recommended:

- All vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident;
- Collision prevention equipment should include radar, multi-frequency radio, foghorns, etc. Additional precautions include:
  - A support / chase vessel with an on-board FLO who is familiar with the fisheries expected in the area;
  - The existence of an internationally agreed 500 m safety zone around the survey vessels;
  - Cautionary notices to mariners; and
  - Access to current weather service information.
- The vessels are required to fly standard flags, lights (three all-round lights in a vertical line, with the highest and lowest lights being red and the middle light being white) or shapes (three shapes in a vertical line, with the highest and lowest lights being balls and the middle light being a diamond) to indicate that they are engaged in towing surveys and are restricted in manoeuvrability, and must be fully illuminated during twilight and night; and
- Report any emergencies to SAMSA.

Cumulative Impact

As noted above, while the proposed 2D and southern 3D survey areas overlap with shipping transport routes, the displacement of shipping would be limited to within the extreme near vicinity of the survey vessels. As this is normally mitigated by a notice to mariners and regular communication through daily notifications, the cumulative impact is deemed to be of **LOW** significance.

TABLE 5-17: IMPACT ON MARINE TRAFFIC AND TRANSPORT ROUTES.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Intensity	High	Regional
Duration	Short term	Short-term
Extent	Regional	Medium
Consequence	Medium	Low
Probability	Probable	Probable
Significance	**Medium**	**LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Nature of Cumulative impact	LOW	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	Low	

5.3.3 Potential Impact on Marine Prospecting, Mining, Exploration and Production Activities

Description of impact

The presence of the survey vessels with the associated 500 m safety zone and proposed safe operational limits could interfere with other prospecting, mining, exploration and production activities in the area.

Assessment

Prospecting and mining

The issuing of rights for different minerals in the same area could result in a conflict between right holders. The proposed survey areas overlap with small portions of marine diamond mining and prospecting concession areas, as well as significant portions of the various phosphate prospecting areas (see Section 4.5.4).

Despite the degree of overlap of the survey areas with these identified prospecting and mining areas, the displacement of vessels undertaking these seismic surveys would, as for shipping described above, be limited to within the extreme near vicinity of the survey vessel.

The potential impact on prospecting in the proposed survey areas is considered to be highly localised and of low intensity in the short-term. The significance of this potential impact is thus assessed to be of **VERY LOW** significance with and without mitigation (see Table 5-18).

Exploration and production

Exploration for oil and gas is currently undertaken in a number of licence blocks off the West, South and East coasts of South Africa (see Figure 4-28). The survey vessels may need to exit the proposed survey areas during line changes on the eastern side of these areas, which may, although unlikely, have an impact on adjacent exploration right holders and associated exploration activities. The potential impact on exploration activities, although unlikely, is considered to be localised, of low to medium intensity in the short-term. The significance of this impact is assessed to be **VERY LOW** with and without mitigation (see Table 5-18).

There are no current development or production activities in the vicinity of the proposed 2D and 3D survey areas off the West and South Coasts. The closest production related activities are located in Block 9 on the South Coast, approximately 100 km to the east of the proposed Reconnaissance Permit area. Thus, the proposed exploration activities would have **NO IMPACT** on other production activities.

Mitigation

- PGS should engage timeously with overlapping and neighbouring right holders in order to discuss the scheduling of the proposed survey in relation to current / proposed exploration activities. This would involve pre-survey notification of navigational co-ordinates of the survey area, timing and duration of proposed activities; and
- Any dispute arising with other right holders should be referred to the DMR or PASA for resolution.

Cumulative Impact

While the proposed 2D and southern 3D survey areas overlap, PGS would be the operator for both surveys. Thus, no material cumulative impact on each of these surveys is expected. For the same resaons as set out above, any cumulative impacts on prospecting, mining, exploration or production activities would be expected to be of **VERY LOW** significance.

TABLE 5-18: IMPACT ON MARINE PROSPECTING, MINING, EXPLORATION AND PRODUCTION ACTIVITIES.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Prospecting and Mining		
Intensity	Low	Low
Duration	Short term	Short term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Possible	Possible
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Exploration		
Intensity	Low	Low
Duration	Short term	Short term
Extent	Local	Local

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Consequence	Very Low	Very Low
Probability	Possible	Possible
Significance	**Very Low**	**VERY LOW**
Status	Negative	Negative
Confidence	Medium	Medium
Nature of Cumulative impact	VERY LOW	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	N/A	

5.4 SOCIO-ECONOMIC IMPACT OF EXPLORATION ACTIVITIES

5.4.1 Potential Impact Related to Job Creation and Business Opportunities

Description of impact

The proposed survey operations would create a minor number of local employment and business opportunities. Direct revenues would be generated as a result of the proposed survey activities. Revenue generating activities are related to the actual operations and include refuelling, vessel / gear repair, port dues and hire of local fishing vessels as support vessel.

Assessment

Offshore exploration is highly technical and requires specialised survey vessels and crews, none of which are based in South Africa. Thus job opportunities during the survey operations would also be very limited. There would, however, be opportunities for local companies to provide support services during the proposed survey operations, e.g. vessel supplies, support vessels, etc. In addition, opportunities are further limited by the very short duration of the proposed operations.

The overall positive impact of job creation and the generation of direct revenues is considered to be local in extent and of very low to low intensity over the short-term. Thus the potential impact of job creation during this phase of exploration is considered to be VERY LOW (positive) with and without mitigation (see Table 5-19).

Mitigation

The use of local companies for support services should be promoted as far as possible.

Cumulative Impact

No cumulative impacts are anticipated.

TABLE 5-19: IMPACT OF JOBS AND THE GENERATION OF DIRECT REVENUES.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Very Low	Very Low
Probability	Probable	Probable
Significance	***Very Low (Positive)***	***VERY LOW (positive)***
Status	Positive	Positive
Confidence	Medium	Medium
Nature of Cumulative impact	None.	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	N/A	

6 CONCLUSIONS AND RECOMMENDATIONS

A summary of the assessment of potential environmental impacts associated with the proposed 2D and 3D seismic surveys is provided in Table 6-1.

In summary, the majority of the impacts associated with the proposed 2D and 3D seismic surveys would be of short-term duration and limited to the immediate survey area. As a result, the majority of the impacts are considered to be of **INSIGNIFICANT** to **MEDIUM** significance after mitigation.

The three key issues identified in this study relate to:

- The potential impact on marine mammals (physiological injury and behavioural avoidance) as a result of seismic noise;
- The potential impact on the fishing industry (vessel interaction, disruption to fishing operations and reduced catch) due to the presence of the survey vessel with its associated safety zone, potential fish avoidance of the survey area and changes in feeding behaviour; and
- The potential impact on fisheries research (vessel interaction and disruption to the research surveys) due to the presence of the survey vessel with its associated safety zone and fish distribution and behavioural patterns which could negatively affect the findings of these surveys.

Although most of the impacts on cetaceans are assessed to have **VERY LOW to LOW** significance with mitigation, the impact could be of much higher significance due to the limited understanding of how short-term effects of seismic surveys relate to longer term impacts. For example, if a sound source displaces a species from an important breeding area for a prolonged period, impacts at the population level could be more significant. In order to mitigate the potential impact on cetaceans it is recommended that the proposed seismic survey programme be planned to avoid they key cetacean migration and breeding period which is from the beginning of June to the end of November. In addition, to avoid encountering humpback whales that may still be moving through the area on their return migrations in December, and the fact that several of the large whale species are also abundant on the West Coast between September and February, it is recommended that the inshore portions of the seismic operations be scheduled in the late summer and early winter period (February - May). Various other measures are recommended to further mitigate the potential impact on cetaceans, including a 60-minute pre-watch period (visually and using PAM technology), 20-minute “soft-start” procedure, temporary termination of survey, etc.

With regards to cumulative and confounding long-term effects on cetaceans from continuous seismic surveys, it must be noted that despite the density of seismic survey coverage over the last 17 years, the Southern Right whale population along the South African coast is reported to be increasing by 6.5% per year and the Humpback whale population by at least 5% per annum. These increases have taken place over a time period when seismic surveying frequency has increased, suggesting that, for these two populations at least, there is no evidence of long-term negative change to population size as a direct result of seismic survey activities.

The potential impact on the fishing industry relates to the temporary exclusion of fishing vessels from important fishing grounds and the potential reduction in catch rates. With regards to temporary exclusion, the potential impact ranges from **VERY LOW** (small pelagic purse-seine and south Coast rock lobster) to **LOW** (mid-

water trawl) and **MEDIUM** (demersal trawl, hake demersal long-line, large pelagic long-line and tuna pole) significance with mitigation. The proposed survey area does not overlap with the inshore West Coast rock lobster and netfish fishing grounds, thus, there would be **NO IMPACT** on these fishing sectors.

The potential impact of reduced catch rates across all fishing sectors active within the proposed survey areas has been rated as of **VERY LOW** significance after mitigation. If fish, however, avoid the survey area and / or change their feeding behaviour it could have a more significant impact on the fishing industry. Research has, however, shown that behavioural effects are generally short-term with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound. Similarly, if there was any interaction between the seismic survey vessel and a fishery the significance of the impact could be higher. Thus it is important that PGS engage timeously with the fishing industry prior to and during the surveys. Regular communication with fishing vessels in the vicinity during surveying would minimise the potential disruption to fishing operations and risk of gear entanglements.

The potential impacts on the demersal trawl and the small pelagic acoustic surveys within the proposed survey area has been rated as of **VERY LOW** significance after mitigation. While the behavioural effects on fish are generally short-term (as noted above), should there be a spatial and temporal overlap between the proposed seismic surveys and the fisheries research surveys, the significance of the impact could be higher. Thus it is recommended that survey operations should, if possible, commence in the western portions of the proposed survey areas to avoid disruption of the planned demersal research trawl survey in January to mid-February 2019. It is further recommended that the portions of the survey areas inshore of the 1 000 depth contour should be surveyed from mid-February to May to avoid disruption of the planned small pelagic acoustic research surveys.

TABLE 6-1: SUMMARY OF THE SIGNIFICANCE OF POTENTIAL IMPACTS OF THE PROPOSED SPECULATIVE 2D AND 3D SEISMIC SURVEYS OFF THE WEST AND SOUTH COASTS OF SOUTH AFRICA.

Potential impact		Significance	
		Without mitigation	With mitigation
Normal seismic / support vessels and helicopter operation:			
Discharge/disposal to the sea		VL	**VL**
Accidental oil spill during bunkering / refuelling	In Port	Insignificant	**INSIGNIFICANT**
	Offshore	VL	**VL**
Noise from seismic and support vessel operations		VL	**VL**
Noise from helicopter operation		Insignificant to VL	**INSIGNIFICANT**
Impact of seismic noise on marine fauna:			
Plankton		VL	**VL**
Invertebrates	Physiological injury	VL	**VL**
	Behavioural avoidance	Insignificant(benthic invertebrates) - VL (squid)	**INSIGNIFICANT**
Fish	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Spawning and reproductive success	VL	**VL**

Potential impact		Significance	
		Without mitigation	With mitigation
	Masking sound and communication	Insignificant	**INSIGNIFICANT**
	Indirect impacts	VL	**VL**
Non-diving seabirds	Physiological injury	Insignificant	**INSIGNIFICANT**
	Behavioural avoidance	Insignificant	**INSIGNIFICANT**
Diving seabirds	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Indirect impacts	Insignificant	**INSIGNIFICANT**
Turtles	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Reproductive success	L	**VL**
	Masking sound and communication	Insignificant	**INSIGNIFICANT**
	Indirect impacts	Insignificant	**INSIGNIFICANT**
Seals	Physiological injury	VL	**VL**
	Behavioural avoidance	VL	**VL**
	Masking sound and communication	VL	**VL**
	Indirect impacts	Insignificant	**INSIGNIFICANT**
Mysticete Cetaceans	Physiological injury	M	**VL**
	Behavioural avoidance	L-M	**VL-L**
	Masking sound and communication	VL - L	**VL**
	Indirect impacts	Insignificant	**INSIGNIFICANT**
Odontocete Cetaceans	Physiological injury	L	**VL**
	Behavioural avoidance	VL-L	**VL**
	Masking sound and communication	L	**VL**
	Indirect impacts	VL	**VL**
Impact on other users of the sea:			
Fishing industry - Temporary exclusion from fishing grounds	Demersal trawl	M	**M**
	Mid-water trawl	L	**L**
	Demersal long-line	M	**M**
	Small pelagic purse-seine	VL	**VL**
	Large pelagic long-line	M	**M**
	Tune pole	M	**M**
	Traditional line-fish	Insignificant	**INSIGNIFICANT**
	South Coast rock lobster	VL	**VL**
	West Coast rock lobster and netfish	NO IMPACT	
- Reduced catch rates	All fishing sectors	L	**VL**
	Fisheries research	L	**VL**
Marine transport routes		M	**L**
Marine prospecting, mining, exploration and production	Prospecting and mining	VL	**VL**
	Exploration and production	VL	**VL**
Job creation and business opportunities		*VL (positive)*	***VL (POSITIVE)***
H=High M=Medium L=Low VL=Very low		All impacts are negative, unless stated otherwise	

SLR is of the opinion that based on the findings of the EMP, (potential impacts generally of **VERY LOW** to **MEDIUM** significance after mitigation) and the transient nature of the proposed seismic surveys, a positive decision should be made by DMR (or delegated authority) in this regard.

6.1 RECOMMENDATIONS FOR MITIGATION

6.1.1 Compliance with EMP and Marpol Standards

- All phases of the proposed project (including pre-establishment phase, establishment phase, operational phase, and decommissioning and closure phase) must comply with the actions listed in the Environmental Management Programme presented in Chapter 7. In addition, the seismic and support vessels must ensure compliance with the MARPOL 73/78 standards.

6.1.2 Permit/Exemption Requirements

- In terms of the Marine Living Resources Act, 1998 (No. 18 of 1998) it is illegal for any vessel to approach or remain within 300 m of whales within South African waters without a permit or exemption. Thus, if the operator or seismic contractor are not able to comply with this restriction, an application should be made to DEA for a permit or exemption.

6.1.3 Communication with Key Stakeholders

- Prior to survey commencement, PGS should consult with the managers[9] of the DAFF research survey programmes to discuss their respective survey and survey programmes and the possibility of altering the exploration programme in order to minimise or avoid disruptions to both parties;
- Prior to survey commencement the following key stakeholders should be consulted and informed of the proposed survey activity (including navigational co-ordinates of the survey area, timing and duration of proposed activities) and the likely implications thereof:
  - > Fishing industry / associations: SA Tuna Association, SA Deep-Sea Trawling Industry Association (SADSTIA), Fresh Tuna Exporters Association, SA Hake Longline Association (SAHALLA), South African Tuna Long-Line Association (SATLA), South African Pelagic Fishing Industry Association (SAPFIA), SA Commercial Linefish Association and South Coast Rock Lobster Association; and
  - > Other key stakeholders: DAFF, Port Captains, South African Maritime Safety Authority (SAMSA) and South African Navy Hydrographic office, Control and Surveillance Unit in Cape Town (Vessel Monitoring System Unit) and other prospecting / exploration right holders.

  These stakeholders should again be notified at the completion of surveying when the survey vessel and support vessels are off location.
- The operator must request, in writing, the South African Navy Hydrographic office to release Radio Navigation Warnings and Notices to Mariners throughout the seismic survey period. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey areas, (2) an indication of the

[9] Deon Durholtz (DeonD@nda.agric.za) and Janet Coetzee (JanetC@nda.agric.za).

proposed survey timeframes and day-to-day location of the survey vessel, and (3) an indication of the 500 m safety zones and the proposed safe operational limits of the survey vessel. These notices should be distributed timeously to fishing companies and directly onto vessels where possible;

- An independent onboard FLO that is familiar with fisheries operational in the area must be appointed for the duration of the survey. The FLO should provide a fisheries facilitation role to identify and communicate with fishing vessels in the area to reduce the risk of gear interaction between fishing and survey activities. The FLO should:
  - report on vessel activity daily;
  - advise on actions to be taken in the event of encountering fishing gear;
  - provide back-up on-board facilitation with the fishing industry and other users of the sea; and
  - set up a daily electronic reporting routine to keep key stakeholders informed of survey activity and progress and fisheries, environmental issues.

  In addition to the above, the FLO should assist in the identification of current fishing target areas to, where possible, allow for the adjustment of the survey plan to accommodate fishing.
- Any fishing vessels target a radar range of 12 nm from the survey vessel should be called via radio and informed of the navigational safety requirements around the survey vessel;
- Ongoing notification is to be undertaken throughout the duration of survey with the submission of daily reports (via email) indicating the vessel's location to key stakeholders, as appropriate;
- Any dispute arising with other right holders should be referred to DMR or PASA for resolution; and
- Marine mammal incidence data and seismic source output data arising from the survey should be made available, if requested, to the Marine Mammal Institute, DEA, DAFF and PASA for analyses of survey impacts in local waters.

6.1.4 Vessel Safety

- The survey vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident;
- Collision prevention equipment should include radar, multi-frequency radio, foghorns, etc. Additional precautions include:
  - A support / chase vessel with FLO familiar with the fisheries expected in the area;
  - The existence of an internationally agreed 500 m safety zone around the survey vessels;
  - Cautionary notices to mariners; and
  - Access to current weather service information.
- The vessels are required to fly standard flags, lights (three all-round lights in a vertical line, with the highest and lowest lights being red and the middle light being white) or shapes (three shapes in a vertical line, with the highest and lowest lights being balls and the middle light being a diamond) to indicate that they are engaged in towing surveys and are restricted in manoeuvrability, and must be fully illuminated during twilight and night; and
- Report any emergency situation to SAMSA.

6.1.5 Emissions, Discharges, into the Sea and Solid Waste

- Ensure adequate maintenance of diesel motors and generators to minimise emissions to the atmosphere;
- Route deck and machinery space drainage to a separate drainage system (oily water catchment system) for treatment to ensure compliance with MARPOL (15 ppm);
- Ensure all process areas are bunded to ensure drainage water flows into the closed drainage system;
- Use drip trays to collect run-off from equipment that is not contained within a bunded area and route contents to the closed drainage system;
- Use low toxicity, biodegradable detergents during deck cleaning to further minimise the potential impact of deck drainage on the marine environment;
- Ensure adequate maintenance of all hydraulic systems and frequent inspection of hydraulic hoses;
- Undertake spill management training and awareness of crew members of the need for thorough clean-up of any spillages immediately after they occur, as this would minimise the volume of contaminants washing off decks;
- Initiate an on-board waste minimisation system;
- Ensure on-board solid waste storage is secure;
- Ensure that waste (solid and hazardous) disposal onshore is carried out in accordance with the appropriate laws and ordinances; and
- Prepare a project specific Emergency Response Plan and Shipboard Oil Pollution Emergency Plan for the proposed seismic survey, which defines the organisational structure and protocols that would be implemented to respond to any incident (including accidental oil / fuel spills) in a safe, rapid, effective and efficient manner.

6.1.6 Offshore Bunkering

- Offshore bunkering should not be undertaken in the following circumstances:
  - Within 50 nm of the coast;
  - Wind force and sea state conditions of 6 or above on the Beaufort Wind Scale;
  - During any workboat or mobilisation boat operations;
  - During helicopter operations;
  - During the transfer of in-sea equipment; and
  - At night or times of low visibility.
- Support vessels must have the necessary spill response capability to deal with accidental spills in a safe, rapid, effective and efficient manner; and
- Crew must be trained in spill management.

6.1.7 Job Creation and the Generation of Direct Revenues

- The use of local companies for support services should be promoted as far as possible.

6.1.8 Vessel Lighting

- Lighting on board survey vessels should be reduced to the minimum safety levels to minimise stranding of pelagic seabirds on the survey vessels at night. All stranded seabirds must be retrieved and released during daylight hours.

6.2 MITIGATION RECOMMENDATIONS SPECIFIC TO SEISMIC SURVEYS

6.2.1 Survey Timing and Scheduling

- The seismic survey should be undertaken outside of the key cetacean migration and breeding period which extends from the beginning of June to the end of November.
- As no seasonal patterns of abundance are known for odontocetes occupying the proposed study area, a precautionary approach to avoiding impacts throughout the year is recommended;
- Survey operations can occur between January to end of May (subject to permit award date and vessel availability);
- For the inshore portions of the proposed survey areas, the following is recommended:
  - As several of the large whale species would be abundant on the West Coast between September and February, the inshore portions between Cape Point (approximately 34° 21'S) and Strandfontein (approximately 31° 45'S) of the seismic operations should be planned to be undertaken in late summer and early winter (February - May).
  - Survey operations should, if possible, commence in the western portions of the proposed survey areas to avoid disruption of the planned demersal research trawl survey in January to mid-February 2019. For the portions of the of the survey areas inshore of the 1 000 m depth contour, there must be simultaneous operational planning in place to avoid disruption of the planned small pelagic acoustic research surveys.

6.2.2 Equipment

- 'Turtle-friendly' tail buoys should be used by the survey contractor or existing tail buoys should be fitted with either exclusion or deflector 'turtle guards'.

6.2.3 Seismic Survey Procedures

- PAM technology
  - > The survey vessel must be fitted with PAM technology, which detects animals through their vocalisations. As the survey is taking place in waters deeper than 1 000 m depth where sperm whales and other deep-diving odontocetes are likely to be encountered, the use of PAM 24-hours a day is highly recommended. As a minimum, PAM technology must be used during the 30-minute pre-watch period and when surveying at night or during adverse weather conditions and thick fog.

> The PAM hydrophone streamer should ideally be towed behind the airgun array to minimise the interference of vessel noise, and should be fitted with two hydrophones to allow directional detection of cetaceans.

> In order to avoid unnecessary delays to the survey programme, it is recommended that a spare PAM cable and sensor are kept onboard should there be any technical problems with the system. However, if there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision/infra-red binoculars must be used at night while PAM is being repaired.

- "Soft-start" procedure, pre-watch period and airgun firing

> A "soft-start" procedure of a minimum of 20 minutes' duration must be implemented when initiating airgun tests (a single or a number of airguns at full power)[10] and / or seismic surveying. This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance.

> "Soft-starts" should be delayed until such time as the area is clear of seabirds (diving), turtles, seals or cetaceans. In the case of turtles and cetaceans the "soft-start" procedure should not begin until after the animals depart the 500 m exclusion zone or 30 minutes after they are last seen. In the case of small cetacean (<3 m in overall length) and seals, which are often attracted to survey vessels, the normal "soft-start" procedures should be allowed to commence, if after a period of 30 minutes small cetaceans or seals are still within 500 m of the airguns for at least a 20-minutes duration. The MMO should monitor small cetacean behaviour during "soft-starts" to determine if the animals display any obvious negative responses to the air-guns and gear or if there are any signs of injury or mortality as a direct result of seismic shooting operations.

> All breaks in airgun firing of longer than 20 minutes must be followed by a 60-minute pre-shoot watch and a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. In order to facilitate a more effective timing of proposed operations when surveying in deeper waters, the 60-minute pre-shoot watch can commence before the end of the survey line (whilst the airguns are still firing). Breaks of shorter than 20 minutes should be followed by a visual assessment for marine mammals and turtles within the 500 m mitigation zone (not a 60-minute pre-shoot watch) and a "soft-start" of similar duration.

> The use of the lowest practicable airgun volume, as defined by the operator, should be defined and enforced.

> During surveying, airgun firing should be terminated when:
  - obvious negative changes to turtle, seal and cetacean behaviour is observed;
  - turtles or cetaceans are observed within 500 m of the operating airgun and appear to be approaching the firing airgun; or
  - there is mass mortality of fish or mortality / injuries to seabirds, turtles, seals or cetaceans as a direct result of the survey.

> The survey should remain terminated until such time the time MMO / PAM operator confirms that:
  - turtles or cetaceans have moved to a point that is more than 500 m from the source;

[10] Note: If the intention is to test a single airgun on low power then a "soft-start" is not required.

- despite continuous observation, 30 minutes has elapsed since the last sighting of the turtles or cetaceans within 500 m of the source; and
- risks to seabirds, turtles, seals or cetaceans have been significantly reduced.

> A log of all termination decisions must be kept (for inclusion in both daily and "close-out" reports).

- MMO and PAM operator

> An independent on-board MMO and a PAM operator must be appointed for the duration of the seismic survey. The MMO and PAM operator must have experience in seabird, turtle and marine mammal identification and observation techniques.

> The duties of the MMO would be to:

<u>Marine fauna:</u>

- Confirm that there is no marine faunal activity within 500 m of the seismic source array prior to commencing with the "soft-start" procedures;
- Record pre-shoot observation regime;
- Record survey activities, including sound levels, "soft-start" procedures and survey periods (duration);
- Monitor marine faunal activity during daytime surveying. Observe and record responses of marine fauna to the seismic survey, including seabird, turtle, seal and cetacean incidence and behaviour and any mortality or injuries of marine fauna as a result of the seismic survey. Data captured should include species identification, position (latitude/longitude), distance from the vessel, swimming speed and direction (if applicable) and any obvious changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns) as a result of the survey activities; and
- Request the temporary termination of the seismic survey, as appropriate. It is important that the MMOs' decisions to terminate firing are made confidently and expediently;

<u>Other:</u>

- Record meteorological conditions;
- Monitor compliance with international marine pollution regulations (MARPOL 73/78 standards); and
- Prepare daily reports of all observations. These reports should be forwarded to the key stakeholders, as appropriate.

> The duties of the PAM operator would be to:

- Ensure that hydrophone streamers are optimally placed within the towed array;
- Confirm that there is no cetaceans activity within 500 m of the vessel prior to commencing with the "soft-start" procedures;
- Record survey activities, including sound levels, "soft-start" procedures and survey periods (duration);
- Record pre-shoot observation regime;
- Monitor cetacean activity during daytime and night time surveying. Record species identification, position (latitude/longitude) and distance from the vessel, where possible; and
- Request the temporary termination of the seismic survey, as appropriate.

> All data recorded by the MMO and PAM operator should form part of the survey "close-out" report.

6.3 MITIGATION RECOMMENDATIONS SPECIFIC TO HELICOPTER OPERATIONS (WHERE REQUIRED)

Mitigation relating to helicopter operations includes:

- Flight paths must be pre-planned to ensure that no flying occurs over MPAs (Marcus Island, Malgas Island, Jutten Island, Langebaan Lagoon, Sixteen Mile Beach, Table Mountain National Park, Helderberg, and Betty's Bay), seal (Kleinzee, Robberg Bucchu Twins, Strandfontein Point, Bird Island, Paternoster Point, Duikerklip, Robbesteen, Seal Island and Geyser Rock) and seabird colonies (Saldanha Bay islands, Dassen Island, Robben Island, Dyer Island, Bird Island, Boulders beach, and Betty's Bay);
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should be avoided. There is a restriction of coastal flights (parallel to the coast within 1 nautical mile of the shore) on the South Coast between the months of June and November to avoid Southern Right whale breeding areas;
- Aircraft may not approach to within 300 m of whales without a permit in terms of the Marine Living Resources Act, 1998;
- The operator must comply with the Seabirds and Seals Protection Act, 1973, which prohibits the wilful disturbance of seals on the coast or on offshore islands;
- The contractor should comply fully with aviation and authority guidelines and rules; and
- All pilots must be briefed on ecological risks associated with flying at a low level parallel to the coast.

7 ENVIRONMENTAL MANAGEMENT PROGRAMME

This chapter lists the auditable environmental protection activities and procedures required to avoid or minimise impacts on the environment from the proposed seismic surveys within the proposed Reconnaissance Permit area located the South and West Coasts of South Africa. It also indicates who is the responsible party and includes a compliance audit column (✓) for auditing purposes and the requirements for closure. The specific environmental protection activities and procedures are addressed under each of the project life cycle phases listed below:

7.1	PLANNING PHASE	7.1.1 Seismic survey timing and scheduling
		7.1.2 Survey equipment
		7.1.3 Survey personnel
		7.1.4 Preparation of subsidiary plans
		7.1.5 Stakeholder consultation and notification
		7.1.6 Permits / exemptions
7.2	ESTABLISHMENT PHASE	7.2.1 Compliance with the EMP
		7.2.2 Environmental awareness training
		7.2.3 Notifying other users of the sea
7.3	OPERATIONAL PHASE	7.3.1 Adherence to the EMP
		7.3.2 Communication with other users of the sea and resource managers
		7.3.3 Prevention of emergencies
		7.3.4 Dealing with emergencies including major oil spills
		7.3.5 Seismic survey procedure and monitoring
		7.3.6 Pollution control and waste management
		7.3.7 Equipment loss
		7.3.8 Use of helicopters
		7.3.9 Bunkering / refuelling at sea
		7.3.10 Vessel lighting
7.4	DECOMMISSIONING AND CLOSURE PHASE	7.4.1 Survey vessels to leave area
		7.4.2 Inform key stakeholders of survey completion
		7.4.3 Final waste disposal
		7.4.4 Information sharing
		7.4.5 Compile seismic survey “close-out” reports

7.1 PLANNING PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**

7.1.1 SEISMIC SURVEY TIMING AND SCHEDULING	Minimise impact on cetaceans and turtles	• The seismic survey should be undertaken outside of the key cetacean migration and breeding period which extends from the beginning of June to the end of November.
		• As no seasonal patterns of abundance are known for odontocetes occupying the proposed study area, a precautionary approach to avoiding impacts throughout the year is recommended;
		• Survey operations can occur between January to end of May (subject to permit award date and vessel availability);
		• For the inshore portions of the proposed survey areas, the following is recommended:
		  ○ As several of the large whale species would be abundant on the West Coast between September and February, the inshore portions between Cape Point (approximately 34° 21'S) and Strandfontein (approximately 31° 45'S) of the seismic operations should be planned to be undertaken in late summer and early winter (February - May).
		  ○ Survey operations should, if possible, commence in the western portions of the proposed survey areas to avoid disruption of the planned demersal research trawl survey in January to mid-February 2019. For the portions of the of the survey areas inshore of the 1 000 m depth contour, there must be simultaneous operational planning in place to avoid disruption of the planned small pelagic acoustic research surveys.
				PGS	Prior to finalisation of survey schedule / timing	MMO close-out report

7.1.2 SURVEY EQUIPMENT	Minimise impact on cetaceans and turtles	• Use 'turtle-friendly' tail buoys. Alternatively, the existing tail buoys should be fitted with either exclusion or deflector 'turtle guards' to prevent turtle entrapment. • The Marine Mammal Observer (MMO) shall inspect tail buoys prior to the survey to ensure guards are in place. If turtles are observed to be trapped, survey operations will be ceased until the animal can be freed from the towed equipment.		PGS / Survey Contractor	Prior to commencement of operation	MMO close-out report
		Seismic surveys: • The seismic survey vessel must be fitted with Passive Acoustic Monitoring (PAM) technology. • PAM technology must be used during both the pre-watch period and when the airguns are active (including "soft-starts", airgun tests and surveying) and when surveying at night or during adverse weather conditions and thick fog. • As the survey is taking place in waters deeper than 1 000 m depth where sperm whales and other deep-diving odontocetes are likely to be encountered, the use of PAM 24-hours a day is highly recommended. • In order to avoid unnecessary delays to the survey programme, it is recommended that a				PAM operator close-out report

7.1 PLANNING PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		spare PAM cable and sensor are kept onboard should there be any technical problems with the system.				
7.1.3 SURVEY PERSONNEL	Minimise impact on marine fauna	Seismic surveys: • Appoint an independent on-board MMO and PAM operator for the duration of the survey. • The MMO and PAM operator must have experience in seabird, turtle and marine mammal identification and observation / detection techniques.		PGS	Prior to commencement of operation	MMO and PAM operator close-out reports
	Minimise impact on other users of the sea	• Appoint an independent on-board Fisheries Liaison Officer (FLO). The FLO must be familiar with fisheries operating in the area.				FLO close-out report
7.1.4 PREPARATION OF SUBSIDIARY PLANS	Preparation for any emergency that could result in an environmental impact	• Ensure the following plans are prepared and in place: > Shipboard Oil Pollution Emergency Plan (SOPEP) as required by MARPOL; > Emergency Response Plan (including MEDIVAC plan); and > Waste Management Plan (see contents in Section 7.3.6). • In addition to the above, ensure that: > There is adequate protection and indemnity insurance cover for oil pollution incidents; and > There is a record of the vessel's seaworthiness certificate and/or classification stamp.		PGS and Survey Contractor	Prior to commencement of operation	Confirm compliance and justify any omissions
7.1.5 STAKEHOLDER CONSULTATION AND NOTIFICATION	PASA notification	• Compile the specific details of each survey into a Survey Notification document and submit to Petroleum Agency of south Africa (PASA). The notification should provide details on the following: > Survey plan / lines; > Survey timing and duration; > Contractor details; > Vessel specifications (including relevant certification and insurance); > Emergency Response Plan; > Shipboard Oil Pollution Emergency Plan (SOPEP); and > Details of MMO, PAM operator and FLO.		PGS	30-days prior to commencement of operations or as requested by PASA	Confirm that notification was sent to PASA
	Stakeholder notification	• Prior to survey commencement the following key stakeholders should be consulted and informed of the proposed survey activity (including navigational co-ordinates of the survey area, timing and duration of proposed activities) and the likely implications thereof: > Fishing industry / associations: - SA Deep-Sea Trawling Industry Association (SADSTIA);		PGS	30 days prior to commencement of operations	Provide copies of all correspondence

7.1 PLANNING PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		- Fresh Tuna Exporters Association; - SA Hake Longline Association (SAHALLA); - South African Tuna Long-Line Association (SATLA); - South African Pelagic Fishing Industry Association (SAPFIA); - SA Commercial Linefish Association; and - South Coast Rock Lobster Association. Other: - PASA; - Department of Agriculture, Fisheries and Forestry (DAFF); - Transnet National Ports Authority; - South African Maritime Safety Authority (SAMSA); - South African Navy Hydrographic office; and - Overlapping and neighbouring right holders. • The notification must also invite stakeholders to be included on the daily report distribution list (only those included on the daily notification database will receive further notification during the survey).				
	Dispute resolution	• Any dispute arising with other right holders should be referred to Department of Mineral Resources (DMR) or PASA for resolution.		PGS	As required	Decision taken by DMR or PASA
7.1.6 PERMITS / EXEMPTIONS	Compliance with legislative requirements	If necessary, apply to (Department of Environmental Affairs (DEA) for a permit or exemption to approach to or remain within 300 m of whales (see note below). The application for a permit or request for an exemption should be submitted to: - Zintle Mapekula, email: zmapekula@environment.gov.za; or - Gcobani Popose, email: gpopose@environment.gov.za). Notes: In terms of the Marine Living Resources Act, 1998 (No. 18 of 1998): • No person may approach within 300 m of a whale by vessel, aircraft or other means without a permit; • A vessel approached by a whale is required to distance itself at 300 m from the whale, unless in possession of a permit; • A vessel may not proceed directly through a school of dolphins or porpoises; and • No person shall attempt to feed, harass, disturb or kill great white sharks, dolphins, seals or turtles.		PGS or Survey Contractor	Prior to commencement of operations	Provide copy of permit / exemption
7.1.7 APPROVAL OF EMP	Compliance with legislative requirements	• Verify that the EMP has been approved by PASA.		PGS	Prior to commencement of operations	Provide Minister's approval letter

7.2 ESTABLISHMENT PHASE

PROJECT PHASE AND ACTIVITIES:	ENVIRONMENTAL OBJECTIVES:	AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:	✓	RESPONSI-BILITY:	TIMING:	REQUIREMENT FOR "CLOSE-OUT" REPORT:
7.2.1 COMPLIANCE WITH EMP	*Operator and contractor to commit to adherence to environmental protection activities and procedures*	• Verify that a copy of the approved EMP is supplied to all Contractors and is on-board the survey and support vessels during the operations. • Operator to commit organisation and Contractor to meet the requirements of the EMP. • Verify procedures and systems for compliance are in place. • Verify correct equipment and personnel are available to meet the requirements of the EMP.		PGS	Prior to commencement of operation	Ensure that a copy of the EMP is provided to the vessel and that an acknowledgment of receipt form is signed
7.2.2 ENVIRONMENTAL AWARENESS TRAINING	*Ensure personnel are appropriated trained*	• Undertake Environmental Awareness Training (including spill management) to ensure the vessel's personnel are appropriately informed of the purpose and requirements of the EMP. • Verify responsibilities are allocated to personnel.		PGS / MMO		Copy of attendance register
7.2.3 NOTIFYING OTHER USERS OF THE SEA	*Ensure that other users are aware of the seismic survey*	• Request, in writing, that the South African Navy Hydrographic office release Radio Navigation Warnings and Notices to Mariners throughout the survey periods. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey areas, (2) an indication of the proposed timeframes of surveys and day-to-day location of the survey vessel(s), and (3) an indication of the 500 m safety zones and the proposed safe operational limits of the survey vessel(s). • Notices to Mariners should also be distributed to fishing companies and directly onto vessels where possible.		PGS / MMO	Notice to mariners to be issued 24 hours prior to start	Confirm that notices were sent to relevant parties Provide copies of notices and list of those to whom it was sent

7.3 OPERATIONAL PHASE

PROJECT PHASE AND ACTIVITIES:	ENVIRONMENTAL OBJECTIVES:	AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:	✓	RESPONSI-BILITY:	TIMING:	REQUIREMENT FOR "CLOSE-OUT" REPORT:
7.3.1 ADHERENCE TO THE EMP	Operate in an environmentally responsible manner	• Comply fully with the EMP (compliance would mean that all activities were undertaken successfully and details recorded); • Subscribe to the principles of an internationally acceptable Environmental Management System on-board the vessels. This includes environmental awareness training, waste management and environmental monitoring, record keeping and continuous improvement; and		PGS / Survey Contractor	Throughout programme	Copies of self-audit reports
7.3.2 COMMUNICATION WITH OTHER USERS OF THE SEA AND RESOURCE MANAGERS	Promote cooperation and successful multiple use of the sea, including promotion of safe navigation	• Daily reports shall be submitted, via email, to key stakeholders and those stakeholders that request to be notified during the survey (see Section 7.1.5). Daily reports should include, but not limited to, the following: > Survey details (incl. percentage completion & start-up procedure); > Vessel interaction; > Meteorological Conditions; > Observation times and sightings; > Waste management; and > Survey strategy (incl. survey progress and next line to be acquired).		MMO	During operations as required	Provide copies of written notices and list of those to whom it was sent
		• Keep constant watch for approaching vessels during operations. • Warn by radio and chase boat if required. • The FLO should provide a fisheries facilitation role to identify and communicate with fishing vessels in the area to reduce the risk of gear interaction between fishing and survey activities. The duties of the FLO include: > Reporting on vessel activity daily; > Advising on actions to be taken in the event of encountering fishing gear; > Providing back-up on-board facilitation with the fishing industry and other users of the sea; and > Daily electronic reporting on vessel activity and recording of any communication and/or interaction.		Officer on watch / FLO	Throughout operation	Daily reports and FLO close-out report
		• Call, via radio, any vessel targets at a radar range of 12 nm from the survey vessel to inform them of the safety requirements around the survey vessel.		FLO		Daily reports and FLO close-out report

7.3 OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
7.3.3 PREVENTION OF EMERGENCIES	Minimise disruption to other legitimate users of the sea by respecting their rights and the chance of emergency occurring and subsequent damage to the environment	• Co-operate with other legitimate users of the sea to minimise disruption to other marine activities. • Vessels are required to fly standard flags, lights (three all-round lights in a vertical line, with the highest and lowest lights being red and the middle light being white) or shapes (three shapes in a vertical line, with the highest and lowest lights being balls and the middle light being a diamond) to indicate that the seismic vessel is engaged in towing surveys and is restricted in manoeuvrability. • Use warning lights during twilight and at night and in periods of low visibility. • Maintain standard visual watch procedures (see Section 7.3.2). • Maintain 500 m safety zone around survey vessel through Notices to Mariners and Navigation Warnings. • 24 hr chase boat on patrol during seismic surveying. • Radio communication to alert approaching vessels (see Section 7.3.2). • Use flares or fog horn where necessary. • Practice weekly emergency response drills. • Ensure vessel has access to current weather service information. • Establish lines of communication with emergency response agencies/facilities: SAMSA, DEA: Marine and Coastal Pollution Management, Smit Amandla Marine and Port Captain(s).		Survey Contractor / FLO	Throughout operation	Record any incidents outside of normal occurrence

7.3 OPERATIONAL PHASE

PROJECT PHASE AND ACTIVITIES:	ENVIRONMENTAL OBJECTIVES:	AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:	✓	RESPONSI-BILITY:	TIMING:	REQUIREMENT FOR "CLOSE-OUT" REPORT:
7.3.4 DEALING WITH EMERGENCIES INCLUDING MAJOR OIL SPILLS (owing to collision, vessel break-up, refuelling etc.)	Minimise damage to the environment by implementing response procedures efficiently	• Adhere to obligations regarding other vessels in distress. • Implement emergency plans in Section 7.1.4. • Notify SAMSA about wrecked vessels (safety and pollution) and the Department of Finance (salvage, customs, royalties). Provide location details to South African Navy (SAN) Hydrographer. • Vessels must have the necessary spill response capability to deal with accidental spills in a safe, rapid, effective and efficient manner. • In the event of a routine incident (e.g. onboard spill or leak) confined to the survey vessel or other incident that does not pose a risk of major harm to the environment or people, then the following steps may be taken: > Mobilisation of onboard response person or team to: - contain the spill and shut off or control the source of the incident event; - clean up the spill or take steps to rectify the incident consequences. > Complete an incident report form; > Conduct an investigation; and > Close out the incident. • In the event of a major oil spill (emergency): > Notify (a) the Principal Officer of the nearest SAMSA office, (b) the DEA's Chief Directorate of Marine & Coastal Pollution Management in Cape Town and (c) Smit Amandla Marine. Information that should be supplied when reporting a spill includes: - Name and contact details of person reporting the incident; - The type and circumstances of incident, ship type, port of registry, nearest agent representing the ships company; - Date and time of spill; - Location (co-ordinates), source and cause of pollution; - Type and estimated quantity of oil spilled and the potential and probability of further pollution; - Weather and sea conditions; and - Action taken or intended to respond to the incident. > Mobilise on-board resources and take all practical steps on the seismic vessel to contain the oil spill; and > Adhere to all notification, investigation procedures, and reporting requirements. • Where diesel, which evaporates relatively quickly, has been spilled, the water should be		PGS	In the event of accident / spill	Record of all spills (Spill Record Book), including spill reports; emergency exercises and audit records. Incident log

7.3 OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		agitated or mixed using a propeller boat/dinghy to aid dispersal and evaporation. • Dispersants should not be used without authorisation of DEA (Marine & Coastal Pollution Management). • Dispersants should not be used: > On diesel or light fuel oil; > On heavy fuel oil; > On slicks > 0.5 cm thick; > On any oil spills within 5 nautical miles off-shore or in depths less than 30 metres; and > In areas far offshore where there is little likelihood of oil reaching the shore. • Dispersants are most effective: > On fresh crude oils; under turbulent sea conditions (as effective use of dispersants requires mixing); and > When applied within 12 hours or at a maximum of 24 hours. • The volume of dispersant application should not exceed 20-30% of the oil volume.				
7.3.5 SEISMIC SURVEY PROCEDURE AND MONITORING	Reduce disturbance of marine life, particularly cetaceans (whales and dolphins), seals, turtles and seabirds (particularly penguins)	MMO and PAM operator: • An on-board MMO and PAM operator shall be assigned to perform marine mammal observations / detections and notifications.		PGS		MMO & PAM operator close-out reports
		Source level: • Ensure the lowest practicable seismic source array volume to achieve the geophysical objective is defined and used throughout the survey period.		PGS	Prior to survey operations	
		PAM equipment: • The PAM hydrophone streamer should ideally be towed behind the airgun array to minimise the interference of vessel noise, and should be fitted with two hydrophones to allow directional detection of cetaceans. • If there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision / infra-red binoculars must be used at night while PAM is being repaired.		PAM operator		MMO & PAM operator close-out reports
		Pre-shoot watch: • Undertake a pre-shoot watch (prior to soft-starts) in order to confirm there is no diving seabird (significant diving activity), seal, turtle or cetacean activity within 500 m of the seismic source array. The period of confirmation for cetaceans must be at least 30		MMO/ PAM operator	Prior to "soft-start" procedures	MMO & PAM operator close-out report

7.3 OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		minutes. • The pre-survey watch is to be undertaken visually and using PAM technology during the day and using only PAM technology at night or during periods of poor visibility.				
		"Soft-start" procedure: • All initiations of airgun tests (a single or a number of airguns at full power)[11] and / or seismic surveying must be carried out as "soft-starts" for a minimum of 20 minutes. This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance. • "Soft-starts" should be delayed until such time as this area is clear of seabirds (diving), turtles, seals or cetaceans. > In the case of turtles and cetaceans the "soft-start" procedure should not begin until after the animals depart the 500 m exclusion zone or 30 minutes after they are last seen. > In the case of seals, which are often attracted to survey vessels, the normal "soft-start" procedures should be allowed to commence, if after a period of 30 minutes seals are still within 500 m of the airguns.		PGS	Prior to airgun tests (at full power) and surveying	MMO & PAM operator close-out report
		Break in seismic acquisition: • All breaks in seismic acquisition of longer than 20 minutes must be followed by the 60-minute pre-shoot watch and a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. • In order to facilitate a more effective timing of proposed operations when surveying in deeper waters, the 60-minute pre-shoot watch can commence before the end of the survey line (whilst the airguns are still firing). • Breaks shorter than 20 minutes should be followed by a visual scan for marine mammals within the 500 m mitigation zone (not a 60 minute pre-shoot watch) and a "soft-start", of similar duration.		PGS	After breaks in seismic acquisition	MMO & PAM operator close-out report

[11] Note: If the intention is to test a single airgun on low power then a "soft-start" is not required.

7.3 OPERATIONAL PHASE

PROJECT PHASE AND ACTIVITIES:	ENVIRONMENTAL OBJECTIVES:	AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:	✓	RESPONSI-BILITY:	TIMING:	REQUIREMENT FOR "CLOSE-OUT" REPORT:
		Monitoring: • MMO is to monitor survey operations visually during the day. Duties include: > Confirm that there is no marine faunal activity within 500 m of the seismic source array prior to commencing with the "soft-start" procedures. > Record pre-shoot observation regime. > Record survey activities, including sound levels, "soft-start" procedures and survey periods (duration). > Monitor marine faunal activity during daytime surveying. Observe and record responses of marine fauna to the seismic survey, including seabird, turtle, seal and cetacean incidence and behaviour and any mortality or injuries of marine fauna as a result of the seismic survey. Data captured should include species identification, position (latitude/longitude), distance from the vessel, swimming speed and direction (if applicable) and any obvious changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns) as a result of the survey activities. > Requesting the temporary termination of seismic acquisition, as appropriate; > Recording meteorological conditions. > Monitoring compliance with international marine pollution regulations (MARPOL 73/78 standards). > Preparing daily reports of all observations. • PAM operator is monitor at night and during periods of poor visibility. Duties include: > Ensure that hydrophone streamers are optimally placed within the towed array. > Confirm that there is no cetaceans activity within 500 m of the vessel prior to commencing with the "soft-start" procedures. > Record survey activities, including sound levels, "soft-start" procedures and survey periods (duration). > Record pre-shoot observation regime. > Monitor cetacean activity during daytime and night time surveying. Record species identification, position (latitude/longitude) and distance from the vessel, where possible. > Request the temporary termination of the seismic survey, as appropriate.		MMO / PAM operator	Throughout survey operations	MMO & PAM operator close-out report
		Temporary termination of seismic acquisition: • During surveying, airgun firing should be terminated when: > obvious negative changes to turtle, seal and cetacean behaviour is observed; > turtles or cetaceans are observed within 500 m of the active sound source and		PGS / Survey Contractor and MMO / PAM operator	Throughout survey operations	MMO & PAM operator close-out report

7.3 OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		appear to be approaching the sound source; or > there is visual evidence of mass mortality of fish or mortality / injuries to seabirds, turtles, seals or cetaceans as a direct result of the seismic survey. • The survey should be terminated until such time the MMO / PAM operator confirms that: > Turtles or cetaceans have moved to a point that is more than 500 m from the sound source; > Despite continuous observation, 30 minutes has elapsed since the last sighting of the turtles or cetaceans within 500 m of the sound source; and > Risks to seabirds, turtles, seals or cetaceans have been significantly reduced. • A log of all termination decisions must be kept.				
7.3.6 POLLUTION CONTROL AND WASTE MANAGEMENT of products disposed of: into the air (exhausts, cfcs and incinerators), to sea (sewage, food, oils), to land (used oils etc, metals, plastics, glass, etc.)	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times	• Implement Waste Management Plan (see Section 7.1.4). The plan must comply with legal requirements for waste management and pollution control (for air and water quality levels at sea) and ensure "good housekeeping" and monitoring practices: > General waste: - Initiate a waste minimisation system. - No disposal overboard. - Ensure on-board solid waste storage is secure. - Transport ashore for disposal. Retain waste receipts. Note: Incineration would require an Atmospheric Emissions Licence. > Galley (food) waste: - No disposal within 3 nm of the coast. - Disposal further than 3 nm needs to be comminuted to particle sizes smaller than 25 mm. - Minimise the discharge of waste material should obvious attraction of fauna be observed. > Deck drainage: - Deck drainage should be routed to a separate drainage system (oily water catchment system). - Ensure all process areas are bunded to ensure drainage water flows into the closed drainage system. - Use drip trays to collect run-off from equipment that is not contained within a bunded area and route contents to the closed drainage system. - Ensure that weather decks are kept free of spillage. - Mop up any spills immediately with biodegradable low toxicity detergents.		PGS	Throughout operation	Provide summary of waste record book / schedule and receipts. Manifest required for all shipments to shore. Report occurrence of minor oil spills and destination of wastes. MMO & PAM operator close-out report.

7.3 OPERATIONAL PHASE

PROJECT PHASE AND ACTIVITIES:	ENVIRONMENTAL OBJECTIVES:	AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:	✓	RESPONSI-BILITY:	TIMING:	REQUIREMENT FOR "CLOSE-OUT" REPORT:
		- Low-toxicity biodegradable detergents should be used in cleaning of all deck spillage. - Ensure compliance with MARPOL standards (15 ppm). > Machinery space drainage: - Vessels must comply with international agreed standards regulated under MARPOL. - Ensure all process areas are bunded to ensure drainage water flows into the closed drainage system. - Use drip trays to collect run-off from equipment that is not contained within a bunded area and route contents to the closed drainage system - All machinery space drainage would pass through an oil/water filter to reduce the oil in water concentration to less than 15 mg/l. > Sewage: - Use approved treatment plants to the MARPOL standards. - No disposal within 4 nm of the coast. - Disposal further than 4 nm needs to be comminuted and disinfected prior to disposal into the sea. > Medical waste: Seal in aseptic containers for appropriate disposal onshore. > Metal: Send to shore for recycling or disposal. > Other waste: - Transport ashore for disposal. - Ensure waste disposal is carried out in accordance with appropriate laws and ordinances. - Retain waste receipts. - Note: Incineration would require an Atmospheric Emissions Licence. > Waste oil: Return used oil to a port with a registered facility for processing or disposal. > Wastewater: Comply with MARPOL. > Minor oil spill: Use oil absorbent. > Emissions to the atmosphere: Properly tune and maintain all engines, motors, generators and all auxiliary power to contain the minimum of soot and unburned diesel.				

7.3 OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		> Other hazardous waste: - Record types and volumes of chemical and hazardous wastes (e.g. neon lights, fluorescent tubes, toner cartridges, batteries, etc.) and destination thereof. - Send to designated onshore hazardous disposal site. Retain waste receipts. • Ensure all crew is trained in spill management.				
7.3.7 EQUIPMENT LOSS	Minimise hazards left on the sea bed or floating in the water column, and inform relevant parties	• Keep a record of lost equipment and all items lost overboard and not recovered. • When any item that constitute a seafloor or navigation hazard are lost on the sea bed, or in the sea, a standard form must be completed which records the date and cause of loss, details of equipment type, vessel Sea Control location, sea state and weather, and the nature of the sea bed. Pass information to PASA and SAMSA. • Notify SAN Hydrographer, relevant fishing associations. SAN Hydrographer will send out Notice to Mariners with this information.		PGS / Survey Contractor and FLO	Throughout operation, in the event of an incident	Provide a list of lost equipment and a copy of record sheet
7.3.8 USE OF HELICOPTERS for emergencies.	Minimise disturbance / damage to marine and coastal fauna	• Flight paths must be pre-planned to ensure that no flying occurs over MPAs (Goukamma, Robberg, Tsitsikammama, Sardinia Bay MPA, Bird Island and Amathole MPA), seal (Seal Island, Robberg Peninsula and Black Rocks) and seabird colonies (Algoa Bay islands, St Croix Island, Jaheel Island, Bird Island, Seal Island, Stag Island and Brenton Rocks); • Report any deviations from set flight plans. • Extensive coastal flights (parallel to the coast within 1 nm of the shore) should be avoided. There is a restriction of coastal flights (parallel to the coast within 1 nm of the shore) on the South Coast between the months of June and November to avoid Southern Right whale breeding areas. • Comply with the Marine Living Resources Act, 1998 which prohibits aircrafts approaching within 300 m of whales without a permit or exemption (see Section 7.1.6). • Comply with the Seabirds and Seals Protection Act, 1973, which prohibits the wilful disturbance of seals on the coast or on offshore islands. • Comply with aviation and authority guidelines and rules. • Brief all pilots on the ecological risks associated with flying at a low level parallel to the coast.		Helicopter contractor	As required	Submit copy of set flight path Copies of reports on deviations from set flight paths

7.3 OPERATIONAL PHASE

PROJECT PHASE AND ACTIVITIES:	ENVIRONMENTAL OBJECTIVES:	AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:	✓	RESPONSI-BILITY:	TIMING:	REQUIREMENT FOR "CLOSE-OUT" REPORT:
7.3.9 BUNKERING / REFUELLING AT SEA	Minimise damage to marine and coastal fauna	• Transfer of oil at sea is not permitted within the economic zone (i.e. 200 miles from the coast) without the permission of SAMSA. Submit an application (including location, supplier and timing) in terms of Regulation 14 to the Principal Officer at the port nearest to where the transfer is to take place. • Offshore bunkering should not be undertaken in the following circumstances: > Within 50 nm of the coast; > Wind force and sea state conditions of 6 or above on the Beaufort Wind Scale; > During any workboat or mobilisation boat operations; > During helicopter operations; > During the transfer of in-sea equipment; and > At night or times of low visibility. • Ensure support vessels must have the necessary spill response capability to deal with accidental spills in a safe, rapid, effective and efficient manner		PGS / Survey Contractor	As required, 5 days prior to refuelling	Confirm that a notice was sent to SAMSA
7.3.10 VESSEL LIGHTING	Minimise impact on seabirds	• Lighting on-board survey vessels should be reduced to the minimum safety levels to minimise stranding of pelagic seabirds on the survey vessels at night. • All stranded seabirds must be retrieved and released during daylight hours		PGS / Survey Contractor		Results of faunal monitoring

7.4 DECOMMISSIONING AND CLOSURE PHASE

PROJECT PHASE AND ACTIVITIES:	ENVIRONMENTAL OBJECTIVES:	AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:	✓	RESPONSI-BILITY:	TIMING:	REQUIREMENT FOR "CLOSE-OUT" REPORT:
7.4.1 SURVEY VESSELS TO LEAVE AREA	Leave survey area as it was prior to survey	• Ensure that all deployed equipment is retrieved.		PGS	On completion of survey	
7.4.2 INFORM KEY STAKEHOLDERS OF SURVEY COMPLETION	Ensure that relevant parties are aware that the seismic campaign is complete	• Inform the PASA and other key stakeholders (see Section 7.1.5) of the survey completion.		PGS	Within two weeks after completion of survey	Copies of notification documentation required.
7.4.3 FINAL WASTE DISPOSAL	Minimise pollution and ensure correct disposal of waste	• Dispose all waste retained on-board at a licensed waste site using a licensed waste disposal contractor.		PGS	When vessel is in port	Receipt required from contractor
7.4.4 INFORMATION SHARING	Information sharing	• Take steps to share data collected during the survey (e.g. marine mammal incidence and behaviour), if requested, to resource managers (including Marine Mammal Institute, DEA, DAFF and PASA).		PGS	As requested	
7.4.5 COMPILE SEISMIC SURVEY "CLOSE-OUT" REPORTS	Ensure corrective action and compliance and contribute towards improvement of EMP implementation	• Compile a "close-out" report at the end of each survey. • The "close-out" report must be based on requirements of the monitoring and EMP. • Provide information / records as indicated in the "close-out" report column of the EMP. • Provide a copy of the report to PASA.		PGS	Within 60 days post surveying or as requested by PASA	

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