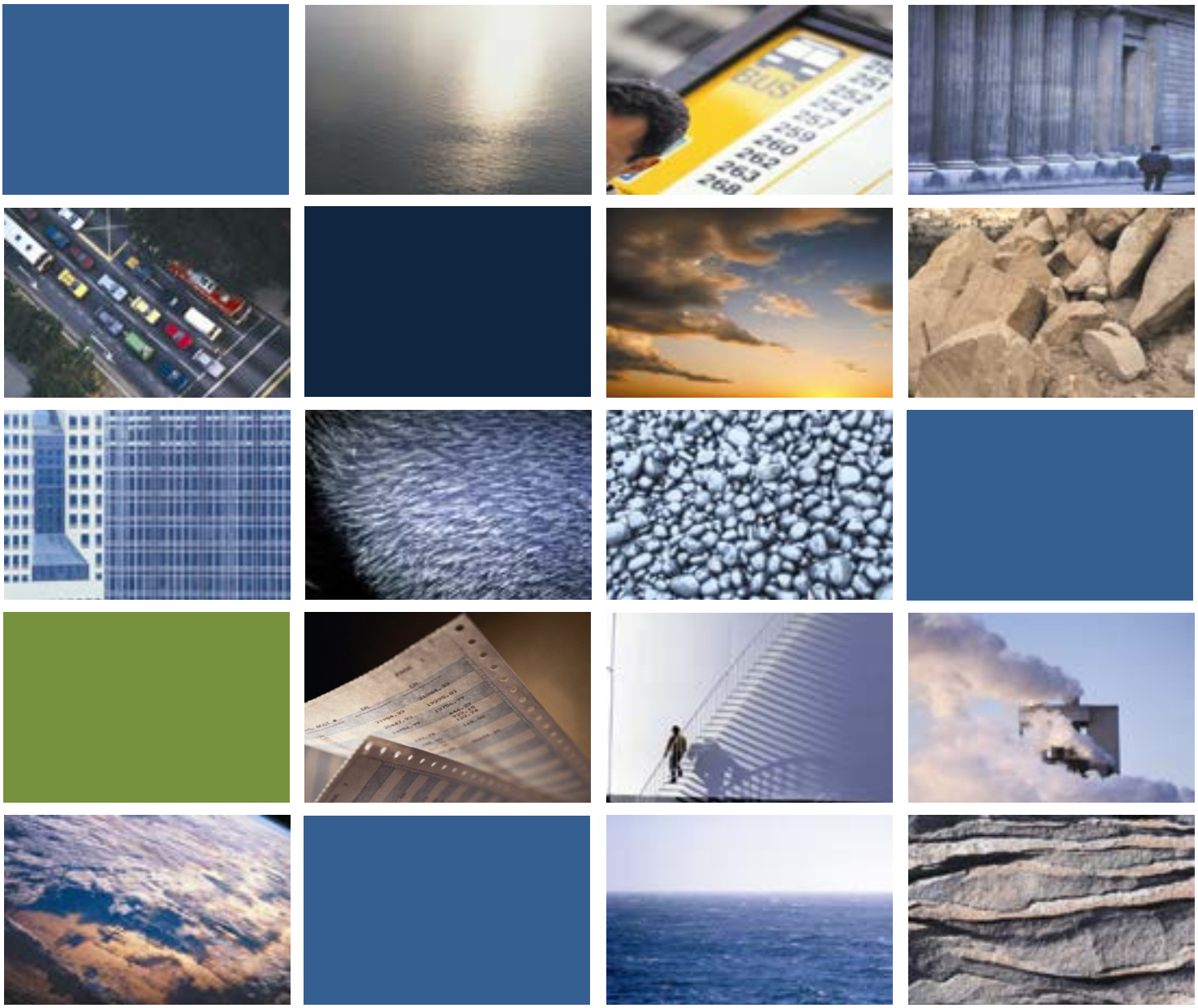


# Transkei and Algoa Exploration Areas

**Environmental Management Programme (EMPr)**

Final Report

June 2013

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Impact Africa

# Transkei and Algoa Exploration Areas:
# *Environmental Management Programme (EMPr)*

## Final Report

June 2013

For and on behalf of
Environmental Resources Management

Approved by: Henry Camp

Signed: 

Position: Partner

Date: 26 June 2013

This report has been prepared by Environmental Resources Management the trading name of Environmental Resources Management Limited, with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client. The report has been prepared for submission to the Petroleum Agency of South Africa (PASA) in support of Impact Africa's application for an Exploration Right for the Transkei Algoa Exploration Area.

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# *EXECUTIVE SUMMARY*

## *INTRODUCTION*

*Impact Africa Limited (Impact Africa)* has submitted an application to the Petroleum Agency of South Africa (PASA) for an Exploration Right in terms of Section 79 of the Mineral and Petroleum Resources Development Act (MPRDA) to explore for oil and gas in the Transkei and Algoa Exploration Areas (hereafter referred to as the *Exploration Areas*) off the East Coast of South Africa. The Exploration Areas comprise license blocks license blocks 3425D, 3426C and 3426D (Algoa Exploration Area) and 3327B, 3327D, 3427B, 3328 (A-C), 3228 C and D, 3229 (A-C), 3129D, and 3130 (A-C) (Transkei Exploration Area). PASA accepted Impact Africa's application on 1 March, 2013.

In terms of the MPRDA, Impact Africa is required to submit an Environmental Management Programme (EMPr) to cover the proposed activities to PASA for consideration and for approval by the Minister of Mineral Resources. Impact Africa has appointed Environmental Resources Management (ERM) to prepare this EMPr. The process of preparing the EMPr involved the evaluation of the environmental and social setting, identification of potential impacts, and development of mitigations or actions to avoid or reduce impacts.

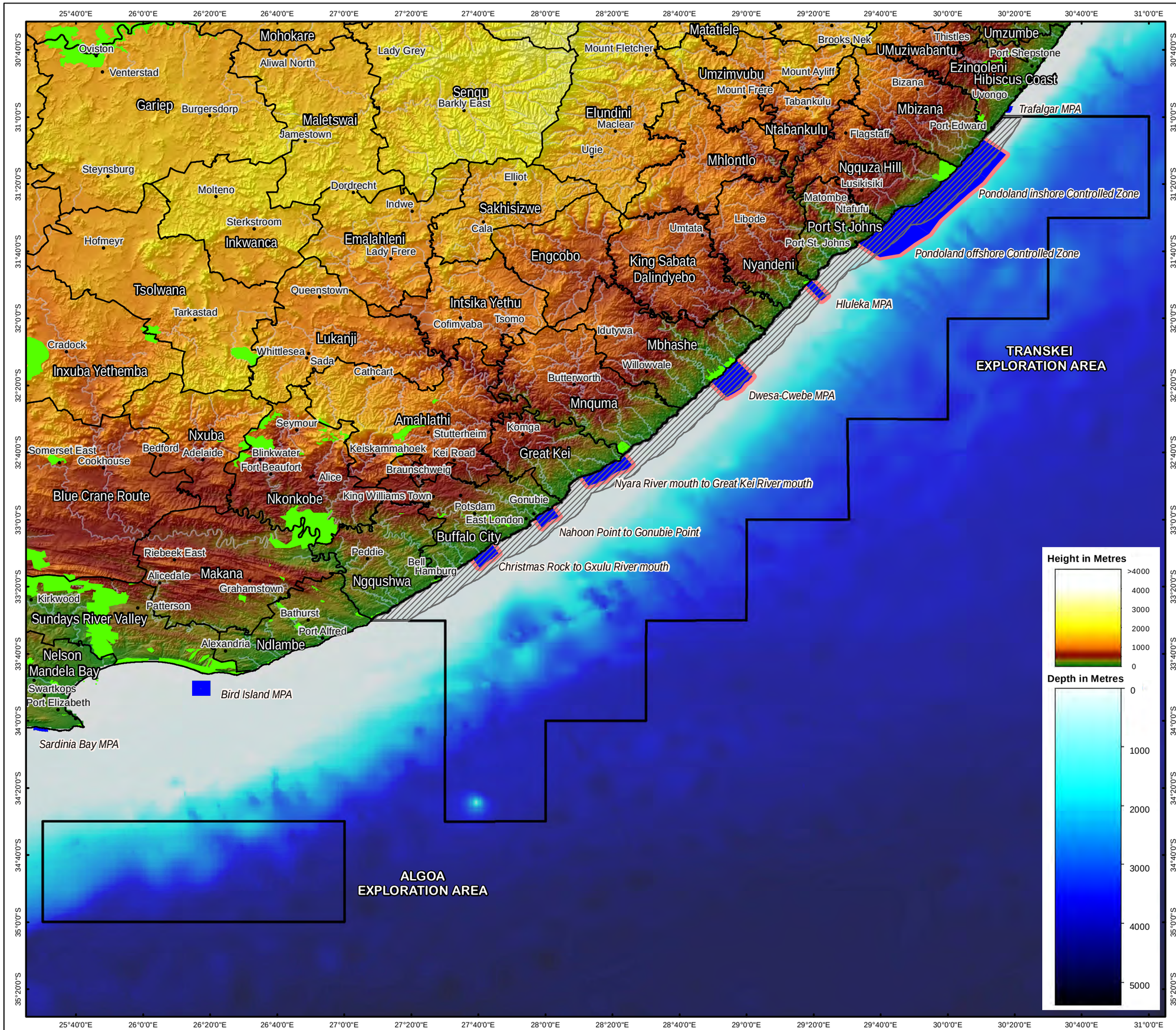
This EMPr summarises the process followed in the compilation of the EMPr. It provides a description of the proposed exploration activities and the environmental and socio-economic conditions of the receiving environment. The EMPr also provides an assessment of the potential environmental and socio-economic impacts of the proposed activities and identifies the mitigation and management measures to be implemented in order to avoid or reduce negative impacts.

Much of the information contained in the EMPr was sourced from PASA's generic EMPr. It also draws on ERM's experience preparing EMPrs for similar activities and in similar settings as well as conducting environmental assessments for oil and gas exploration activities globally. It also incorporates the results of studies of specific topic areas including:

- Marine fish and fishing activities by David Japp of CapFish;
- Marine fauna by Dr Andrea Pulfrich of Pisces Environmental Services; and
- Marine archaeology by Jonathan Sharfman of African Centre for Heritage Activities.

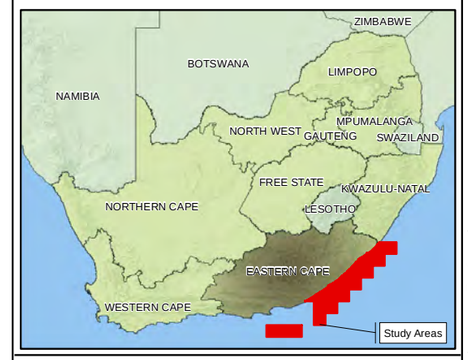
### *Location*

The proposed Exploration Areas are located between Port Elizabeth in the Eastern Cape Province (33° 54 'S, 23° 36'E), and Ramsgate in the KwaZulu-Natal Province (30°40'S, 30°20'E) (*Figure I.1*). The Transkei Exploration Area extends along a narrow strip of the continental shelf to a maximum distance of approximately 135 km off the Eastern Cape coastline (*Figure I.1*). The Algoa Exploration Area is located further offshore immediately south of the continental shelf, approximately 100 km from the Port Elizabeth shoreline. The proposed Exploration Areas cover an area of approximately 45,838 km². The proposed exploration activities (described in *Chapter 2*) may be undertaken over much of the Exploration Areas.




## Legend

- Towns
- Perennial Rivers
- LocalMunicipalities
- National Parks (2011)
- Marine Protected Areas (MPA)
- Areas of Interest
- 10km Coastal Seismic Buffer Zone (no airgun firing)
- 2km MPA Seismic Buffer Zone (no airgun firing)




SCALE:

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TITLE:

Location of the Algoa -Transkei Exploration Area

CLIENT:

IMPACT AFRICA

| DATE: June 2013 | CHECKED: CA | PROJECT: 0194759 |
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| DRAWN: AB | APPROVED: HC | SCALE: 1 : 2 000 000 |

DRAWING: Location of the Algoa-Transkei Exploration Areas Rev1.mxd

REV: 1


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ERM

Projection: Geographic , Datum: Wgs84
Source: ENPAT (2001) SANBI (2012) NGI,
British Oceanographic Data Centre (BODC) - GEBCOData
Inset Map: Esri Data and Maps

SIZE: A3

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### *PROJECT DESCRIPTION*

Impact Africa's proposed 3-year work programme currently consists of the following activities:

- Airborne geophysics (gravity and magnetics) data will be acquired for identification of prospective areas of structural trap development and to address depth to basement/magnetic source.

- 2D or 3D seismic data will be acquired, and or licensed, processed, and interpreted.

- Surface heat flow measurements will be taken to determine thermal regime and calibrate thermal models.

- Seabottom bathymetry will be determined using a multibeam echosounder to look for hydrocarbon seepages and constrain boundary conditions.

- A seabed and water column sampling program will be carried out to identify seabed and near surface features indicative of natural hydrocarbon seepage.

The purpose of undertaking such exploration activities is to investigate the subsea geological structures to determine the presence of naturally occurring hydrocarbons (i.e. oil and gas).

A seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be implemented, within which there will be no firing of airguns. No exploration activities will occur within the Marine Protected Areas.

### *KEY ASPECTS OF THE AFFECTED ENVIRONMENT*

Salient features related to the baseline environmental conditions within the East Coast area in general, and the proposed exploration areas, in particular, are presented below:

- The main features affecting weather patterns are the mid-latitude cyclone and South Atlantic and Indian Ocean anticyclone cells.
- Easterly winds predominate during austral summer and westerly winds during austral winter.
- The majority of waves (reaching a maximum of 10 m high), although westward-traveling, develop under prevailing easterly winds during summer and autumn.
- Water temperatures vary seasonally and in relation to the distance offshore, increasing offshore towards the centre of the Agulhas Current.

- Faunal communities within the offshore marine habitat are comparatively homogenous, largely as a result of the greater consistency in water temperature at depths around the South African coastline, than in the shallower coastal waters.
- There are numerous intertidal and shallow subtidal reefs that support a wide diversity of marine flora and fauna and a relatively high percentage of endemic species.
- Two important benthic habitats (i.e. Port Elizabeth Offshore Area and the Protea Banks) have been identified within the proposed exploration areas.
- Biological communities occurring in the proposed exploration areas comprise plankton, fish and marine mammal diversities, which often displaying considerable temporal and spatial variability (even at small scales).
- Only three species of birds (Grey-headed gull, Caspian tern and Swift tern are thought to breed regularly along the East Coast, within the proposed exploration areas (CSIR 1998). Despite this, many of the river mouths and estuaries along this coastline serve as important roosting and foraging sites for a variety of other seabirds.
- The continental shelf waters support greater and more variable concentrations of plankton biomass than offshore waters, with species composition varying seasonally.
- During the winter months of June to August, the penetration of northerly-flowing cooler water along the Eastern Cape coast and up to southern KwaZulu-Natal effectively expands the suitable habitat available for pilchards, resulting in a 'leakage' of large shoals northwards along the coast in what has traditionally been known as the 'sardine run'. The shoals can attain lengths of 20-30 km and are typically pursued by Great White Sharks, Copper Sharks, Common Dolphins, Cape Gannets and various other large pelagic predators.
- Numerous commercially important fish species are found within the proposed exploration areas, including kingklip, hake, anchovy and pilchards. Squid and rock lobsters are also prevalent within these parts.
- There are between 28 and 38 species of cetaceans (whales and dolphins) that are known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur in the region and one seal species, the Cape fur seal (*Arctocephalus pusillus*).
- Of the migratory cetaceans that may pass through the proposed exploration areas the blue, sei and humpback whales are listed as "Endangered" and the Southern Right and Fin whales as "Vulnerable".
- The demersal trawl, mid-water trawl and demersal long-line, handline, rock lobster and squid jig fisheries all have proportions of fishing grounds that overlap with small portions of the proposed exploration areas, particularly the western part of the proposed Algoa Exploration Area.
- A high proportion of the pelagic longline fishery grounds occur within the proposed exploration areas, in both the Transkei and Algoa Exploration Areas.

- There is a high distribution of shipping traffic within the proposed exploration areas. This traffic is located relatively close to shore, and generally includes commercial and fishing vessels.
- There is a high presence of recreational uses along the coastline, predominantly within inshore waters in the vicinity of coastal towns and holiday resorts.
- The East Coast, particularly the Transkei coastal area, is home to a large poor rural community that is directly reliant on the coast/marine resources to supplement their livelihoods.
- There are four MPAs that extend a few nautical miles from the shoreline within the proposed exploration areas, including the Amathole (Gxulu, Gonubie, and Kei) MPA, the Dwesa-Cwebe, Hluleka and Pondoland MPAs.
- There are some 188 estuaries located along the East Coast region, between Gonubie (near East London) and Isipingo (near Durban).
- The coastal region is considered to be rich in maritime and underwater cultural heritage.
- Four mariculture farms are located within the proposed Transkei Exploration Area, and one mariculture farm (oyster) is located just to the west of the project area, near to the town of Port Alfred.

### *CONSULTATION ACTIVITIES*

The consultation process followed was in accordance with the requirements contained within the Minerals and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA), the MPRDA Regulations GN 527 of 2004, and the generic EMPr guideline and template documents. The following activities were undertaken as part of the consultation:

- A stakeholder database was developed through stakeholder analysis and using previous studies in the area.
- A Background Information Document was compiled and distributed to all identified I&APs.
- Adverts were placed on Friday 22 March 2013 in *The Times*, *Die Burger* (Eastern Cape), *The Herald* and the *Daily Dispatch*, notifying the public about the proposed project and providing details of the consultation process and information on how members of the public could provide input forthcoming survey and inviting their comment.
- A period of 21 calendar days (22 March 2013 to 12 April 2013) was allowed for I&APs to submit issues or concerns for consideration in the compilation of the EMPr. This period also allowed for members of the public to register as I&APs and/or submit issues or concerns.
- All issues raised were compiled into a short Comments and Responses Report that formed part of the draft EMPr.

- The draft EMPr was made available to I&APs for a period of 30 calendar days (24 May – 24 June) on the project website. Notification was sent directly to all I&APs.
- During the disclosure period ERM conducted a series of face-to-face engagements including *group meetings* (in an open house format) and *focused group meetings* (in a standard meeting format) as part of the stakeholder engagement process. All Interested & Affacted Parties (I&APs) on the stakeholder database were notified of and invited to the group meetings.
- All comments received on the EMPr have been compiled and documented in the Comments and Responses report. No substantive changes have been made to the EMPr in preparing the Final Report for submission to PASA.

Key issues raised during the initial comment period related to the following:

- Potential for impacts on sensitive marine fauna;
- Potential impacts on fisheries in the area.
- Potential for adverse impacts on marine heritage resources in the area; and
- Proximity to the sensitive Marine Protected Areas (MPA).

A number of mitigation measures are recommended within the impact assessment to avoid or reduce the impacts and are summarised in the Implementation Plan contained in *Part B* of the EMPr.

### *SUMMARY OF IMPACT ASSESSMENT*

The impact assessment identifies and assesses the actual and potential environmental effects of the proposed exploration activities associated with different stages of the project. In addition, measures to mitigate negative impacts and enhance of positive impacts are described.

Of the proposed exploration activities, the potential impacts associated with airborne geophysics, multi-beam bathymetry and the seabed sampling programme are briefly discussed in *Chapter 6*, as these activities are expected to have low associated impacts. The impacts of seismic surveys are assessed in more detail.

The impact assessment identified two impacts relating to seismic surveys where the residual (post mitigation) impact is deemed to be of low significance:

- The potential impacts on cetaceans is deemed to be of low to medium significance (prior to mitigation) and of negligible to low significance after the implementation of mitigation measures such as soft-starts and not initiating shooting until confirmation that there are no cetaceans within

500 m of the seismic vessel, as well as the avoidance of certain important migration time periods..

- The impacts on commercial and recreational fishing are deemed to be of low to medium significance (prior to mitigation) due to the potential reduction in catch as a result of disturbance of fishing gear, the implementation of the exclusion zone and potential movement of fish from the usual fishing habitat and grounds. After the implementation of mitigation measures such as liaison and notification of fishing operators, this impact is deemed to be of negligible to low significance.

The impacts on fish, turtles, seabirds and mariculture are deemed to be of low significance (prior to mitigation) and negligible after mitigation. The remainder of the impacts assessed are deemed to be of negligible significance (post mitigation).

In terms of socio-economic impacts the impacts associated with tourism and recreation are deemed to be low (before and after mitigation), and the impact to diving and underwater related activities is deemed to be low- medium (prior to mitigation) and low after the implementation of mitigation measures. The impact on sites of historic, archaeological and cultural interest (including shipwrecks) is deemed insignificant after the implementation of mitigation measures.

Mitigation measures identified within the impact assessment are summarised into an Implementation Plan which describes the framework for implementation of environmental and social controls during all phases of the exploration activities. In order to facilitate the implementation of controls, the Implementation Plan specifies the appointment of a Fisheries Liaison Officer (FLO) and a Marine Mammal Observer (MMO) during certain activities. Key mitigation measures for seismic activities also include the use of soft start procedures (only initiated once key marine fauna species are confirmed – as far as possible - to not be within 500 m of the exploration vessel), MMOs to perform visual observations to monitor impacts on cetaceans, diving birds and turtles and specifically ensure that the seismic vessel does not fire within 500 m of these species. An MMO will also be required on board during the undertaking of the bathymetric survey in order to ensure the minimisation of impacts to marine fauna. The use of Passive Acoustic Monitoring (PAM) is recommended, specifically during night time when visual observations are not possible. Monitoring, auditing and reporting requirements are defined within the Implementation Plan to monitor Impact Africa's compliance with the EMPr. In addition a seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be implemented, within which there will be no firing of airguns. No exploration activities will occur within the MPAs (i.e. Amathole, Dwesa-Cwebe, Hluleka and Pondoland MPAs).

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*LIST OF ACRONYMS*

| | |
|---|---|
| 2 D | Two-Dimensional |
| 3 D | Three-Dimensional |
| BID | Background Information Document |
| CBO | Community Based Organisation |
| CCA | Crowther Campbell and Associates |
| CPUE | Catch per Unit Area |
| CSIR | Council for Scientific and Industrial Research |
| DEA | Department of Environmental Affairs |
| DMR | Department of Mineral Resources |
| EIA | Environmental Impact Assessment |
| EMPR | Environmental Management Programme |
| ER | Exploration Rights |
| ERM | Environmental Resources Management |
| FLO | Fisheries Liaison Officer |
| HESS | High Energy Seismic Survey Team |
| IADC | International Association for Drilling contractors |
| IAGC | International Association of Geophysical contractors; |
| I&APs | Interested & Affected Parties |
| IMO | International Marine Organisation |
| IPIECA | International Petroleum Industry Environmental Conservation Association |
| ISO | International Standards Organization; |
| JNCC | Joint Nature Conservation Committee |
| LFAS | Low Frequency Active Sonar |
| MARPOL | International Convention for the Protection of Pollution from Ships, 1973 as modified by the Protocol of 1978 |
| MMO | Marine Mammal Observer |
| MPA | Marine Protected Area |
| MRPDA | Mineral & Petroleum Recourses Development Act |
| NEMA | National Environmental Management Act |
| NGO | Non-Governmental Organisation |
| NSMRL | Naval Submarine Medical Research Laboratory |
| OGP | International Association for Oil and Gas Producers |
| ONR | Office of Naval Research |
| PAM | Passive Acoustic Monitoring |
| PASA | Petroleum Agency of South Africa |
| PTS | Permanent Threshold Shifts |
| RSA | Republic of South Africa |
| SB/R | Spawning Biomass per Recruit |
| SHE | Safety, Health and Environment |
| SAMSA | South African Maritime Safety Authority |
| SAN | South African Navy |
| TCP | Technical Cooperation Permits |
| TTS | Temporary Threshold Shifts |
| VPA | Virtual Population Analysis |

# 1 GENERAL INFORMATION

## 1.1 INTRODUCTION

*Impact Africa Limited (Impact Africa)* has submitted an application to the Petroleum Agency of South Africa (PASA) for an Exploration Right in terms of Section 79 of the Mineral and Petroleum Resources Development Act (MPRDA) to explore for oil and gas in the Transkei and Algoa Exploration Areas (hereafter referred to as the *Exploration Areas*) off the East Coast of South Africa. The Exploration Areas comprise license blocks 3425D, 3426C and 3426D (Algoa Exploration Area) and 3327B, 3327D, 3427B, 3328 (A-C), 3228 C and D, 3229 (A-C), 3129D, and 3130 (A-C) (Transkei Exploration Area). PASA accepted Impact Africa's application on 1 March, 2013.

In terms of the MPRDA, Impact Africa is required to submit an Environmental Management Programme (EMPr) to cover the proposed activities to PASA for consideration and for approval by the Minister of Mineral Resources. Impact Africa has appointed Environmental Resources Management (ERM) to prepare this EMPr. The process of preparing the EMPr involved the evaluation of the environmental and social setting, identification of potential impacts, and development of mitigations or actions to avoid or reduce impacts.

This EMPr summarises the process followed in the compilation of the EMPr. It provides a description of the proposed exploration activities and the environmental and socio-economic conditions of the receiving environment. The EMPr also provides an assessment of the potential environmental and socio-economic impacts of the proposed activities and identifies the mitigation and management measures to be implemented in order to avoid or reduce negative impacts.

Much of the information contained in the EMPr was sourced from PASA's generic EMPr. It also draws on ERM's experience preparing EMPrs for similar activities and in similar settings as well as conducting environmental assessments for oil and gas exploration activities globally. It also incorporates the results of studies of specific topic areas including:

- Marine fish and fishing activities by David Japp of CapFish;
- Marine fauna by Dr Andrea Pulfrich of Pisces Environmental Services; and
- Marine archaeology by Jonathan Sharfman of African Centre for Heritage Activities.

Curriculum Vitae of the environmental assessment practitioners and the relevant specialists are attached in *Part C*.

## 1.2 LEGISLATIVE REQUIREMENTS

The proposed exploration activities are regulated by two environmental regulations:

- Minerals and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA); and
- National Environmental Management Act (No. 107 of 1998), as amended (NEMA).

Both of these laws are described below in further detail.

### 1.2.1 Minerals and Petroleum Resources Development Act and Regulations

On 1 May 2004, the Minerals and Petroleum Resources Development Act (MPRDA) (No. 28 of 2002) was promulgated replacing the former Minerals Act (No. 50 of 1991). The MPRDA gives effect to Section 24 of the Constitution requiring that the nation's mineral and petroleum resources are developed in an orderly and ecologically sustainable manner while promoting justifiable social and economic development.

In terms of Section 79 of the MPRDA, certain oil and gas exploration activities require the granting of an Exploration Right by PASA, the current designated controlling agency. This involves the submission of an application form and the subsequent submission of an EMPr within 120 days following notice of acceptance of the application.

Section 52 of the MPRDA Regulations (Government Notice Regulations (GNR) 527 of 23 April 2004) sets out the content requirements for an EMPr (*Box 1.1*).

### Box 1.1 Contents of an EMPr required by the MPRDA regulations

- Description of the environment likely to be affected by the proposed exploration operation;
- Assessment of the potential impacts of the proposed exploration operation on the environment, socio-economic conditions and cultural heritage, if any;
- Summary of the assessment of the significance of the potential impacts and the proposed mitigation and management measures to minimise adverse impacts and benefits;
- Financial provision which must include the determination of the quantum of the financial provision contemplated in regulation 54 and details of the method providing for the financial provision contemplated in regulation 53;
- Planned monitoring and performance assessment of the EMPr;
- Closure and environmental objectives;
- Record of the public participation undertaken and the results thereof; and
- Undertaking by the applicant regarding the execution of the environmental management plan (EMPr).

### *1.2.2 National Environmental Management Act*

*General Requirements*

Section 37 of the MPRDA requires that the EMPr is compiled according to the principles of Integrated Environmental Management (IEM). These IEM principles are listed in terms of Section 2 of NEMA. They apply to all organs of State and alongside other considerations (including socio-economic considerations) and guide the administration and interpretation of environmental management legislation in South Africa. Relevant NEMA principles include the following:

- Development must be socially, environmentally and economically sustainable.
- Promotion of environmental justice and equitable access to environmental resources.
- Avoidance, minimisation and remediation of ecosystem disturbance and biodiversity loss.
- Waste must be avoided or reduced, reused and recycled.
- Participation of interested and affected parties must be promoted and their views must be taken into account.
- Specific attention must be given to sensitive, vulnerable and highly dynamic ecosystems.
- Lifecycle responsibility must be ensured.

Chapter 5 of NEMA, as amended, outlines the general objectives and implementation of Integrated Environmental Management (IEM). This provides a framework for the integration of environmental issues into the planning, design, decision-making and implementation of plans and development proposals that are likely to have a detrimental effect on the environment.

*Listed Activities*

Regulations governing the environmental authorisation process are also promulgated in terms of NEMA. In this regard, GNR 544 and GNR 545 of 18 June 2010 list activities requiring environmental authorisation from the Department of Environmental Affairs (or provincial departments).

Activity 21 of GNR 545 lists "any activity which requires an exploration right or renewal thereof as contemplated in sections 79 and 81 respectively of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)" as requiring an environmental authorisation.

However, in terms of Section 14(2) of the National Environmental Management Amendment Act No. 62 of 2008, the provisions of NEMA and

the listed activities made under NEMA relating to prospecting, mining, exploration and production will only commence 18 months after the commencement of the Mineral and Petroleum Resources Development Amendment Act, 2008 ("MPRD Amendment Act").

The MPRD Amendment Act came into force on 7 June 2013 and as such the activity listed in GNR 545 regarding the requirement for an exploration right (or renewal) will commence on 7 December 2014. As the activity has not as yet commenced, the proposed exploration activities, including the environmental aspects, are currently regulated solely by the MPRDA.

Despite the above, should any further drilling or production activities be required, Impact Africa would have to apply for authorisation in terms of the Environmental Impact Assessment (EIA) Regulations and apply for further rights in terms of the MPRDA. Furthermore, additional public consultation activities would be required in terms of both pieces of legislation (MPRDA and NEMA).

### *1.2.3 Impact Africa's Environmental Policy and Monitoring*

The operator would undertake a number of actions as required by their corporate environmental policies and procedures.

This would include appropriate monitoring during the proposed exploration activities as presented in the Implementation Plan in *Part B*. The operator would track performance against objectives and targets specified in this EMPr. The operator would appoint an Environmental Officer to undertake monitoring on an on-going basis to verify the protection of the environment and the safety of personnel and contractors. The monitoring activities would generate a list of recommended corrective actions, which would be used as a tool to document all corrective actions taken and how they were performed. In addition, the operator would conduct a performance assessment as determined by PASA.

At the conclusion of each exploration activity a close-out report would be prepared, which would include monitoring and performance assessments. This report would outline the implementation of the EMPr and Implementation Plan (*Part B*) and highlight any problems and issues that arose during the seismic survey.

### *1.2.4 Petroleum Agency South Africa Requirements*

*Background*

In 1967, the government of the Republic of South Africa granted to Soekor (Pty) Ltd (under exploration Lease OP26) the right to explore for oil and gas in the whole of the offshore region of the South African Coast (with the exception of the area under the now defunct OP8, a five nautical mile coastal

strip between Cape Town and the Wilderness). In 1994, the offshore region to approximately the 2 000 m isobath was divided into licence blocks numbered 1 to 18 for the purposes of licensing acreage for oil and gas exploration to international companies.

In 1996, the Soekor Petroleum Licensing Unit, now the Petroleum Agency of South Africa (PASA), was created with the prime function of attracting international exploration companies to prospect for offshore oil and gas. The OP26 Lease was transferred to PASA in October 2000.

*Technical Cooperation Permits (TCP) and Exploration Rights*

On 4 September 2012, the South African Government executed a 12 month Technical Cooperation Permit (TCP) with Impact Africa for the Transkei Algoa Exploration Area. As allowed by the TCP, Impact Africa applied for an Exploration Right for the same area prior to expiry of the TCP. In terms of the Exploration Right application, Impact Africa is required to submit an EMPr for the proposed exploration activities on or before 28 June 2013.

*Financial Provision and Competence*

The financial provision for the proposed exploration work programme is estimated to be USD 10.1 million, which is the estimated cost for management and/or rehabilitation of potential negative impacts that may be incurred during the proposed exploration work programme. The determination of the amount of the financial provision is set out in *Part C*. Discussions are being held with PASA regarding the method to put in place the financial provision.

*Notification Requirements*

PASA requires that prior to each survey, an Environmental Notification containing full details of the planned survey is sent to Interested and Affected Parties (I&APs) for comment and subsequent authorisation by PASA. A copy of each notification will be appended to the EMPr.

At the end of each survey an Environmental Close-Out Report will be compiled and a copy submitted to the Department of Mineral Resources (DMR) and PASA. Each Environmental Close-Out Report will be compiled in accordance with the MPRDA and associated regulations contained within GN 527 of 2004.

### *1.2.5 Exploration Right Applicant Details*

Details of the Exploration Right applicant are given below:

(a) TCP holder: Impact Africa

Effective Date of TCP: 4 September 2012

(b) Name of Operator & contact details:

**Impact Africa Limited**
Physical Address:
Griffin House
West Street
Woking, Surrey
GU21 6BS
UNITED KINGDOM
VAT : GB 113 9452 26

Postal Address:
Griffin House
West Street
Woking, Surrey
GU21 6BS
UNITED KINGDOM
VAT : GB 113 9452 26

Contact: Nicole Lomberg

Email: nlomberg@impactoilandgas.co.uk

Tel: +44 (0) 1483 750 588

(d) Name of South African manager/responsible person: See above.

## *1.3 PROPOSED ACTIVITIES*

Impact Africa's proposed 3-year work programme currently consists of the following activities:

- Airborne geophysics (gravity and magnetics) data will be acquired for identification of prospective areas of structural trap development and to address depth to basement/magnetic source
- 2D or 3D seismic data will be acquired and or licensed, processed, and interpreted.
- Surface heat flow measurements will be taken to determine thermal regime and calibrate thermal models.
- Seabottom bathymetry will be determined using a multibeam echosounder to look for hydrocarbon seepages and constrain boundary conditions.
- A seabed and water column sampling program will be carried out to identify seabed and near surface features indicative of natural hydrocarbon seepage.

It is anticipated that the exploration programme would commence with the airborne geophysics survey in 2014. It should, however, be noted that some of the phases might occur in parallel or the final order of activities may change.

The purpose of undertaking such exploration activities is to investigate the subsea geological structures to determine the presence of naturally occurring hydrocarbons (i.e. oil and gas).

No additional work is anticipated during the three year Exploration Right period.

## 1.4 DESCRIPTION OF THE EXPLORATION AREA

### 1.4.1 Location

Impact Africa Limited is proposing to undertake exploration for hydrocarbon reserves in the Transkei and Algoa Exploration Areas off the East Coast of South Africa (refer to *Figure 1.1*). The proposed Exploration Areas are located between Port Elizabeth in the Eastern Cape Province (33° 54 'S, 23° 36'E), and Ramsgate in the KwaZulu-Natal Province (30°40'S, 30°20'E). The Exploration Areas comprise license blocks 3425D, 3426C and 3426D (Algoa Exploration Area) and 3327B, 3327D, 3427B, 3328 (A-C), 3228 C and D, 3229 (A-C), 3129D, and 3130 (A-C) (Transkei Exploration Area).

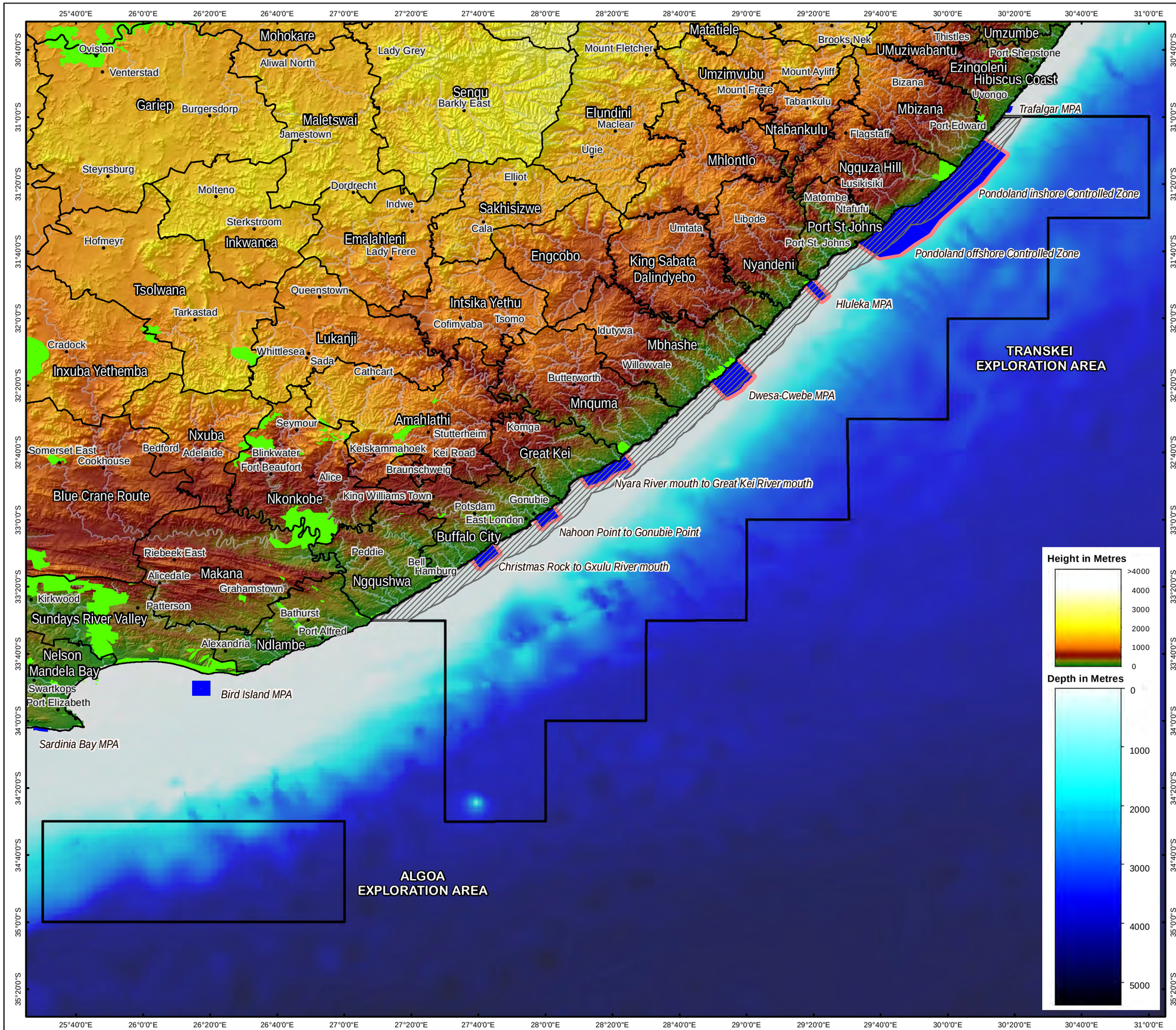
A narrow strip (approximately 5 km to 45 km wide) of the continental shelf is found along the northern extent of the Transkei Exploration Area. This shelf area broadens westwards towards the Algoa Exploration Area. The shelf drops off rapidly at the northern boundary of the Algoa Exploration Area, to depths of approximately 4,000 m.

The proposed Exploration Areas are made up of a group of whole and partial license blocks covering an area of approximately 45,838 km² which generally stretches from the shoreline to an outer range of between 100 km and 180 km offshore. Proposed exploration activities (described in *Chapter 2*) could potentially be undertaken over much of the above defined Exploration Areas.

Two thirds of the Explorations Area lies within the Agulhas (Marine) Bioregion, with the remaining north eastern portion within the Natal (Marine) Bioregion. (1) Marine Protected Areas (MPAs), declared in terms of the Marine Living Resources Act (No. 18 of 1998), that fall within the proposed Exploration Areas are the Amathole, Dwesa-Cwebe, Hluleka and Pondoland MPAs (for further details refer to *Chapter 3*).

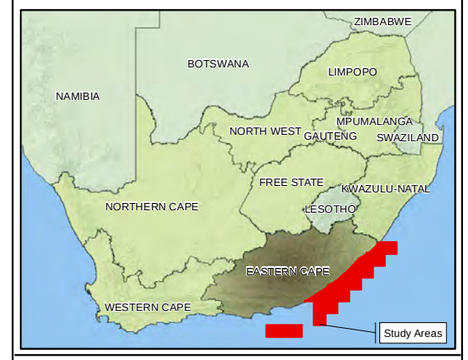
Major settlements closest to the Exploration Areas include Port Elizabeth, Port Alfred, East London, Port St Johns, Port Edward and Ramsgate.

(1) Defined by the South African National Spatial Biodiversity Assessment, Lombard *et al*. 2004




## Legend

- Towns
- Perennial Rivers
- LocalMunicipalities
- National Parks (2011)
- Marine Protected Areas (MPA)
- Areas of Interest
- 10km Coastal Seismic Buffer Zone (no airgun firing)
- 2km MPA Seismic Buffer Zone (no airgun firing)




SCALE:

0 20 40 60 80 100

Kilometres

N

TITLE:

Location of the Algoa -Transkei Exploration Area

CLIENT:

IMPACT AFRICA

| DATE: June 2013 | CHECKED: CA | PROJECT: 0194759 |
|---|---|---|
| DRAWN: AB | APPROVED: HC | SCALE: 1 : 2 000 000 |

DRAWING: Location of the Algoa-Transkei Exploration Areas Rev1.mxd

REV: 1


*ERM*
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Cape Town
Tel: +27 21 681 5400
Fax: +27 21 686 0736


ERM

Projection: Geographic , Datum: Wgs84
Source: ENPAT (2001) SANBI (2012) NGI,
British Oceanographic Data Centre (BODC) - GEBCOData
Inset Map: Esri Data and Maps

SIZE: A3

T:\Gis Projects\0194759_XOM Algoa Transkei Exploration\Mapping\MXD\Location of the Algoa-Transkei Exploration Areas Rev1.mxd

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### *1.4.2 Subsea Geology and Hydrocarbon Potential*

The primary exploration concept in this area is a hypothesized deep water sandstone play. The blocks are partially covered by 1970's-vintage, regional 2D seismic surveys (10-20 kilometre line spacing), which are located in the north-western portion of the area. No wells have been drilled in this acreage, to date. Impact Africa is currently studying the inventory of data from the area to determine the best methods for further exploration. This involves reprocessing and analysis of appropriate lines of older seismic data to develop a work programme for future exploration.

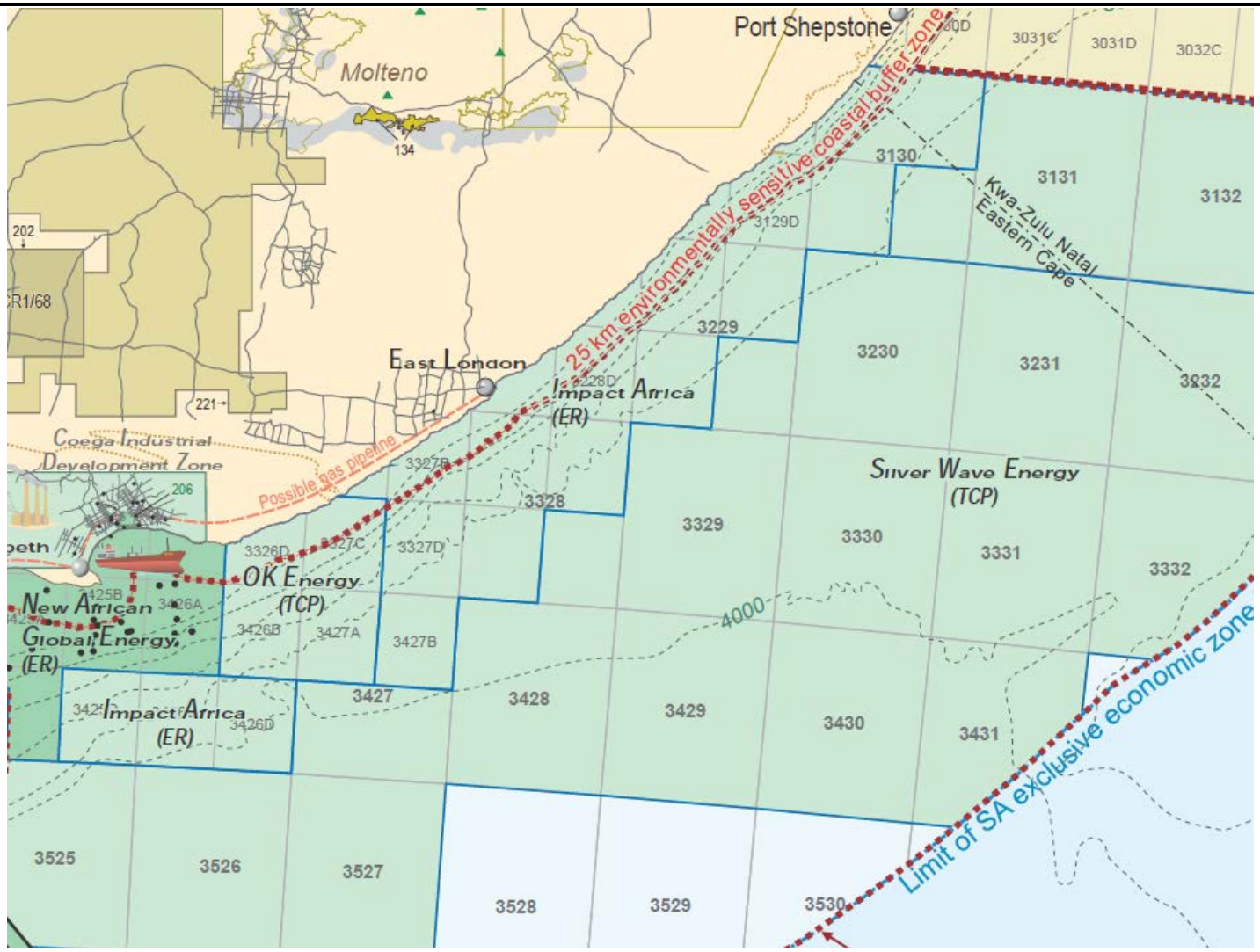
### *1.4.3 Location of Other Oil and Gas Activities*

The following is a description of other known oil and gas related activities in the proximity of the Exploration Areas. See *Figure 1.2*.

- Silver Wave Energy has a TCP for an area to the southeast, adjacent to both the Transkei and Algoa Exploration Areas.
- The northeast section of the Transkei exploration area is bordered by an area under application for an Exploration Right by Sasol Petroleum International and an ExxonMobil TCP.
- Between the Algoa and Transkei blocks is a block under TCP by OK Energy. OK Energy has recently applied for an Exploration Right
- NewAGE has recently undertaken seismic surveys within the Algoa Gamtoos block, located between the shore and the Algoa Exploration Area.
- PGS has applied for a Reconnaissance Permit to undertake a speculative seismic survey. The area under application covers the entire Transkei and Algoa Exploration Areas as well as the area further offshore.

This section covers only applications for oil and gas activities.

*Figure 1.2* *Locality map showing the delineation of other neighbouring projects*




Source: http://www.petroleumagencysa.com

## *1.5 PURPOSE AND NEED*

Exploration is carried out by international and local companies that are awarded an exploration right by the South African government. The main objective of further exploration is to investigate the subsea geological structures to determine the presence of naturally occurring hydrocarbons (i.e. oil and gas), ultimately ensuring the optimal development of the natural oil and gas resources of the Republic of South Africa.

Current interest in exploration in South Africa by experienced international exploration companies, in the face of a very competitive market for exploration acreage, indicates that the potential exists in the South African offshore for commercial oil and gas discoveries. This will be to the benefit of both the country and its people through additional government revenues, job creation, security of the supply of South Africa's oil and gas products, and contribution to economic growth.

The activities described in *Chapter 2* form an essential basis of hydrocarbon exploration campaigns and allow the petroleum industry to gain an understanding of potential sources of oil and gas.

## 1.6 STRUCTURE OF THIS EMPR

As per the Generic PASA EMPr report, this report comprises three parts, the structure and contents of which is summarised below:

*Table 1.1 Structure of this EMPr*

| Section | Chapter | Description |
|---|---|---|
| PART A | Chapter 1 | **General Information**<br>An introduction to the EMPr and background information regarding the project and the lease agreement |
| | Chapter 2 | **Project Description: Introduction**<br>Provides background and describes the proposed exploration activities |
| | Chapter 3 | **Description of the Affected Environment**<br>Describes the current baseline conditions of the potentially affected environment |
| | Chapter 4 | **Consultation with Interested and Affected Parties**<br>An overview of the consultation process followed in the development of the EMPr |
| | Chapter 5 | **Socio-economic Assessment**<br>Provides an overview and brief assessment of the socio-economic impacts associated with the project |
| | Chapter 6 | **Environmental Assessment**<br>Provides an overview and brief assessment of the Environmental impacts associated with the project |
| | Chapter 7 | **Conclusion**<br>Provides a conclusion of the EMPr |
| | Chapter 8 | **References**<br>Provides a list of references |
| PART B | Implementation Plan | **Implementation Plan**<br>A framework tool for the implementation of the mitigation measures during the seismic survey |
| PART C | Supporting Documentation | **Supporting Documentation**<br>Contains supporting and administrative documentation |

# 2 DESCRIPTION OF THE PROPOSED ACTIVITIES

## 2.1 OVERVIEW

In the application for an Exploration Right, Impact Africa Limited is proposing a three-year exploration programme. The proposed exploration programme would be conducted in phases. Some of the phases might occur in parallel or the final order of phases and activities may change.

The proposed exploration programme is currently envisaged to include the following activities:

- Airborne geophysics survey using a fixed wing aircraft to identify geological structural trends and prospective areas of structural trap development and to address depth to basement/magnetic sources.
- Acquisition and or licensing, processing and interpretation of 2D and/or 3D seismic data.
- Measurement of surface heat flow to determine thermal regime and calibrate thermal models.
- Determination of seabottom bathymetry using a multibeam echosounder to look for hydrocarbon seepages and constrain boundary conditions.
- Sampling and analysis of the seabed and water column to identify seabed and near surface features indicative of natural hydrocarbon seepage.

The proposed exploration programme would likely commence with airborne geophysics acquisition in 2014. Thereafter the integrated water column analysis and seabed sampling programme would be undertaken in order to identify seabed features that are indicative of natural hydrocarbon seepage and to sample sediments and associated hydrocarbons at and just below the seabed. Based on the findings of the seabed sampling programme target areas would be identified for seismic data acquisition.

These activities are discussed in more detailed in the following Sections.

## 2.2 AIRBORNE GEOPHYSICS PROGRAMME INCLUDING GRAVITY GRADIOMETRY

Impact Africa proposes to acquire airborne high-resolution gravity gradiometry data, as well as gravity and magnetic data covering all or parts of the Exploration Areas up to 45,838 km$^2$. Acquisition of these data sets and integration of the airborne geophysical data with well data, and other geologic and geophysical data sets, will support future seismic acquisition planning

programmes, as well as support integrated seismic interpretation efforts, exploration concepts and exploration strategies.

Acquisition would be accomplished using a fixed wing aircraft. To obtain data and resolution to the proper quality, the survey design would likely include relatively low flight altitudes (typically at a 120 m terrain or sea level clearance) and relatively close line spacing of generally less than 1 km parallel spaced lines, typically oriented at right angles to the main geological structure orientation.

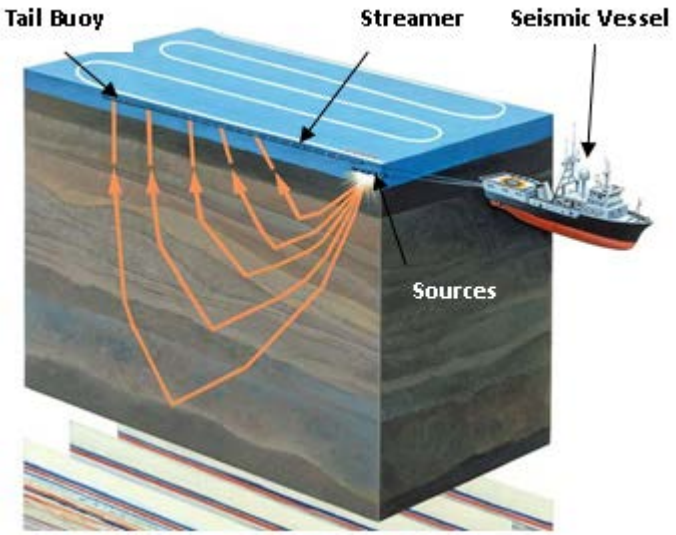
Impact Africa proposes to acquire airborne gravity and magnetic data covering all or parts of the Transkei Algoa Exploration Area with a minimum of 7,500 km$^2$, which in that case would take in the conservative order of 60 days. If data were to be acquired over the entire Transkei Algoa Exploration Area then this would take in the order of 180 days to complete. Acquisition of these data sets and integration of the airborne geophysical data with well data, and other geologic and geophysical data sets, would provide support for future seismic acquisition planning programmes, as well as support integrated seismic interpretation efforts, exploration concepts and exploration strategies.

## *2.3 SEISMIC SURVEY*

### *2.3.1 Overview*

Seismic surveys are carried out in the investigation of sub-sea geological formations during marine oil and gas prospecting. During the seismic surveys high level, low frequency acoustics are directed towards the seabed from near-surface acoustic sources that are towed by a seismic vessel. Signals reflected from geological interfaces below the sea floor are recorded by multiple receivers (or hydrophones) towed in a single or multiple streamer (see *Figure 2.1*). Analyses of the returned signals allow for interpretation of sub-sea geological formations.

*Figure 2.1 Illustration of the Principles of Offshore Seismic Acquisition Surveys*




Source: ERM, 2006

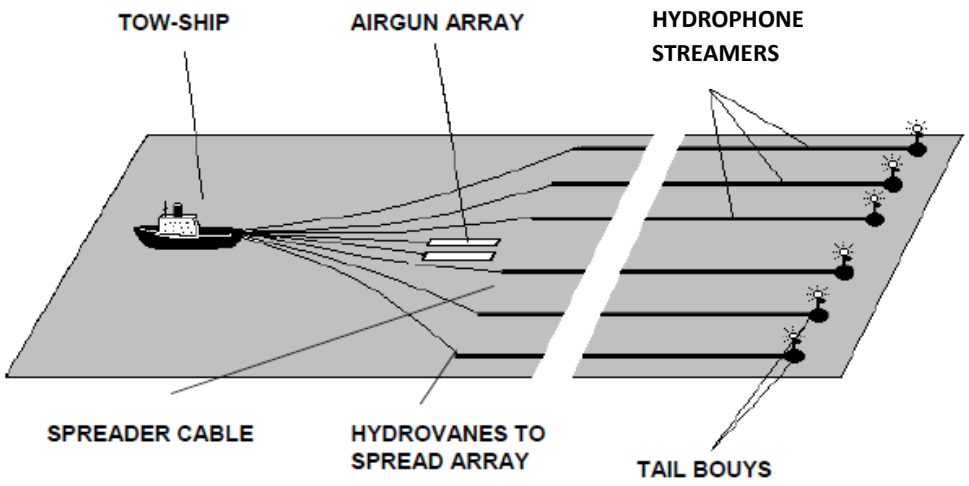
### 2.3.2 2D and 3D Seismic Surveys

Seismic surveys are undertaken to collect either two-dimensional (2D) or three-dimensional (3D) data. The 2D surveys provide a vertical slice through the earth's crust along the survey trackline. 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. 2D surveys are typically applied to obtain regional data from widely spaced survey grids (tens of kilometres). Infill 2D surveys on closer grids (down to 1 km spacing) are applied to provide more detail over specific areas of interest such as potentially drillable petroleum prospects. For a 2D survey the entire seismic array from the tow-ship to the end of the streamer may be up to 12 000 m or more in length.

Advances in position-fixing of the vessel and streamer tail buoys as well as computer processing and display has allowed 3D data sets to be obtained. A typical 3D seismic survey configuration is illustrated in *Figure 2.2* and comprises three components:

- a towed airgun array;
- up to 12 or more lines of hydrophones spaced 5 to 10 m apart (*Figure 2.2*) and between 3 m and 25 m below the water surface. The array can be upwards of 12 000 m long and 1 200 m wide;
- a control and recording system co-ordinating the firing of shots, the recording of returned signals and accurate position fixing.

*Figure 2.2 The Configuration of a Typical 3D Seismic Survey Operation*




Source: CCA, 2001

The data is gathered as a 3D data set, which can be processed and displayed in a variety of ways. The 3D surveys are typically applied to promising petroleum prospects to assist in fault line interpretation, distribution of sand bodies, estimates of oil and gas in place, and the location of exploration wells.

As data acquisition requires that the position of the survey vessel and the array be accurately known, seismic surveys utilise accurate navigation of the sound source over pre-determined survey transects. As a result, the array and the hydrophone streamers need to be towed in a set configuration behind the seismic vessel, means that the survey operation has limited manoeuvrability while operating, and is unable to deviate from the planned seismic lines. Ship tracks in a 3D survey are typically up to 1200 m apart because of the wide turning circle (~ 6 km) of the vessel and its streamer dimensions.

### *2.3.3 Seismic Vessel and Equipment*

A seismic vessel travels along transects of a prescribed grid that is carefully chosen to cross any known or suspected geological structure in the area. The acoustic source is fired at approximately 6-20 second intervals. The sound waves are reflected by boundaries between sediments of different densities and velocities and returned signals are computer processed after being recorded by the hydrophone streamers. During surveying vessels travel at a speed of four to six knots.

The seismic survey would involve a towed airgun array, which provides the seismic source energy for the profiling process, and a seismic wave detector system, usually known as a hydrophone streamer (see *Figure 2.3*). 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 3 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 are illustrated in *Figure 2.7* below.

***Figure 2.3 Seismic Vessel Conducting a 3D Seismic Survey***



### *2.3.4 Sound Sources*

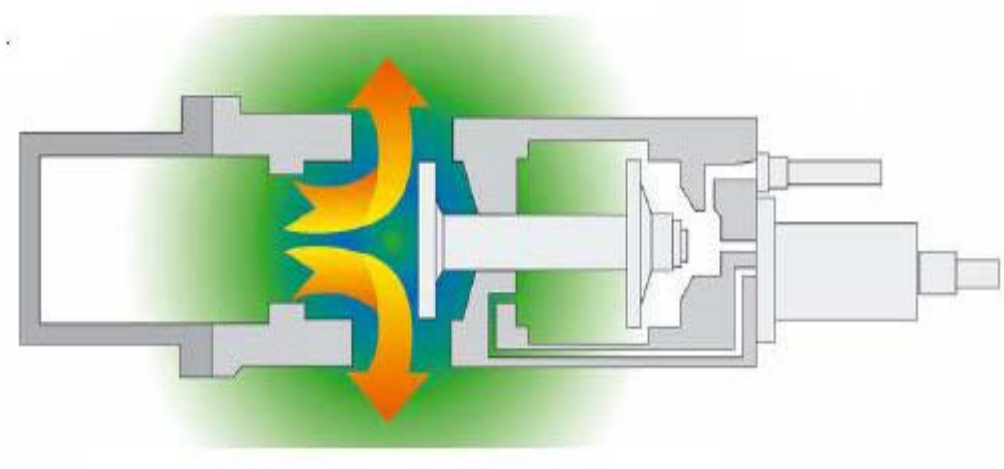
Sound sources (commonly referred to as 'airguns') are underwater pneumatic devices from which high-pressure air is released suddenly into the surrounding water (see *Figure 2.4*). On release of pressure the resulting bubble pulsates rapidly producing an acoustic signal that is proportional to the rate of change of the volume of the bubble. The acoustic signal propagates through the water and the subsurface and reflections are transmitted back to the surface. The sound source must be submerged in the water, typically at a depth of 5 to 25 m.

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 of airguns

(usually comprised of between 12 and 70 airguns in total) and are normally towed between 50 m and 100 m behind the seismic vessel (refer to $S_1$ & $S_2$ in *Figure* 2.5). The airgun would be fired at approximately 10 to 20 second intervals at an operating pressure of between 2,000 to 2,500 psi and a volume of 3,000 to 5,000 cubic inches. Such airgun source arrays would be expected to produce sound levels of around 220 dB re 1 µPa2 m. However, based on analogue sound sources, sound levels for the seismic survey can theoretically be expected to attenuate below 160 dB at distances of less than approximately 1325 m from the source array.

The frequency of the signal depends on the energy of the compressed air prior to discharge. The majority of energy produced is in the 0 - 120 Hz bandwidth, although energy at much higher frequencies is also recorded. High-resolution surveys and shallow penetration surveys require relatively high frequencies of 100-1000 Hz, while the optimum wavelength for deep seismic work is in the 10-80 Hz range.

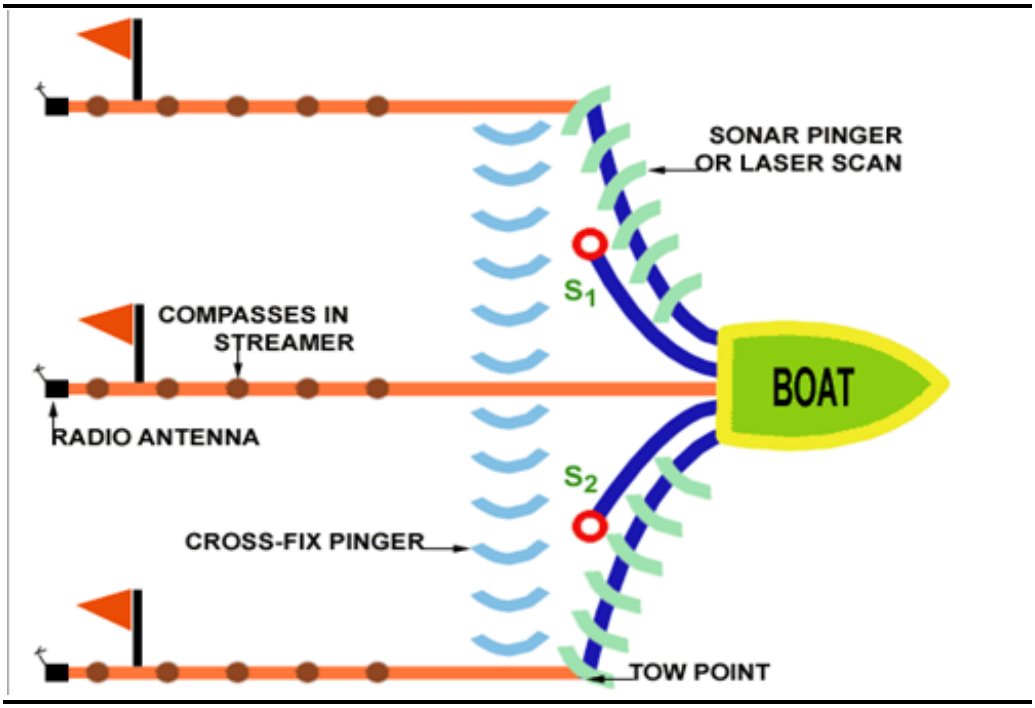
***Figure 2.4 A Typical Marine Airgun***



Source: OGP/IAGC 2002

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. Although the peak levels during the shot may be high the overall energy is limited by the duration of the shot.

*Figure 2.5 Diagram Representing 3D Seismic Survey Layout*



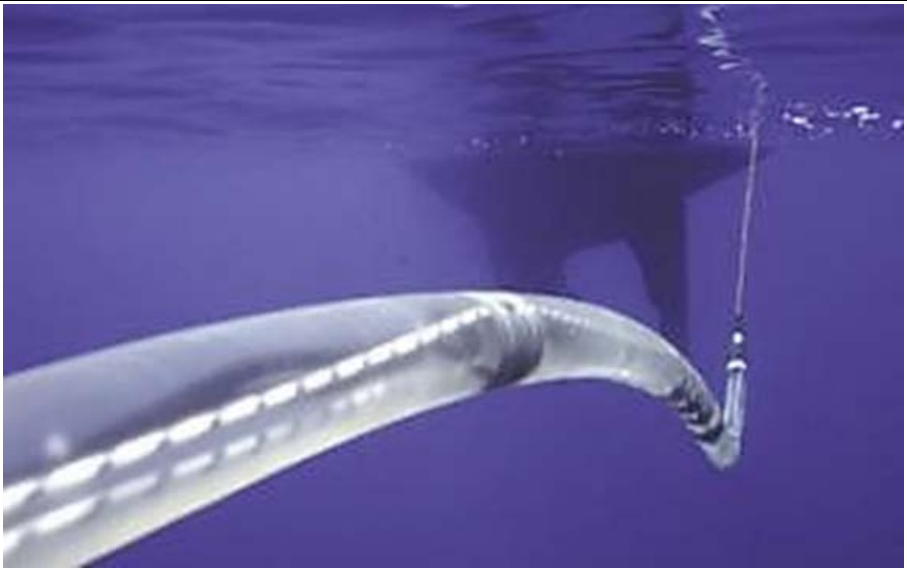

Source: ERM, 2006

### 2.3.5 *Recording Equipment*

Signals reflected from geological boundaries below the sea floor are recorded by hydrophones mounted inside streamer cables. Hydrophones are typically made from piezoelectric material encased in a plastic hose. This hose containing the hydrophones is called a streamer. A typical marine streamer containing hydrophones is illustrated in *Figure 2.6*. 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.

The length of streamers can range from 2 000 m to 12 000 m or more. A 2D survey involves only one length of streamer towed behind the vessel, while 3D surveys typically involve an array of up to 12 streamers, spaced 50 m to 100 m apart.

*Figure 2.6 A Typical Marine Streamer Containing Hydrophones*



Source: ERM, 2006

### *2.3.6 Exclusion Zone*

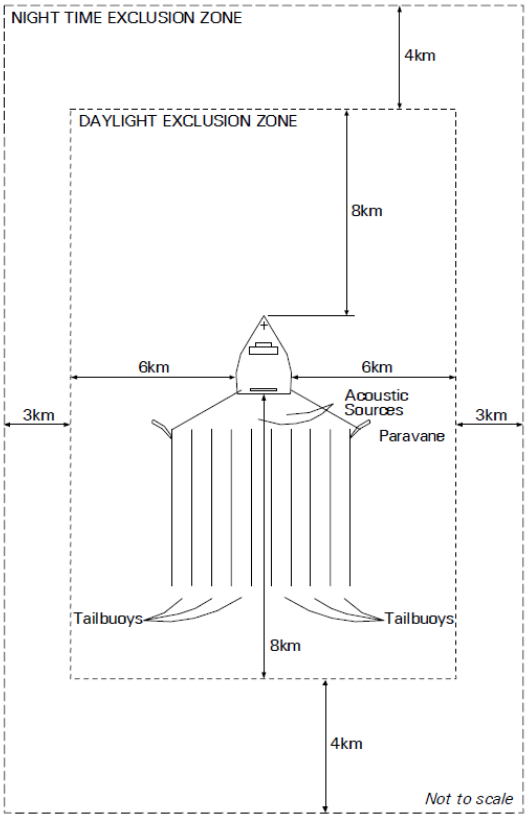
Under the International Maritime Organization (IMO) Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), a seismic survey vessel that is engaged in surveying is defined as a 'vessel restricted in its ability to manoeuvre' which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. Vessels engaged in fishing shall, so far as possible, keep out of the way of the seismic survey operation. As such, it is protected by a 500 m safety zone and it is an offence for unauthorised vessel to enter the safety zone. In addition to a statutory 500 m safety zone, a seismic contractor will 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 2.7*.

Under the South Africa Marine Traffic Act, 1981 (No. 2 of 1981), a seismic survey vessel and its array of airguns and hydrophones fall under the definition of an "offshore installation" and as such it is protected by a 500 m safety buffer zone. It is an offence for an unauthorised vessel to enter the safety zone. In addition to the statutory limit, the seismic vessel would also request an additional safety buffer zone during operations of typically 8 km fore and aft of the vessel and 6 km abeam during daylight and 12 km fore and aft and 9 km abeam during the night.

For semi-industrial, industrial and recreational fishers and other related activities, the operator will communicate the seismic survey journey plan and exclusion areas well in advance so that the appropriate planning can be done. The operator will develop a communication plan which will include

communications with all major fishing stakeholders and other relevant players. Notices to mariners will be communicated through the proper channels and the operator will inform the harbour/ port masters at Cape Town, Port Elizabeth, Ngqura, Mossel Bay, Durban and Richards Bay of the exclusion zone.

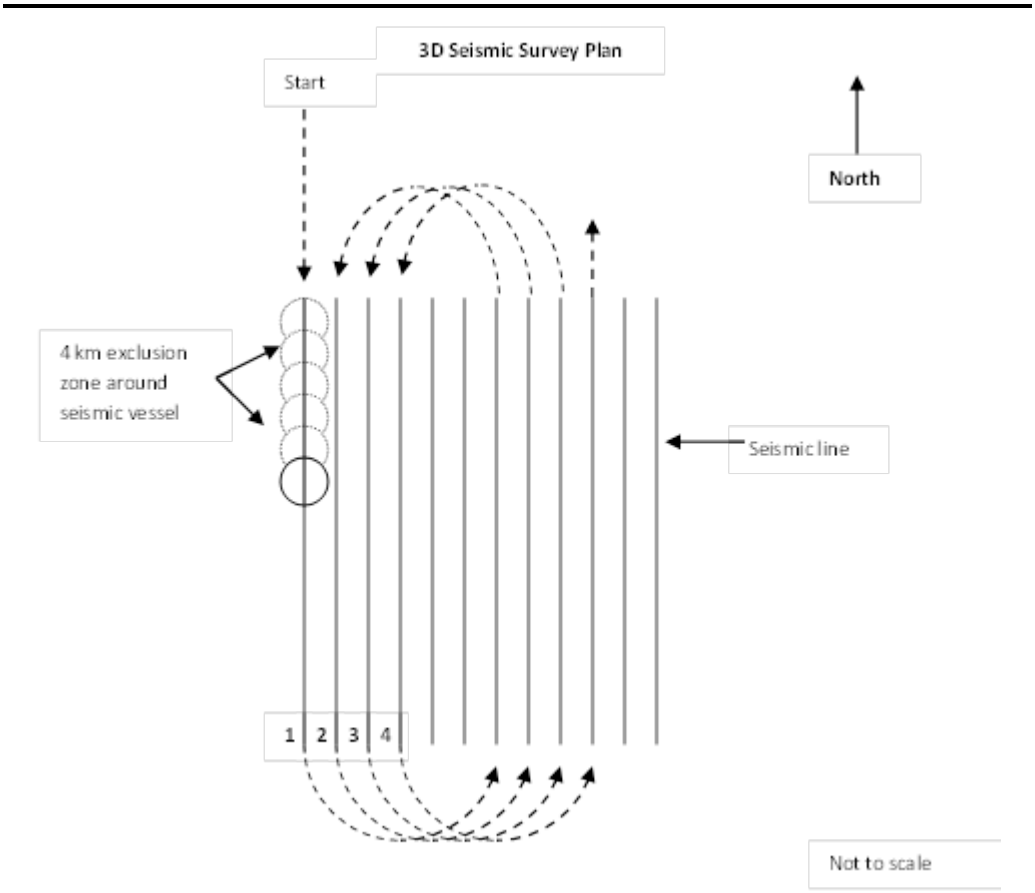
*Figure 2.7 Safe Operational Limit around a 3D Seismic Survey Array*




Source: CCA, 2001

The 3D survey may deploy up to 12 streamers or more, where an overlap in seismic lines is required. The seismic vessel may therefore need to systematically turn and acquire the lines in the form of a spiral. As a result of the level of coverage and overlap required during the 3D survey, it is likely that the exclusion time for all users of this area will be significantly greater than for the 2D survey (refer to *Figure 2.8*).

*Figure 2.8 Schematic Illustrating the Movement of a 3D Seismic Vessel*




Source: ERM, 2006

### 2.3.7 *Specifics of the Seismic Survey Programme*

*Overview*

For this investigation Impact Africa is proposing to undertake acquisition of a 2D seismic survey. However, if it is determined by on-going analysis of existing data as well as data collected through proposed surveys, that acquisition of a seismic dataset utilising 3D seismic techniques might be a more advantageous approach for data collection, then a 3D seismic survey might be substituted for the 2D survey or may be done in addition to the 2D seismic survey.

The proposed 2D seismic survey would be approximately 5,000 km of seismic survey lines in length comprising a number of low density spaced survey lines over the Exploration Areas. In terms of timing, although survey commencement would ultimately depend on date of Exploration Right approval, availability of seismic contractors and other factors, it is anticipated that the survey would be undertaken during the summer of 2014/2015 and would take approximately 150 days to complete.

Specific details of the seismic survey would be developed based on the results of other studies and following selection of a seismic survey contractor and survey vessel. The specific details of the survey will be submitted to PASA through a formal Environmental Notification.

*Appointment of Seismic Contractor*

Specific seismic survey projects that are undertaken after the submission of the EMPr will be recorded as Environmental Notifications appended to the EMPr documentation. Details of the actual operation will be included in the Environmental Notifications for these projects.

The seismic contractor for this survey has not yet been appointed. The operator will only appoint seismic acquisition contractors that are members of the International Association of Geophysical Contractors (IAGC) which requires that members adhere to a strict code of environmental conduct associated with the following guidelines:

- Environmental Management in Oil & Gas Exploration & Production. 254 May 1997;
- Guidelines for Waste Management 413 Sep 2008;
- Environmental Manual for Worldwide Geophysical Operations. PDF format only IAGC 2001; and
- Guidelines for HSE Auditing in the Geophysical Industry. Report 6.53/245 September 1996.

At this stage no specific contractor or vessel has been contracted for the proposed survey and thus specific details of the seismic survey will only be set when the operator has engaged the contractor. The specifics of the survey will be detailed in an Environmental Notification that will be submitted to PASA for acceptance. The Environmental Notification will provide the following details:

- Survey location and journey management plan;
- Survey schedule and duration;
- Vessel specifications;
- Certification of contractor and vessel compliance;
- Environmental, health and safety plan (including Emergency Response Plan); and
- Relevant insurances.

*Employment and Vessel Supplies*

Any additional labour for the survey will be employed through the seismic acquisition contractor. The size and nature of the crew will depend on the size of the vessel, and is expected to consist of between 35 and 50 people on-board at any one time. Highly skilled and experienced crew and seismic operators are required for the seismic operations. Given the specific technical and experience requirements the crew is likely to consist of international specialists of various nationalities. On-board marine mammal observers (MMOs) as well as some unskilled and semi-skilled workers should be sourced from South Africa where reasonably possible.

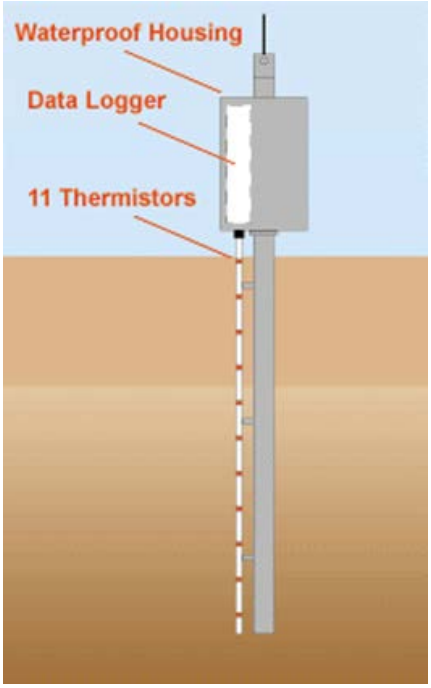
Vessel supplies, including food and water will likely be loaded at either of the Ports at Cape Town, Durban, or Port Elizabeth. The operator will inspect the seismic vessel before the start of the seismic acquisition activities. Fuel and lubricants used during the seismic acquisition period will likely be purchased at Cape Town, Durban, or Port Elizabeth.

Bunkering of the seismic survey vessel is anticipated to be undertaken at the Port of Cape Town, Durban, or Port Elizabeth but refuelling while at sea would be also considered.

## 2.4 *SURFACE HEAT FLOW MEASUREMENTS, SEABED AND WATER COLUMN SAMPLING PROGRAMME*

The heat flow measurements would be conducted using heat flow probes, which would measure both the temperature and thermal conductivity of sediments *in situ* up to 12 m below the seabed. The measurement probe typically consists of a 6 cm diameter solid alloy steel bar, which extends from the wire termination at the top through the 500 kg lead-fill weight stand, down to the tip of the heat flow probe. The out-rigged thermistor string is attached parallel to the steel bar. The measurement device would be dropped from a vessel into the seabed, allowed to equilibrate and then recovered to the surface. No samples or other materials would be recovered with the heat flow probe. Acquisition of this data would be used to determine the thermal regime and calibrate thermal models to understand hydrocarbon system potential.

*Figure 2.9 Example of Heat Flow Probe*




Source: XOM, 2013 Heat flow probe (http://www.tdi-bi.com/field_services/hf_info/description.htm).

It is anticipated that up to 50 measurements may be collected across the Exploration Areas, which would take in the order of 60 days to complete.

The water column samples may be measured or samples may be taken for analysis such as naturally occurring hydrocarbon, heavy and trace metal analysis. Additionally a Conductivity, Temperature, Depth (CTD) profiler may be deployed to measure additional parameters such as salinity, temperature, dissolved oxygen and turbidity. An estimated number of water sample stations has yet to be determined, however, for each station it is expected that three water depths will be sampled, including:

- near surface (~1 m below surface);
- mid-water; and
- near bottom.

Mid-water samples will likely be taken approximately 10 m below a measureable (distinct) thermocline. The depth of the thermocline will be determined using a single deployment of the CTD profiler. If a distinct thermocline does not exist, or cannot be established, the mid-water sample-will be taken at a depth that is nominally half-way between the water's surface and the seabed.

Although specific water sampling equipment selections are yet to be made, there are many discrete water sampling devices available. Niskin™ and Go-

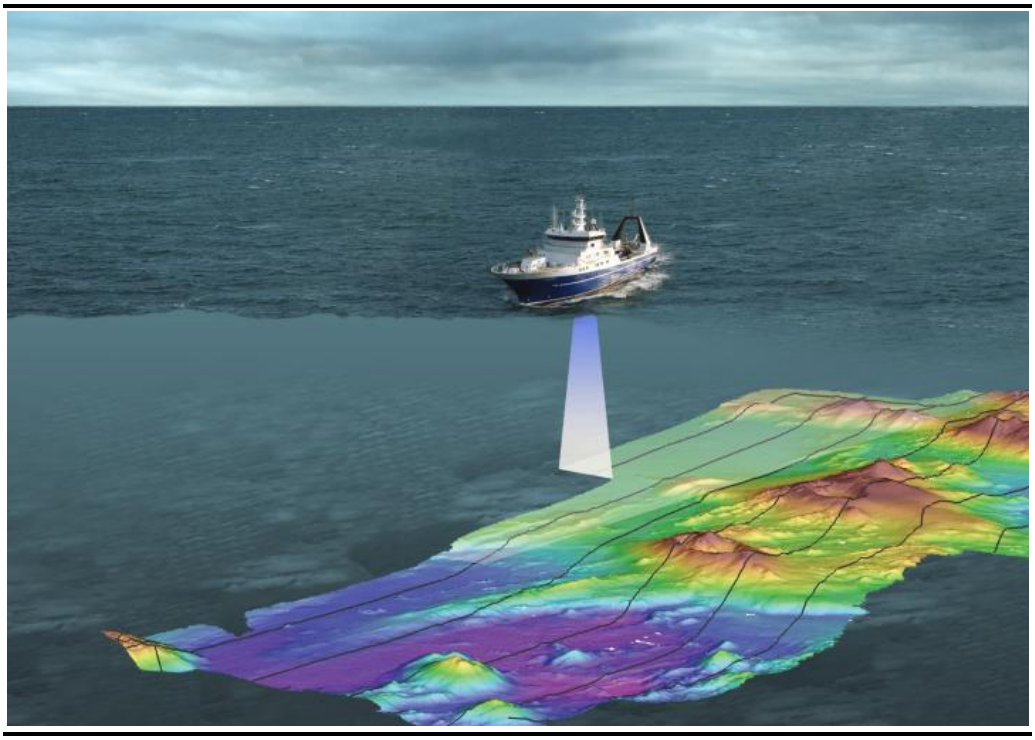
Flo™ are examples of commonly available discrete samplers suitable for water column sampling and can be deployed singularly, in chains separated at pre-defined depth intervals, or attached to intelligent depth actuated clusters (rosettes).

## 2.5 *MULTI-BEAM ECHO SOUNDER AND SUB-BOTTOM PROFILE PROGRAMME (SONAR TECHNIQUES)*

The multi-beam bathymetry survey would be undertaken over the majority of the Exploration Areas. This system produces a digital terrain model of the seafloor (refer to *Figure 2.10*).

A marine survey vessel would be equipped with a multi-beam echo sounder to obtain swath bathymetry and a sub-bottom profiler to image the seabed and the near surface geology. The multi-beam system provides depth sounding information on either side of the vessel's track across a swath width of approximately two times the water depth. The multi-beam echo sounder emits a fan of acoustic beams from a transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1µPa at 1m. The sub-bottom profiler emits an acoustic pulse from a transducer at frequencies ranging from 3 kHz to 40 kHz and typically produces sound levels in the order of 206 db re 1µPa at 1m. The operating frequencies of the acoustic equipment used in sonar surveys typically fall into the high frequency kHz range.

***Figure 2.10 The multibeam system uses a fan of sound beams to construct a 3-D picture of the seafloor.***



Source: http://www.niwa.co.nz/our-science/oceans/common-questions/all/seafloor-mapping

The bathymetric data alone is not sufficient to identify all possible hydrocarbon seeps, as many seeps have no bathymetric expression. Backscatter data is typically collected concurrently by multi-beam echosounders as it can measure several properties of the seafloor associated with hydrocarbon seeps including; hardness; roughness; and volumetric heterogeneity. One or more of these three properties can result in an increase in backscatter intensity recorded by the multi-beam system and aid in the identification of potential natural hydrocarbon seeps on the seafloor in the survey area.

The data acquired by these sonar techniques will be used to identify, prioritise, and target potential piston coring and heat-flow measurement locations. Selected sites could then be sampled with navigated piston cores.

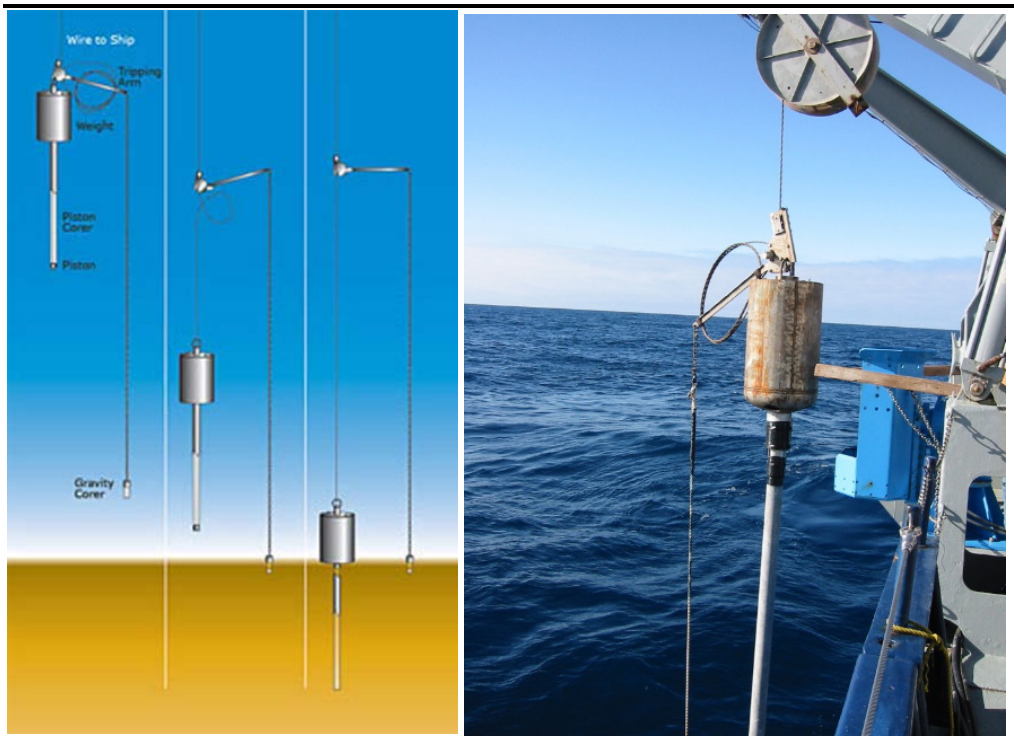
It is anticipated that data acquisition would take in the order of 150 days to complete assuming a vessel speed of 5 knots.

## *2.6 SEDIMENT CORING PROGRAMME*

The Sediment Coring Programme would include piston coring in order to sample for natural hydrocarbon seepage. A piston corer would be used to collect seabed samples.

Piston coring is one of the more common methods used to collect seabed samples for geochemical analysis (*Figure 2.11*). The piston coring operation is carried out (*Figure 2.12*) by winching the tool over the side of the vessel and lowering the corer to just above the seabed (A). As the trigger weight hits the bottom (B), it releases the weight on the trigger arm and the trigger arm begins to rise. Once the trigger arm has risen through its full 1.2 m of travel (C), the corer is released to free-fall the 3 m distance to the bottom, forcing the core barrel to travel down over the piston into the sediment. When the corer hits the end of its 3 m slack loop, the piston starts up the core barrel (D) creating suction below the piston, and expelling the water out the top of the corer. When forward momentum of the core has stopped, a slow pullout on the winch is begun. The suction created by the core sample in the liner prevents movement of the piston to the top of the core barrel in response to tension on the core wire. This suction triggers the separation of the top and bottom sections of the piston (E). The bottom half of the piston remains in place over the sediment to maintain integrity of the sample, while the top half (attached to the coring wire) "fetches up" against the stop in the core head, allowing the corer to be pulled out of the sediment. The entire assembly, including the sample, is retrieved onboard the vessel.

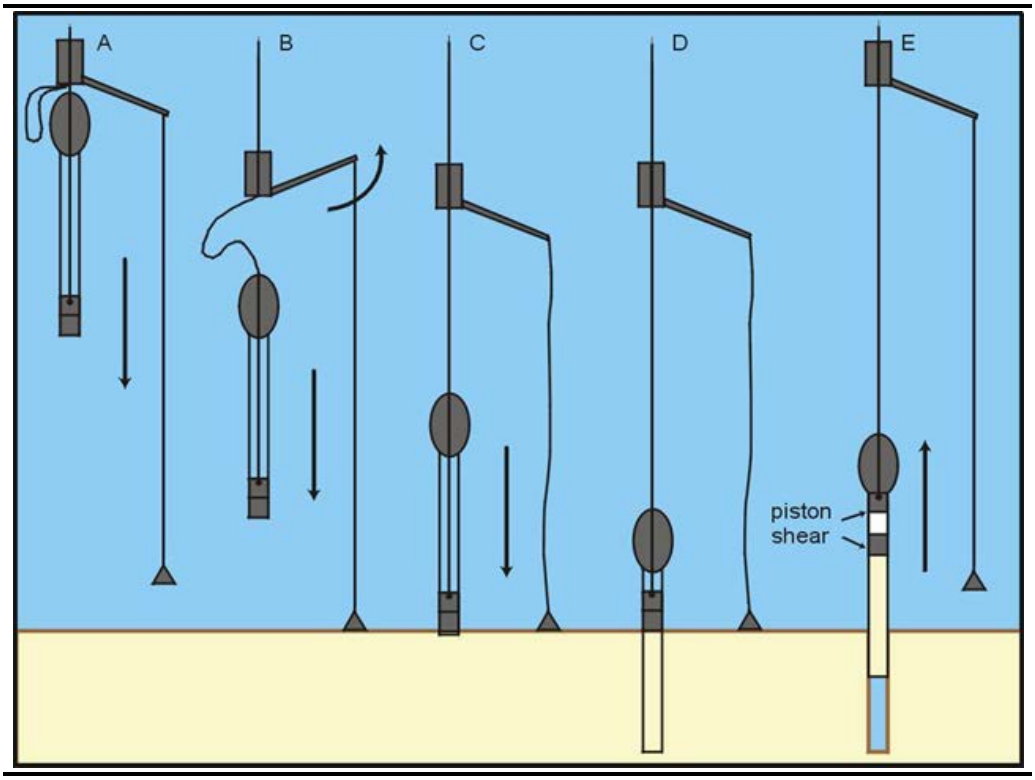
*Figure 2.11 Example of a Piston Corer*




Source: //www.whoi.edu/cms/images/instruments/2005/12/pistoncorer_n_17289.jpg and http://nsm1.nsm.iup.edu/hovan/research/splat/SPLAT-Images/20.jpg

The recovered cores are visually examined at the surface for indications of hydrocarbons (gas hydrate, gas parting, or oil staining) and three sets of sub-samples are retained for further geochemical analysis in a laboratory. Any material having geologic or environmental interest would be preserved for further study. The remaining sediment would be returned to the seabed.

*Figure 2.12 Diagram Illustrating a Piston Core Operation at the Seabed*




Source: TDI-Brooks

It is anticipated that up to 50 core samples would be collected across the Exploration Areas. Each individual core would have a disturbance area and volume of 0.01 $m^2$ and 0.07 $m^3$, respectively, resulting in a total disturbance area and volume of approximately 0.39 $m^2$ and 3.53 $m^3$, respectively. The number of cores samples and the exact location would be identified following the analysis of the multi-beam bathymetric survey results.

It is anticipated that the initial seabed sampling programme would take in the order of 120 days to complete.

## 2.7 SUPPORT OPERATIONS

*Seismic Survey*

While seismic survey tracks are planned (where possible) to avoid submerged obstacles such as fishing gear, once on track a seismic survey vessel towing streamers is unable to easily change course to avoid smaller, more transient obstacles such as fishing gear/ fish traps and boats. Therefore, support vessels in the form of a 'sweeper vessel' and chase boat will accompany the seismic vessel. The 'sweeper vessel' will travel ahead of the seismic vessel removing fishing gear and other obstacles from the path of the vessel, or liaising with fishing operators to do so. The chase boat would be equipped with radar and communications systems to patrol the area during the survey

so that other vessels adhere to the safety buffer operational limits. The chase boat would assist in alerting other vessels (e.g. fishing, transport, etc.) about the survey and the lack of manoeuvrability of the survey vessel. The chase boat would also provide logistics support to the survey vessel. In addition, helicopters may be utilised for crew/supply transfers from the seismic and support vessels.

## 2.8 NOISE, WASTE EMISSIONS AND DISCHARGES

*Atmospheric Emissions*

Air emissions would be generated by combustion of diesel fuel to power the exploration survey vessels and aircraft. The air emissions from the survey and support vessels would be no greater than that from any other vessel of a similar tonnage.

Depending on how the vessel contracted for the survey is fitted, certain types of non-hazardous waste may be incinerated on-board the vessel. The incineration of any waste on-board would release soot as well as minor amounts of air pollutants (CO, $CO_2$). If the vessel does not have an incinerator on-board waste would be transported to shore for disposal.

*Discharges to the Sea*

All survey vessels will comply with international agreed standards regulated under MARPOL 73/78, as well as the South African Marine Pollution Act (Act 2 of 1986 -which incorporate MARPOL 73/78 standards) and the Dumping at Sea Control Act. The International Association of Geophysical Contractors have a 'no dumping at sea' policy.

*Noise Emissions*

The noise emissions from survey vessels and aircraft above the surface of the sea would be no greater than that from any other vessel of a similar size.

# 3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

## 3.1 INTRODUCTION

This *Chapter* describes the existing biophysical and socioeconomic baseline conditions of the Transkei and Algoa Exploration Areas and surroundings. This provides the basis from which the potential impacts are predicted.

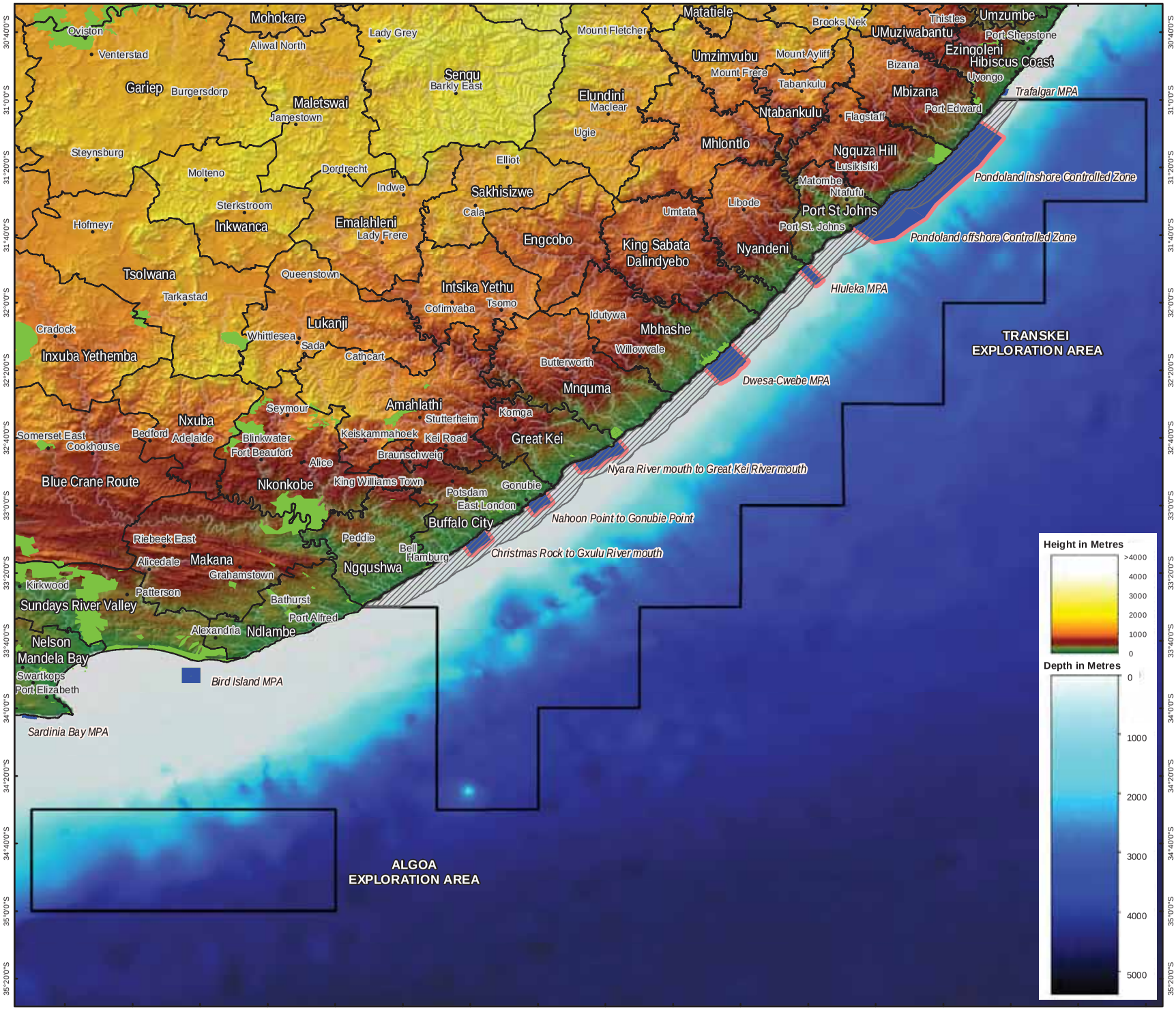
Information is provided for the East Coast which for the purposes of this report extends from Cape Padrone (33° 45'S, 26° 30' E) to the Mozambique Border at Ponta do Ouro (26° 40'S, 32° 52' E). The Exploration Areas are predominantly located in the southern portion of the East Coast, with the Transkei Exploration Area located directly adjacent to the coast and the Algoa Exploration Area further offshore.

Much of the information contained within this Chapter is based on the *Generic EMPr for Oil and Gas Prospecting off the Coast of South Africa* (CCA and CMS 2001). This information was supplemented by specialist studies of marine fauna (Pisces Environmental Services (Pty) Ltd, 2013), marine heritage (African Centre for Heritage Activities, 2013) and fisheries (CapFish SA (Pty) Ltd, 2013). Please refer to *Part C* for complete versions of each of the respective specialist reports.

## 3.2 GENERAL LOCATION

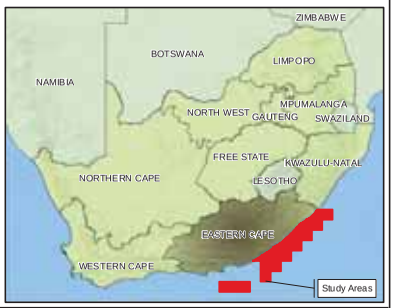
The proposed Exploration Areas are located between Port Elizabeth in the Eastern Cape Province (33° 54 'S, 23° 36'E), and Ramsgate in the KwaZulu-Natal Province (30°40'S, 30°20'E) (refer to *Figure 3.1*). The Transkei Exploration Area extends along a narrow strip of the continental shelf to a maximum distance of approximately 135 km off the Eastern Cape coastline (*Figure 3.1*). The Algoa Exploration Area is located further offshore immediately south of the continental shelf, approximately 100 km from the Port Elizabeth shoreline.

The proposed Exploration Areas cover an area of approximately 45,838 km². The proposed exploration activities (described in *Chapter 2*) may be undertaken over much of Exploration Areas.




## Legend

- Towns
- Perennial Rivers
- LocalMunicipalities
- National Parks (2011)
- Marine Protected Areas (MPA)
- Areas of Interest
- 10km Coastal Seismic Buffer Zone (no airgun firing)
- 2km MPA Seismic Buffer Zone (no airgun firing)




SCALE:

0 20 40 60 80 100

Kilometres

TITLE:

Location of the Algoa -Transkei Exploration Area

CLIENT:

IMPACT AFRICA

| | | |
|---|---|---|
| DATE: June 2013 | CHECKED: CA | PROJECT: 0194759 |
| DRAWN: AB | APPROVED: HC | SCALE: 1 : 2 000 000 |

DRAWING: Location of the Algoa-Transkei Exploration Areas Rev1.mxd

REV: 1


ERM
2nd Floor, The Great Westerford
240 Main Road
Ronderbosch, 7725
Cape Town
Tel: +27 21 681 5400
Fax: +27 21 686 0736


Projection: Geographic , Datum: Wgs84
Source: ENPAT (2001) SANBI (2012) NGI, British Oceanographic Data Centre (BODC) - GEBCOData
Inset Map: Esri Data and Maps

SIZE: A3

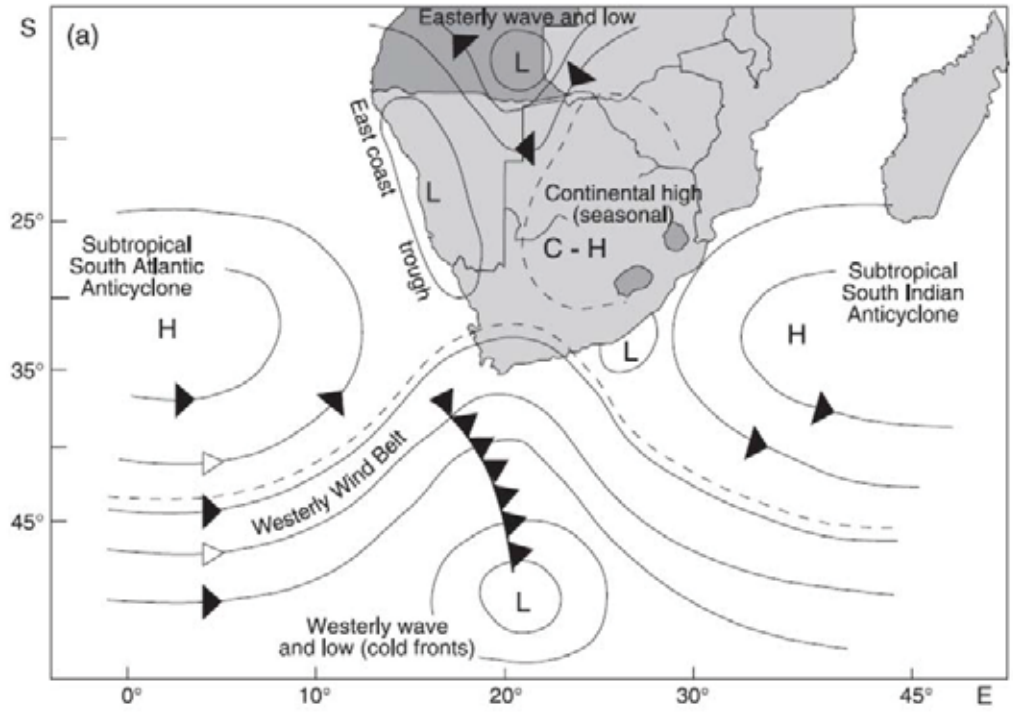
T:\Gis Projects\0194759_XOM Algoa Transkei Exploration\Mapping\MXD\Location of the Algoa-Transkei Exploration Areas Rev1.mxd

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## 3.3 METEOROLOGY

Weather patterns along the southern portion of the East Coast (Cape Padrone to southern KwaZulu-Natal) are affected by both mid-latitude cyclones developing in the westerly wind belt, and South Atlantic and Indian Ocean anticyclone cells (Schumann, 1998) (*Figure 3.2*). Eastward travelling mid-latitude cyclones, and associated coastal low pressure systems, are prevalent throughout the year, although north-easterly winds increase during the South African summer (Schumann, 1998). Conversely, berg winds tend to occur during the winter months (Wiseman *et al*., 1993). Land and sea breezes are common and occur along the southern section of the East Coast although they vary seasonally (Schumann *et al*., 1991). The climate off the East Coast is also affected by other less regular weather patterns such as low pressure cells that may remain to the northeast of Durban for several days; cut-off low pressure cells; and tropical cyclones during summer and autumn (Hunter, 1988; Schumann, 1998).

***Figure 3.2 Main Weather Systems Associated with Southern Africa***




Source: Roberts, 2005

Basic weather patterns along the East Coast are linked to the eastward movement of coastal low pressures that form on the West Coast during pre-frontal conditions (Hunter, 1988). These coastal low pressure systems are typically around 100 km wide and travel in an anti-clockwise path along the South African coast at a speed of between 6-30 m/sec (Jury *et al*., 1990; Schumann, 1998). Moving at this speed they can traverse the east coast region

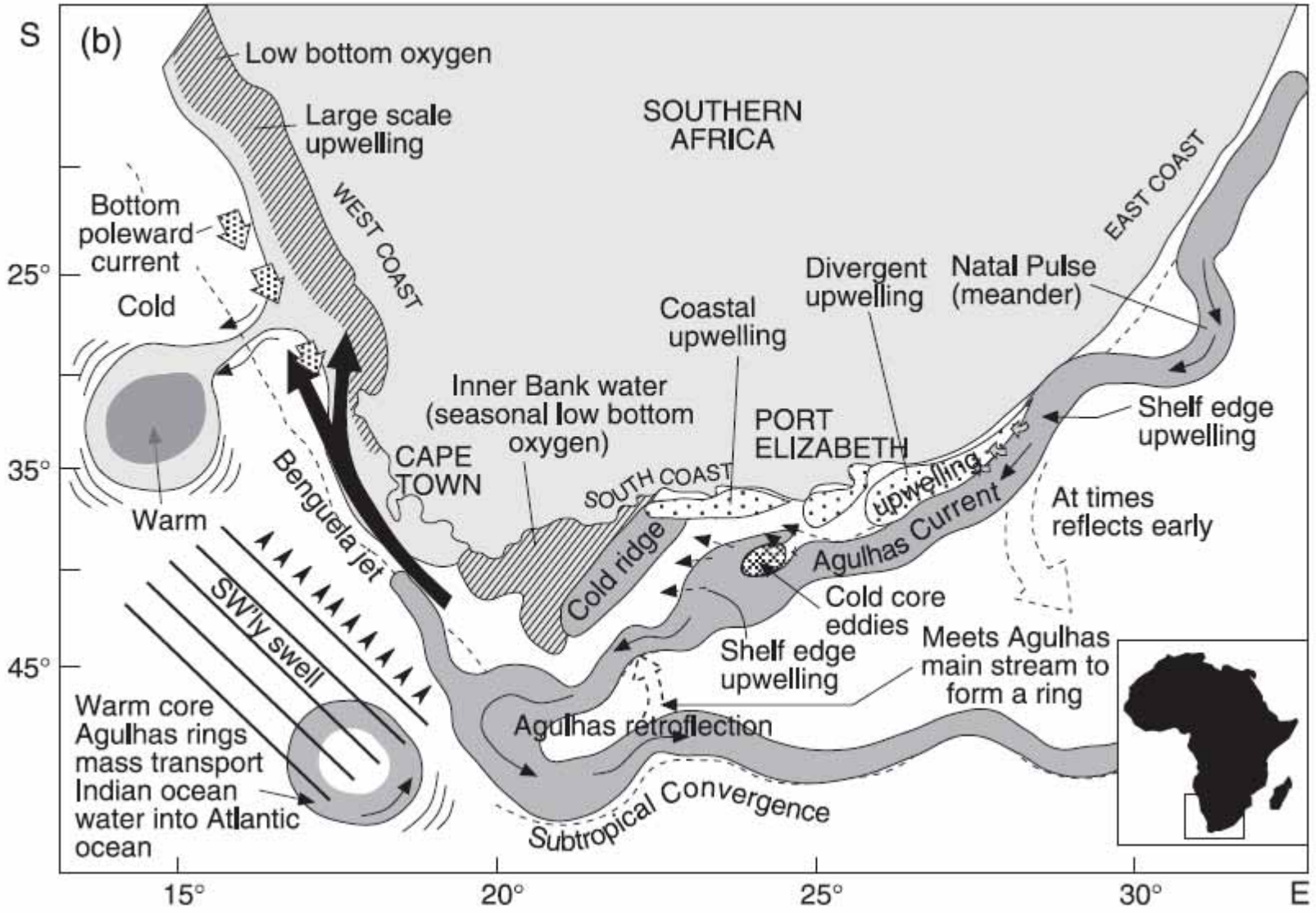
in under three days (CSIR, 1998a). Northeasterly wind speeds increase (occasionally to gale force) as the coastal low reaches the coastline, and then drop to very strong (often gale force) south-easterly winds, with these conditions regularly continuing for 24 hours before returning to the northeast (CCA, 2001).

## 3.4 PHYSICAL OCEANOGRAPHY

The East Coast region is situated along the eastern extension of the Agulhas Bank, which at its southern-most point extends over 10° of longitude to some 250 km offshore at its widest point, at approximately 21° 00' E, directly south of Cape Agulhas (Jackson *et al.*, 2012). A transition zone between the warm Agulhas Current waters to the east, and the cool waters of the Benguela Current system to the west occurs on the bank (*Figure 3.1*). While the western Agulhas Bank (particularly its inshore region) is viewed as part of the Benguela Current upwelling system, the eastern Agulhas Bank is directly influenced by the warm, southward flowing Agulhas Current. The oceanography of the region (particularly the inshore area), is largely dependent on the local coastline and bathymetric orientation in relation to the prevailing easterly and westerly winds (Boyd and Shillington, 1994).

A number of physical processes and features associated with the South African coastal region are illustrated in *Figure 3.3*. The following Section provides a summary of the key physical processes and features, which affect the physical oceanography of the Exploration Areas.

*Figure 3.3* ***Important Physical Processes and Features associated with the South African Coastal Region.***

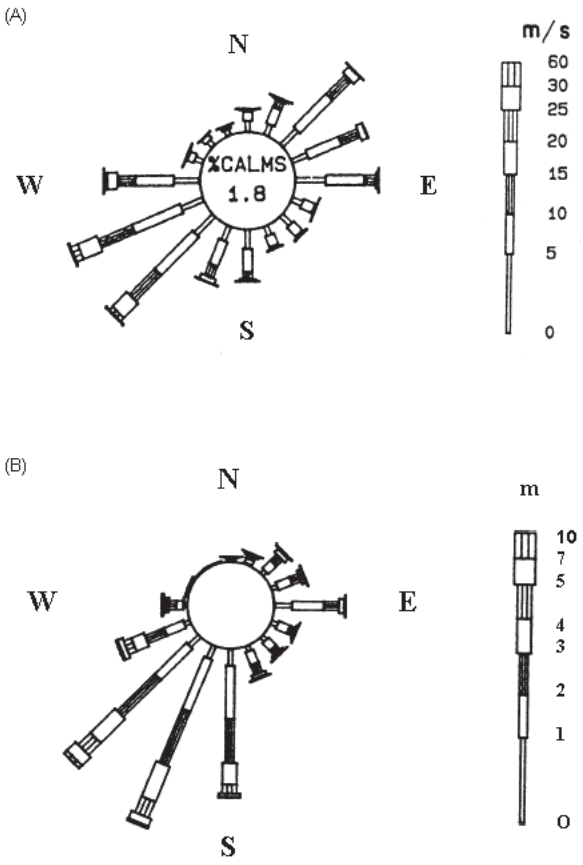



Source: Roberts, 2005.

### 3.4.1 Waves

Swell rose data gathered by Voluntary Observing Ships (VOS) in the area 32° 34' S and 27° 29' E (located southwest of East London) are provided in *Figure 3.4* (Wiseman *et al.*, 1993). Swells typically travel in a northeasterly direction, reaching a maximum of 10 m high, although westward-traveling swells develop under prevailing easterly winds during South African summer and autumn (Wiseman *et al.*, 1993). Less regular weather systems generating large swells along the East Coast include low pressure weather cells to the northeast of Durban, cut-off low pressure cells and tropical cyclones (Hunter, 1988; Schumann, 1998).

***Figure 3.4 Annual wind (A) and swell rose (B) gathered by VOS in the area 32° 34' S, 27° 29' E.***




Source: Wiseman *et al.*, 1993

### 3.4.2 Tides

Tides are semi-diurnal along the East Coast (Schumann, 1998). There is a marginal increase in tidal range from west to east such that tides along the KwaZulu-Natal coastline occur almost simultaneously (Schumann, 1988). Tidal levels for East London are provided in *Table 3.1*.

***Table 3.1 Tide levels (m) at East London (South African Tides Tables, 1979).***

| Sea level | East London |
|---|---|
| MHWS | 2 |
| ML | 1.2 |
| MLWS | 0.4 |
| Amplitude (mean) | 1.6 |

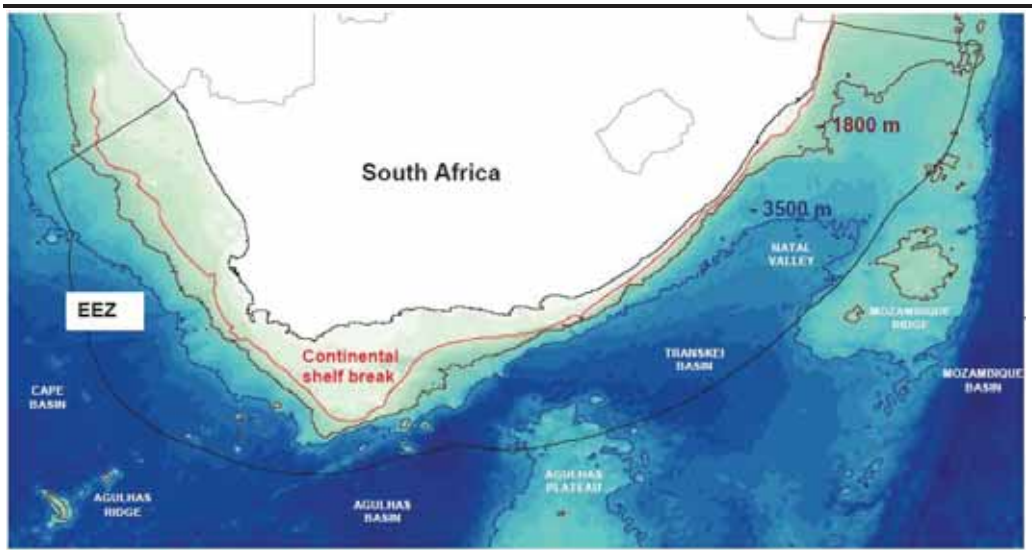
MHWS - Mean High Water Springs
ML - Mean Level
MLWS - Mean Low Water Springs

### *3.4.3 Bathymetry and Sediments*

The bathymetry of the East Coast is generally characterised by a narrow continental shelf (the shelf area between Richards Bay and Port Elizabeth varies in width from 5 km to 45 km wide) that drops off rapidly (Figure 3.5). In the region of Algoa Bay, the narrow shelf widens, with depth increasing gradually to the shelf break at a depth of 140 m off Port Elizabeth, 130 m off Cape St Francis, and 300 m south of Cape Agulhas (Birch & Rogers 1973). Between 22 and 26° E, the shelf break indents towards the coast (refer to *Figure 3.5*) forming the Agulhas 'bight' (Schumann 1998). Outside the shelf break, depth increases rapidly to more than 1,000 m (Hutchings 1994).

Along the coast of the Eastern Cape Province, the continental shelf descends into the Transkei Basin (refer to *Figure 3.5* below) (CCA, 2001).

***Figure 3.5 Offshore bathymetry of the South African EEZ. The continental shelf break is shown in red, and the 1800m and 3500m isobaths are shown in brown and blue respectively.***




Source: CCA, 2001; Redrawn from Dingle *et al.* (1987).

### 3.4.4 Water Masses

The oceanic waters of the East Coast and within the proposed Exploration Areas comprise numerous water masses. Surface waters are a combination of Tropical Surface Water from the South Equatorial Current, and Subtropical Surface Water from the mid-latitude Indian Ocean which regularly enters the Agulhas Current from the east at depths of between 150 and 300 m. The surface waters are warmer than 20°C and of a lower salinity than the South Indian Ocean, Equatorial Indian Ocean and Central water masses present below. However, the characteristics of surface water do vary due to isolation and mixing (Schumann, 1998).

Water temperatures along the East Coast vary seasonally, and in relation to the distance offshore; increasing offshore towards the centre of the Agulhas Current. Gründlingh (1987) found that seasonal variation (warmest in summer and coldest in winter) only occurs in the upper 50 m of the water column, with insignificant variations occurring deeper down. According to Schumann (1998), water temperatures within the Agulhas Current may exceed 25° C in summer and 21° C in winter, and are permanently warmer than the water inshore and offshore of it. Water temperatures also decrease with depth, with temperatures at 50 m below the surface being ~ 4° C cooler than the surface in summer, and 1° C cooler in winter.

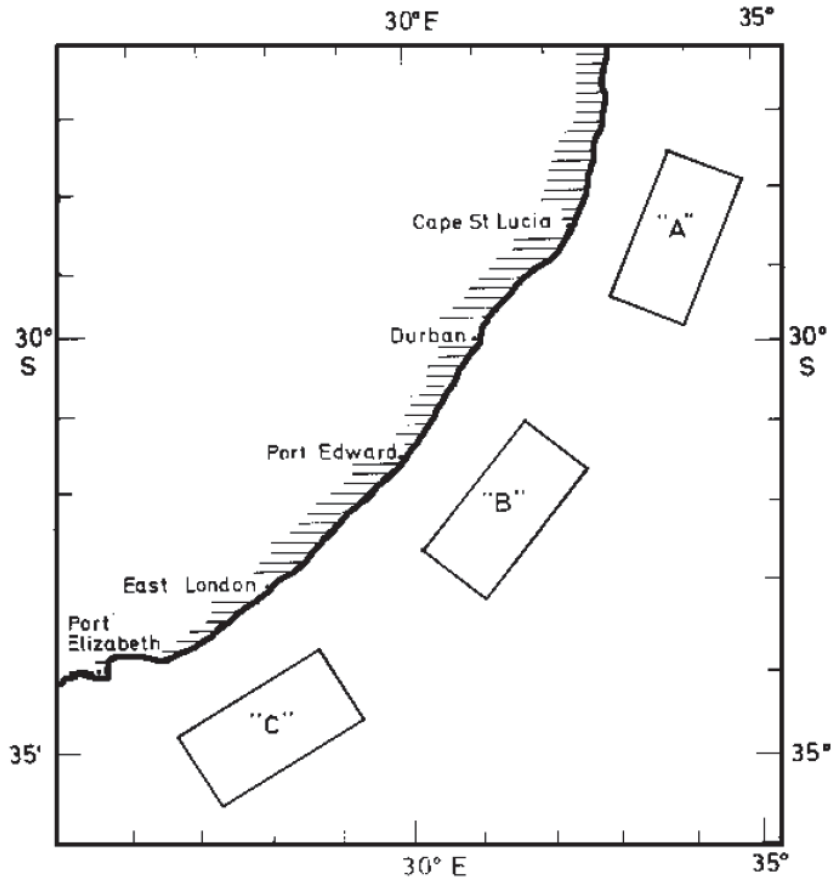
Seasonal variation in temperatures is limited to the upper 50 m of the water column (Gründlingh, 1987), increasing offshore towards the core waters of the Agulhas Current. South of Mbashe and East London, a persistent wedge of cooler water is present over the continental shelf during summer (Beckley & Van Ballegooyen, 1992), extending northwards to the southern KwaZulu-Natal coast in winter. This wedge is typically cooler than 19° C, but may be cooler than 16° C between East London and Port Alfred and south of Mbashe. Inshore, waters are warmest during South African autumn, with warm water tongues found off Cape Recife (near Port Elizabeth) from January to March and off Knysna (west of the Exploration Areas) from October to January and during August.

Strong and persistent thermoclines are common over the shelf, extending inshore during the summer, but breaking down during the cooler and windier winter conditions (Schumann & Beekman, 1984; Boyd & Shillington, 1994). Thermoclines at the eastern edge of the South Coast are located at 20 to 40 m depth (Largier & Swart, 1987).

The Agulhas Current cools as it moves southward. Gründlingh (1987) recorded the water temperature in three offshore areas (≤ 400 m) approximately 170 km offshore of St Lucia, Port Edward and East London (*Figure 3.6*). The blocks thus fell outside the central stream of the Agulhas Current thus minimising the temperature variances from lateral movement of the current (Gründlingh, 1983).

Beckley and Van Ballegooyen (1992) note that offshore surface waters are generally warmer than 22° C along the East Coast. They report that during summer, a wedge of cooler water is situated over the continental shelf to the south of Mbashe and East London. During winter, this wedge extends northwards to the southern KwaZulu-Natal coast. The temperature of this wedge typically ranges between 16° and 19° C, but may drop below 16° C in the section between East London and Port Alfred, and to the south of Mbashe. Off Mbashe there is also a substantial temperature front along the inshore edge of the Agulhas Current (Beckley and Van Ballegooyen, 1992; Pearce *et al*., 1978).

***Figure 3.6 Location of Areas A, B and C in analyses of water temperatures along the East Coast***



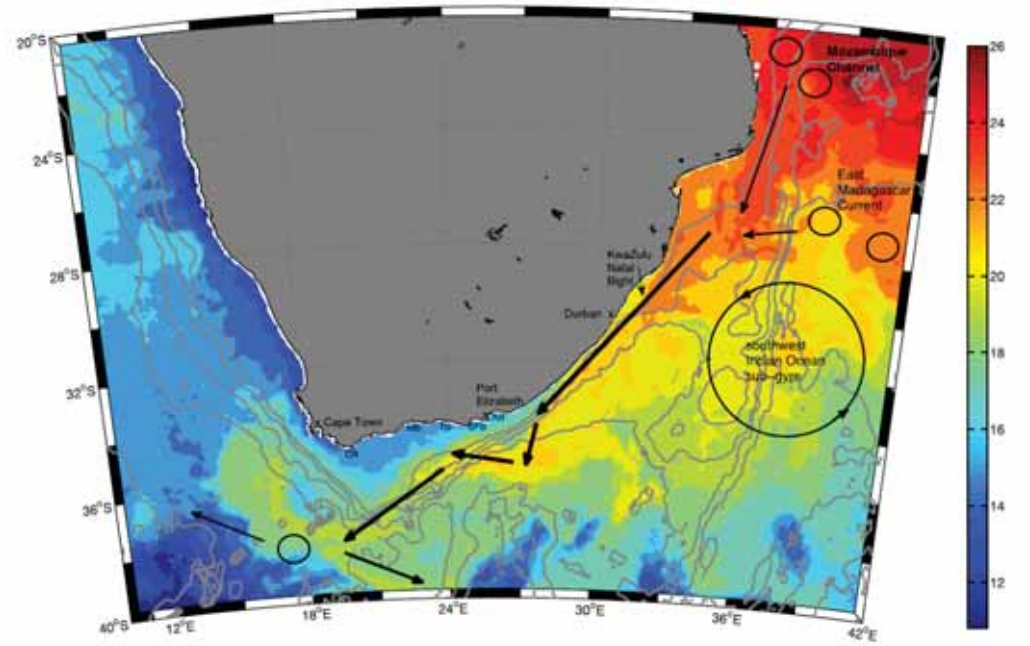

Source: Grundlingh, 1987 in CCA 2001

### 3.4.5 Circulation

The Agulhas Current forms part of the western boundary of the anticyclonic Indian Ocean gyre (Shannon, 1998; Jackson *et al*., 2012). The current develops between 25° and 30° S and travelling in a southwesterly direction along the east coast of Southern Africa before veering away from the coast between 16° and 20° E (*Figure 3.7*). The Agulhas Current is about 100 km wide and 1000 m deep (Schumann, 1998), equating to a volume of about 75 × $10^6$ $m^3$/sec at Port

Edward, increasing by 6 × $10^6$ $m^3$/sec 100 km south (Gründlingh, 1980). The current flows rapidly along the edge of the continental shelf (Grundlingh, 1983), travelling at a surface speed of 1-1.5m/s in the centre although speeds above 2.5 m/sec have been recorded (Pearce *et al.*, 1978).

***Figure 3.7 Sea Surface Temperature (September 2010) and the Agulhas Current (black arrows)***




Source: Jackson *et al.*, 2012
Note: Grey lines indicate the bathymetry in 1000 m intervals. Small circles indicate eddies and acronyms indicate the following: CA for Cape Agulhas, MB for Mossel Bay, TS for Tsitsikamma, SFB for St. Francis Bay, and AB for Algoa Bay.

Four distinct current regions have been identified at the surface by Pearce, 1977. These include:

- The inshore region which is characterised by relatively cool, slow moving water over the continental shelf.
- The western boundary of the current which experiences intense horizontal shear and a relatively strong temperature gradient (1 to 2° C in 10 km).
- The current core where current speeds are greater than 1 m/sec. Temperatures in this zone vary from around 22° C in August to 27° C in March.
- The eastern boundary of the current consisting of weak gradients offshore of the core region. Both current speed and temperature gradually reduce away from the coast.

### 3.4.6 Upwelling

Upwelling in the Agulhas Current has been proposed to take place in a number of ways and locations. Gründlingh and Pearce (1990) report that a degree of dynamic upwelling could be caused by eddies in the large clockwise loops (deeper than 100m) that occur between Richards Bay and Durban. Lutjeharms *et al*. (2000; 1989) found that a wedge of cold upwelling water is often present along the Natal Bight. The upwelling has a base length of between 50 and 130 km and is usually situated off Richards Bay. Although such upwelling only lasts for up to two days the effects often remain longer. For instance, cold water filaments from this upwelling area often extend up to 160 km southward along the Agulhas Current. According to Lutjeharms *et al*., (1989), the upwelling is created by the relationship between the coastal offset and the Agulhas Current. More recently, Schumann (1998) reported that the upwelling of cold water moves onto the continental shelf from the inner edge of the Agulhas Current, especially to the south of East London. Cold water rises over the shelf at Ekman, veering in the lowest boundary layer, with evidence of this taking place from Port Edward (Schumann, 1986). These mechanisms are aided by upwelling at the coast.

### 3.4.7 Seamounts

Geological features of note in the vicinity of the Exploration Areas include various banks, knolls and seamounts (all collectively referred here as 'seamounts'). These seabed features protrude into the water column, and are subject to, and interact with, the water currents surrounding them. The effects of such seabed features on the surrounding water masses can include the up-welling of relatively cool, nutrient-rich water into nutrient-poor surface water (refer to *Section 3.4.6* above) thereby resulting in higher levels of primary productivity (Clark *et al.* 1999), which can in turn strongly influence the distribution of organisms on and around seamounts.

Compared to the surrounding deep-sea environment, seamounts typically form biological hotspots with a distinct, abundant and diverse fauna, many species of which remain unidentified. Consequently, the fauna of seamounts is usually highly unique and may have a limited distribution restricted to a single geographic region, a seamount chain or even a single seamount location (Rogers *et al.* 2008). Levels of endemism on seamounts are also relatively high compared to the deep sea.

South Africa's seamounts and their associated benthic communities have not been sampled by either geologists or biologists (Sink & Samaai 2009). However, SANBI (2011) has recognised two important seamounts, located offshore to the west of the proposed exploration areas (*Figure 3.36*Figure 3.36). These include the Protea Seamount and the Southwest Indian Seamount (refer to *Figure 3.36*). Neither of these seamounts fall within the proposed exploration areas.

### 3.4.8 Nutrient Distributions

Nitrate-nitrogen concentrations in Agulhas Current source water range from 7 to 10 M/l, while those of subthermocline water may be up to 20 M/l (Carter *et al.*, 1987). Primary production is nitrogen-limited in the upper layers of the euphotic zone, but light-limited in the sub-surface chlorophyll maximum layer (Probyn and Lucas, 1987). During winter, when the water column is well mixed, bottom nutrients mix upwards and nutrient concentrations in the surface waters are higher than in summer (CSIR and CCA, 1998).

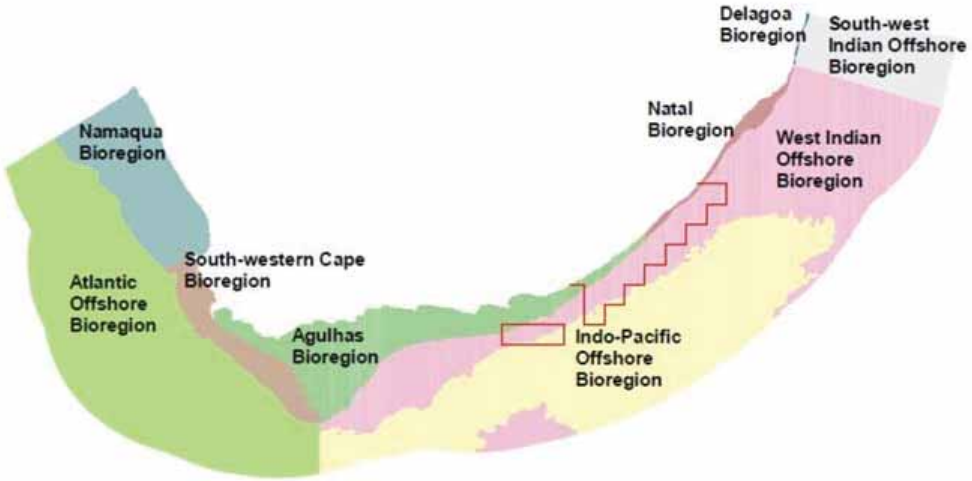
### 3.4.9 Turbidity

Natural turbidity and/or suspended sediment concentration measurements from the East Coast are sparse. Suspended sediment distributions within South African near-shore waters range between 5 mg – 5 g/l (Zoutendyk, 1985). The higher values are associated with high wave conditions resulting from storms, and/or flood-waters as substantial sediment loads are deposited into the East Coast marine environment by summer river run-off (Flemming and Hay, 1988).

## 3.5 BIOLOGICAL ENVIRONMENT

A considerable portion of the proposed exploration areas is located beyond the 50 m depth contour. Communities within the offshore marine habitat are comparatively homogenous, largely as a result of the greater consistency in water temperature at depths around the South African coastline, than in the shallower coastal waters. Nonetheless, there are a number of inshore and offshore bioregions that fall into the proposed Exploration Areas, given their extent and distribution (Lombard *et al.*, 2004). The most prominent of these is the West Indian Offshore Bioregion, as illustrated in *Figure 3.8* below.

***Figure 3.8*** ***The Inshore and Offshore Bioregions occurring in the Proposed Exploration Areas (red outline)***




Source: Adapted from Lombard *et al*. 2004

The biological communities occurring in the proposed Exploration Areas consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The nearshore and offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments, deep-water reefs and the water column. The biological communities 'typical' of these habitats are described in the following *Sections*, focussing both on dominant, commercially important and conspicuous species, as well as sensitive species such as threatened species.

### *3.5.1 Phytoplankton*

The nutrient-poor characteristics of the Agulhas Current water are reflected in comparatively low primary productivity in the southern portion of the proposed Exploration Areas, with mean *chlorophyll a* concentrations averaging between 1 to 2 mg/m³ over the whole year in the top 30 m of the water column. *Chlorophyll a* concentrations vary seasonally, being minimal in winter and summer (< 1 to 2 mg/m³), and maximal (2 to 4 mg/m³) in spring and autumn (Brown 1992). Along the eastern half of the South Coast phytoplankton concentrations are usually higher than further west, comprising predominantly large cells (Hutchings 1994). Along the KwaZulu-Natal coast, primary productivity in inshore areas is low, with *chlorophyll a* concentrations ranging between 0.03 and 3.88 µg/l (Carter & Schleyer 1988).

### 3.5.2 Zooplankton

On the South Coast, the biomass of mesozooplankton increases from west (~0.5-~1.0 g C/m2) to east (~1.0-~2.0 g C/m2), mirroring the eastward increase in *chlorophyll a* concentrations. Dense swarms of euphausiids dominate this zooplankton component, and form an important food source for pelagic fishes (Cornew *et al*., 1992; Verheye *et al*., 1994).

On the East Coast, continental shelf waters support greater and more variable concentrations of zooplankton biomass than offshore waters (Beckley & Van Ballegooyen 1992), with species composition varying seasonally (Carter & Schleyer 1988). Copepods represent the dominant species group (Carter & Schleyer 1988), but chaetognaths are also abundant (Schleyer 1985).

### 3.5.3 Ichthyoplankton

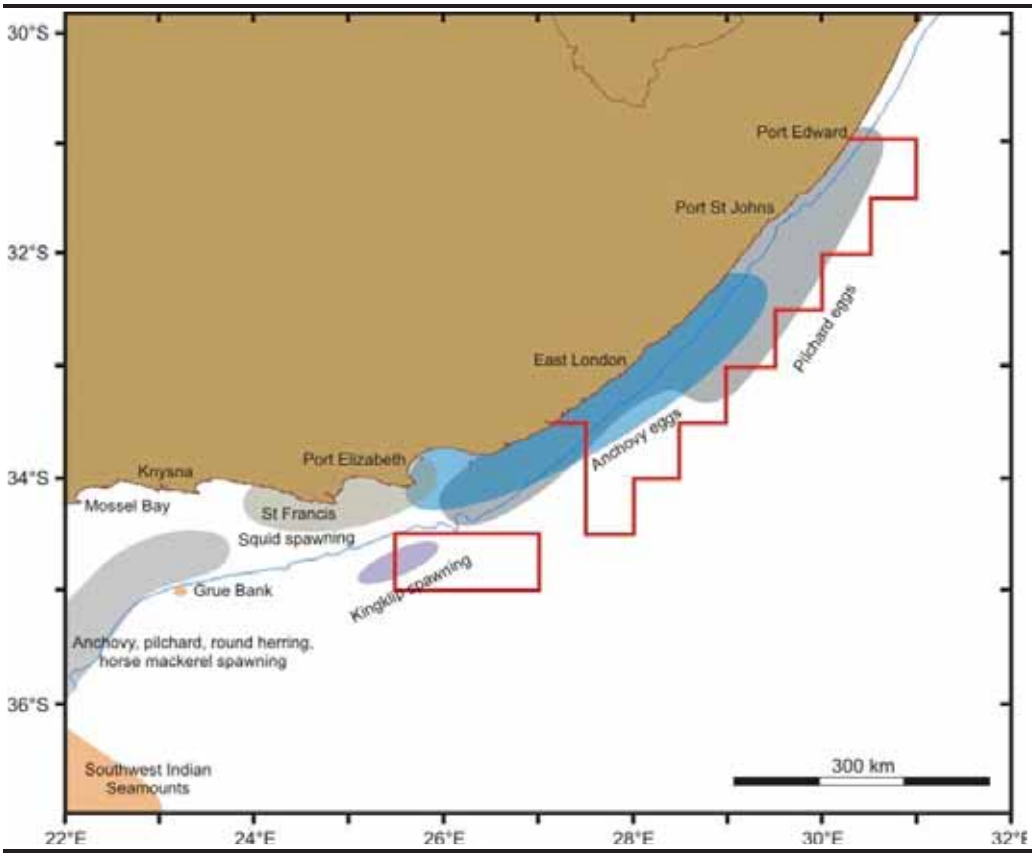
Ichthyoplankton comprises both fish eggs and larvae, and although a small component of the overall plankton, is an important due to the commercial importance of fisheries.

Along the East Coast, ichthyoplankton is primarily confined to inshore waters, with larval concentrations varying between 0.005 and 4.576 larvae/$m^3$. Concentrations, however, decrease rapidly with distance offshore (Beckley & Van Ballegooyen 1992).

A variety of pelagic species, including anchovy, pilchard, and horse mackerel, are reported to spawn east of Cape Agulhas (approximately 300 km to the west of the proposed Exploration Areas) (Crawford 1980; Hutchings 1994; Roel & Armstrong 1991) (*Figure 3.9*). In the case of pilchards (*Sardinops sagax*), adults move eastwards and northwards after spawning. After the sardine run in June and July, pilchard eggs occur in inshore waters along the Eastern Cape and the southern KwaZulu-Natal coast (Anders 1975; Connell 1996). Anchovy (*Engraulis japonicus*) eggs have also been reported in the water column during December, as far north as St Lucia (Anders 1975). There is thus an overlap of egg and larval distributions of these species within the proposed Transkei Exploration Area.

Of the demersal species, kingklip spawn off the shelf edge to the south of St Francis and Algoa Bays, coincident with the Algoa Exploration Area (Hutchings 1994). Squid (*Loligo* spp.) larvae are also widely distributed in inshore waters (<50 m), in close proximity to the north-west boundary of the Algoa Exploration Area (Augustyn *et al*., 1994) (refer to *Section 3.5.4* below).

***Figure 3.9 Important Fishing Banks, Seamounts, and Spawning Areas in Relation to the Proposed Exploration Areas***




Source: Anders 1975, Crawford et al. 1987, Hutchings 1994
Note: 200 m depth contour shown in blue.

### *3.5.4 Invertebrates*

The intertidal and shallow subtidal reefs along the East Coast of South Africa support a wide diversity of marine flora and fauna and a relatively high percentage of endemic species (Turpie *et al*., 2000, Awad *et al*., 2002). However, information about benthic reef communities and hard grounds in the proposed Transkei Exploration Area is limited to descriptions of reef ecosystems in the Pondoland area [(1)] (Celliers *et al*., 2007). Pondoland stretches between the Mthatha River and the Mtamvuna River in the Eastern Cape Province, along a coastal strip that is a maximum of 50 km wide. The following description is summarised from this study and from descriptions of South Africa's reef types provided in SANBI's Reef Atlas Project.

The nearshore reefs of the Pondoland coast shelter a mix of subtropical and warm-temperate fauna that manifest both a latitudinal and longitudinal shift

(1) Pondoland is a natural region, located in the coastal belt off the Eastern Cape province of South Africa. Its territory is the former Pondo Kingdom and the traditional region of the Pondo people.

in benthic composition over a relatively short distance. There is a change from low-diversity macroalgae dominated communities on the shallow high-profile reefs in the north to high-diversity (and comparatively high total living cover and high biomass) communities dominated by sponges, ascidians and bryozoans, on low-profile deeper reefs and reefs to the south. The shallow-water algae-dominated habitats also harbour hard corals (*Stylophora pistillata*), with wave action strongly influencing the community structure. This shift is concomitant with a reduction in available light associated with increased water turbidity. The shift from a habitat defined primarily by phototropism to a benthic community dominated by suspension-feeders is probably driven by higher sediment loads and the greater availability of nutrients coming from the numerous rivers along this portion of the coast. The reduction in available light with depth similarly allows non-phototrophic species — such as sponges and ascidians — to compete with algae for space on the reef.

Further south in the Port Elizabeth area, inshore reefs to -30 m depth also show relatively distinct changes in community structure, being characterised by diverse reef assemblages dominated by cauliflower soft coral (Sink *et al*., 2011). Further south off Goukamma, the reefs are characterised by equally distributed high and low profile areas. The benthic taxa are dominated by bryozoans and sponges (22.9 percent and 21.1 percent respectively), followed by gorgonians (16.4 percent), ascidians (13.7 percent) and algae (10.1 percent). Crinoids (8.4 percent) and hydrozoans (7.5 percent) constitute < 10 percent of the overall occurrence. Community composition in this area is strongly affected by linefishing, with higher abundance of algae and crinoids at fished sites, and higher sponge cover on reefs within the Goukamma Marine Protected Area (MPA).

*Squid*

The squid (*Loligo vulgaris reynaudii*) occurs extensively on the Agulhas Bank out to the shelf edge (500 m depth contour) increasing in abundance towards the easternmost boundary of the South Coast region, between Plettenberg Bay and Algoa Bay (Augustyn 1990; Sauer *et al*., 1992; Augustyn *et al*., 1994). Adults are normally distributed in waters greater than 100 m in depth, except along the eastern half of the South Coast where they also occur inshore, forming dense spawning aggregations at depths between 20 to 130 m. These spawning aggregations are a seasonal occurrence reaching a peak in November and December.

*Rock Lobster and Crayfish*

The deep-water rock lobster (*Palinurus gilchristi*) occurs on rocky substrate in depths of 90 to 170 m between Cape Agulhas and southern KwaZulu-Natal. Larvae drift southwards in the Agulhas Current, settling in the south of the

Agulhas Bank before migrating northwards again against the current to the adult grounds (Branch *et al*., 2010). The species is fished commercially along the southern Cape Coast between the Agulhas Bank and East London, with the main fishing grounds being in the 100 to 200 m depth range south of Cape Agulhas on the Agulhas Bank, and off Cape St Francis, Cape Recife and Bird Island.

Other deep-water crustaceans that may occur in the proposed Exploration Areas are the shovel-nosed crayfish (*Scyllarides elisabethae*) and the Natal deep-sea rock lobster (*Palinurus delagoae*). The shovel-nosed crayfish occurs primarily on gravelly seabed at depths of around 150 m, although it is sometimes found in shallower water. Its distribution range extends from Cape Point to Maputo in Mozambique. The Natal rock lobster similarly occurs on open areas of mud and rubble at depths of 180-300 m. Larvae settle offshore with juveniles and adults migrating inshore as they age.

Other rock lobster species occurring in shallower waters on the south and east coasts include the West Coast rock lobster (*Jasus lalandii*), East Coast rock lobster (*Panulirus homarus*), Longlegged spiny lobster (*Panulirus longipes*), the ornate spiny lobster (*Panulirus ornatus*) and the painted spiny lobster (*Panulirus versicolor*), all of which are typically associated with shallow-water reefs, although the West Coast lobster has been recorded at depths of 120 m (Branch *et al*. 2010).

### *3.5.5 Benthic Biota*

The benthic biota of offshore soft bottom substrates constitutes invertebrates that live on (epifauna), or burrow within (infauna), the sediments, and are generally divided into megafauna (animals >10 mm), macrofauna (>1 mm) and meiofauna (<1 mm). The structure and composition of benthic soft-bottom communities is primarily a function of abiotic factors such as water depth and sediment grain size, but others such as current velocity and organic content abundance also play a role (Snelgrove & Butman 1994; Flach & Thomsen 1998; Ellingsen 2002). Further shaping is derived from biotic factors such as predation, food availability, larval recruitment and reproductive success. The high spatial and temporal variability for these factors results in seabed communities being both patchy and variable. In nearshore waters where sediment composition is naturally patchy, and significant sediment movement may be induced by the dynamic wave and current regimes (Fleming & Hay 1988), the benthic macrofauna are typically adapted to frequent disturbance. In contrast, further offshore where near-bottom conditions are more stable, the macrofaunal communities will primarily be determined by sediment characteristics and depth.

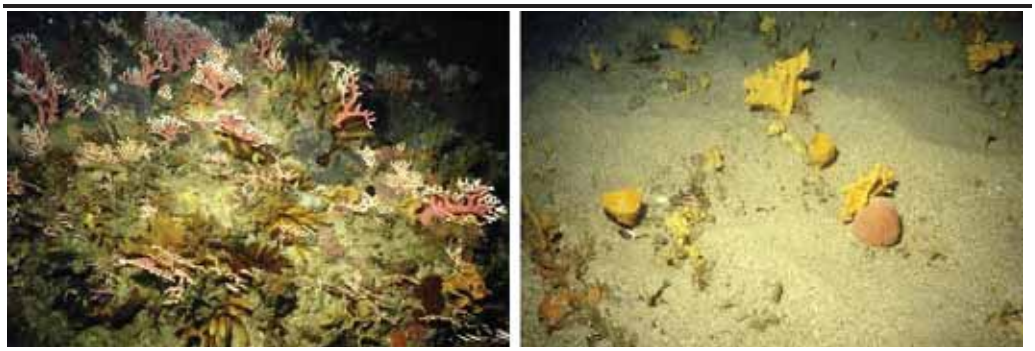
There is insufficient information available on benthic invertebrates in the proposed Exploration Areas to allow for a description of the zoogeographic distribution of benthic macrofaunal communities (McClurg 1988). However, from studies conducted off the West Coast it can be deduced that in general species diversity, abundance and biomass is relatively low on inshore substrates, but increases from the shore to the ~80 m depth. Communities are characterised equally by polychaetes, crustaceans (of which amphipods, copepods and ostracods are the dominant types), echinoderms and molluscs. Further offshore, to 120 m depth, the midshelf is a particularly rich benthic habitat where biomass can attain 60 g/m$^2$ dry weight (Christie 1974; Steffani 2007b). The comparatively high benthic biomass in this midshelf region represents an important food source to carnivores such as the mantis shrimp, cephalopods and demersal fish species. Outside of this rich zone, biomass declines to 4.9 g/m$^2$ at 200 m depth and then is consistently low (<3 g/m$^2$) on the outer shelf (Christie 1974). The meiobenthos includes the smaller species such as nematode worms, flat worms, harpacticoid copepods, ostracods and gastrotriches. Some of the meiofauna are adept at burrowing while others live in the interstitial spaces between the sand grains.

The benthic fauna of the continental slope beyond ~450 m depth are poorly known, largely due to limited opportunities for sampling, and to date very few areas of the continental slope off the South and East Coasts have been surveyed. With minimal changes in sea floor topography and hard substrate, such areas are likely to offer minimal habitat diversity or niches for animals to occupy. Detritus-feeding crustaceans, holothurians and echinoderms tend to be the dominant epi-benthic organisms of such habitats. Also associated with soft-bottom substrates are demersal communities that comprise bottom-dwelling invertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source.

In recent years there has also been increasing interest in deep-water corals and sponges because of their likely sensitivity to disturbance and long generation times. These benthic filter-feeders generally occur at depths exceeding 150 m. Some coral species form reefs while others are smaller and remain solitary. Corals and sponges add structural complexity to otherwise uniform seabed habitats thereby creating areas of higher biological diversity (Breeze *et al*. 1997; MacIssac *et al*. 2001). Their frameworks offer refugia for a greater variety of invertebrates and fish (including commercially important species) within, or in association with, the living and dead frameworks. The Agulhas Bank hosts a diversity of deep-water corals and sponges (*Figure 3.10*), that have establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current. Substantial shelf areas should thus potentially be capable of supporting rich, deep-water benthic, filter-feeding communities. Offshore benthic communities occurring on reefs on the central Agulhas Bank

include protected cold water porcelain coral *Allopora nobilis*, sponges, crinoids and bryozoans (*Figure 3.10*, left photo), whereas a variety of habitat-forming sponges, colonial ascidians and hydroids occur on sandy seabed (*Figure 3.10*, right photo).

***Figure 3.10 Offshore Benthic Communities Occurring on Reefs on the Central Agulhas Bank***



Source: Andrew Penney from Pulfrich, 2013

Despite the lack of information on the subject, small parts of two focus areas (refer to *Section 3.6.6*) with important benthic habitats have been identified within the proposed Exploration Areas. These include the shelf and shelf edge between Cape St Francis and Port Alfred, including the area offshore of Port Elizabeth (within the proposed Algoa Exploration Area) and the area offshore of the KwaZulu-Natal South Coast (called Protea Banks). A summary of these areas is provided in *Section 3.6.6* below.

### *3.5.6 Pelagic and Demersal Fish*

The South and East Coast ichthyofauna is diverse, comprising a mixture of temperate and tropical species. As a transition zone between the Agulhas and Benguela current systems, the South Coast ichthyofauna includes many species occurring also along the West and/or East Coasts. The seabed of the Agulhas Bank substrate is also diverse comprising areas of sand, mud and coral thereby contributing to increased benthic fauna and thus fish species.

Small pelagic shoaling species occurring along the South Coast include anchovy (*Engraulis encrasicolus*), pilchard (*Sardinops sagax*), round herring (*Etrumeus japonicas*), chub mackerel (*Scomber japonicas*) and horse mackerel (*Trachurus trachurus capensis*). Anchovies are usually located between the cool upwelling ridge and the Agulhas Current (Hutchings 1994), and are larger than those of the West Coast. Having spawned intensively in an area around the 200 m depth contour between Mossel Bay and Plettenberg Bay between October and January, most adults move inshore and eastwards ahead of warm

Agulhas Current water. The Agulhas Bank area is, however, not considered an important anchovy recruitment ground (Hampton 1992). Round herring juveniles similarly occur inshore along the South Coast, but move offshore with age (Roel *et al*. 1994; Hutchings 1994).

Pilchards are typically found in water between 14 °C and 20 °C. Spawning occurs on the Agulhas Bank during spring and summer (Crawford 1980), with recruits being found inshore along the South Coast (Hutchings 1994). It is thought that the Agulhas Bank may be a refuge for pilchard under low population levels, and therefore vital for the persistence of the species (CCA & CSIR 1998). During the winter months of June to August, the penetration of northerly-flowing cooler water along the Eastern Cape coast and up to southern KwaZulu-Natal effectively expands the suitable habitat available for this species, resulting in a 'leakage' of large shoals northwards along the coast in what has traditionally been known as the 'sardine run'. The cool band of inshore water is critical to the sardine run as the sardines will either remain in the south or only move northwards further offshore if the inshore waters are above 20 °C. The shoals can attain lengths of 20-30 km and are typically pursued by great white sharks, copper sharks, common dolphins, cape gannets and various other large pelagic predators (www.sardinerun.co.za). Catch rates of several important species in the recreational shoreline fishery of KwaZulu-Natal have been shown to be associated with the timing of the sardine run (Fennessey *et al.* 2010). Other pelagic species that migrate along the coast include elf (*Pomatomus saltatrix*), geelbek (*Atractoscion aequidens*), yellowtail (*Seriola lalandi*), kob (*Argyrosomus* sp), seventy-four (*Cymatoceps nasutus*), strepie (*Sarpa salpa*), cape stumpnose (*Rhabdosargus holubi*) and mackerel (*Scomber japonicus*), which are all regular spawners, particularly within KwaZulu-Natal waters (Van der Elst 1988).

Large migratory pelagic species that occur in offshore waters and beyond the shelf break include dorado (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*) and black, blue and striped marlin (*Makaira indica*, *M. nigricans*, *Tetrapturus audax*), frigate tuna (*Auxis thazard*), skipjack (*Katsuwonus pelamis*), longfin tuna/albacore (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), Southern bluefin tuna and bluefin tuna (*Thunnus maccoyii* and *T. thynnus thynnus*, respectively) (Van der Elst 1988; Smale *et al*., 1994).

There is a high diversity of *Teleosts* (bony fish) and *Chondrichthyans* (cartilaginous fish) associated with the inshore and shelf waters of the South and East Coasts, many of which are endemic to the Southern African coastline and form an important component of the demersal trawl and long-line fisheries. The Cape hake (*Merluccius capensis*), is distributed widely on the Agulhas Bank, while the deep-water hake (*Merluccius paradoxus*) is found further offshore in deeper water (Boyd *et al*. 1992; Hutchings 1994). Juveniles

of both species occur throughout the water column in shallower water than the adults. Kingklip (*Genypterus capensis*) is also an important demersal species, with adults distributed in deeper waters along the whole of the South Coast, especially on rocky substrate (Japp *et al*. 1994). They are reported to spawn in an isolated area beyond the 200 m isobaths between Cape St Francis and Port Elizabeth during spring (see *Figure 3.9*). Juveniles occur further inshore. The Agulhas or East Coast sole (*Austroglossus pectoralis*) inhabits inshore muddy seabed (<125 m) on the shelf between Cape Agulhas and Algoa Bay (Boyd *et al*. 1992). Apart from the above-mentioned target species, numerous other by-catch species are landed by the South Coast demersal trawling fishery including panga (*Pterogymnus laniarius)*, kob (*Argyrosomus hololepidotus*), gurnard (*Chelidonichthyes* spp.), monkfish (*Lophius* sp.), John Dory (*Zeus capensis*) and angel fish (*Brama brama*).

The shallower inshore areas (<100 m) along the South and East Coasts comprise a varied habitat of rocky reefs and soft-bottom substrates, which support a high diversity of endemic sparid and other teleost species (Smale *et al*. 1994) (*Figure 3.11*), some of which move into inshore protected bays to spawn (Buxton 1990) or undertake spawning migrations up the coast to KwaZulu-Natal. Those species that undertake migrations along the South and East Coasts include red steenbras, white steenbras (summer), kob, geelbek and elf (winter). Spawning of the majority of species endemic to the area occurs in spring and summer. Many of these species form an important component of the commercial and recreational line fishery. Furthermore, there are numerous pelagic species that frequent near shore waters and are targeted by line-fishermen (*Table 3.2*).

***Figure 3.11 The South Coast Reefs Support a Wide Diversity of Teleost Species Including Musselcracker (left) and Red Stumpnose (right)***



Source: http://spearfishingsa.co.za, www.easterncapescubadiving.co.za from Pulfrich, 2013

***Table 3.2 Important demersal and pelagic linefish species landed by commercial and recreational boat fishers and shore anglers along the South and East Coasts***

| Common Name | Species Name |
|---|---|
| **Demersal teleosts** | |
| Bank steenbras | Chirodactylus grandis |
| Belman | *Umbrina canariensis* |
| Blacktail | *Diplodus sargus* |
| Blue hottentot | *Pachymetopon aeneum* |
| Bronze bream | *Pachymetopon grande* |
| Cape bank steenbras | *Chirodactylus grandis* |
| Cape stumpnose | *Rhabdosargus holubi* |
| Carpenter | *Argyrozona argyrozona* |
| Dageraad | *Chrysoblephus christiceps* |
| Englishman | *Chrysoblephus anglicus* |
| Fransmadam | *Boopsoidea inornata* |
| Galjoen | *Dichistius capensis* |
| Grey chub | *Kyphosus biggibus* |
| Kob | *Argyrosomus hololepidotus* |
| Mini kob | *Johnius dussumieri* |
| Musselcracker | *Sparodon durbanensis* |
| Natal stumpnose | *Rhabdosargus sarba* |
| Poenskop | *Cymatoceps nasutus* |
| Pompano | *Cymatoceps nasutus* |
| Red roman | *Chrysoblephus laticeps* |
| Red steenbras | *Petrus rupestris* |
| Red stumpnose | *Chrysoblephus gibbiceps* |
| River bream | *Acanthopagrus berda* |
| Rockcod | *Epinephalus* spp. |
| Sand steenbras | *Lithognathus mormyrus* |
| Santer | *Cheimerius nufar* |
| Scotsman | *Polysteganus praeorbitalis* |
| Seventyfour | *Polysteganus undulosus* |
| Slinger | *Chrysoblephus puniceus* |
| Snapper salmon | *Otolithes ruber* |
| Spotted grunter | *Pomadasys commersonnii* |
| Squaretail kob | *Argyrosomus thorpei* |
| Steentjie | *Spondyliosoma emarginatum* |
| Strepie | *Sarpa salpa* |
| White steenbras | *Lithognathus lithognathus* |
| White stumpnose | *Rhabdosargus globiceps* |
| Wreckfish | *Polyprion americanus* |
| Zebra | *Diplodus cervinus* |
| | |
| **Pelagic teleosts** | |
| Elf | *Pomatomus saltatrix* |
| Garrick/leerfish | *Lichia amia* |
| Geelbek | *Atractoscion aequidens* |
| Green jobfish | *Aprion virescens* |
| King mackerel | *Scomberomorus commerson* |
| Kingfish species | *Caranx* spp. |
| Queenfish | *Scomberoides commersonianus* |
| Queen mackerel | *Scomberomorus plurilineatus* |
| Tenpounder | *Elops machnata* |

| Common Name | Species Name |
|---|---|
| Wahoo | *Acanthocybium solandri* |
| Yellowtail | *Seriola lalandi* |

Source: Adapted from CCA & CMS 2001

A wide variety of chondrichthyans occur in nearshore waters of the South Coast (*Table 3.3*), some of which, such as St Joseph shark (*Callorhincus capensis*), soupfin shark (*Galeorhinus galeus*) and biscuit skate (*Raja straeleni*), are also landed by the trawl and line fishery. *Table 3.3* below lists a number of other chondrichthyan species that occur along the South and East Coasts of South Africa.

### *Table 3.3 Some of the Chondrichthyan Species Occurring along the South and East Coasts*

| Common Name | Species Name |
|---|---|
| Great white shark | *Carcharodon carcharias* |
| Ragged-tooth shark | *Odontaspis taurus* |
| Bronze whaler shark | *Carcharhinus brachyurus* |
| Dusky shark | *Carcharhinus obscures* |
| Blacktip shark | *Carcharhinus limbatus* |
| Hammerhead shark | *Sphyrna* spp. |
| Lesser Sandshark | *Rhinobatus annulatus* |
| Milkshark | *Rhizoprionodon acutus* |
| Gully shark | *Triakis megalopterus* |
| Skates | Rajiformes |
| Stingrays | Dasyatidae |
| St Joseph shark | *Callorhincus capensis* |
| Soupfin shark | *Galeorhinus galeus* |
| Diamond ray | *Gymnura natalensis* |
| Tiger catshark | Tiger catshark |
| Izak | *Halohalaelurus regani* |
| Puffadder shyshark | *Haploblepharus edwardsii* |
| Houndsharks | *Mustelus* spp. |
| Bullray | *Myliobatis aquilla* |
| Yellowspotted catshark | *Scyliorhinus capensis* |
| Spiny dogfish | *Squalus* spp |
| Electric ray | *Torpedo fuscomaculata* |

Source: Adapted from CCA & CMS 2001

### *3.5.7 Turtles*

Three species of turtle occur along the South Coast, most frequently the leatherback (*Dermochelys coriacea*), and occasionally the loggerhead (*Caretta caretta*) and the green (*Chelonia mydas*) turtle. Along the East Coast the olive ridley (*Lepidochelys olivacea*) and hawksbill turtle (*Eretmochelys imbricata*) may also be encountered. In the IUCN Red listing, the leatherback and hawksbill

are described as Critically Endangered, the loggerhead and green turtles are 'Endangered' and the olive ridley is 'Vulnerable' on a global scale. Leatherback turtles are thus 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). As a signatory of CMS, South Africa has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles. South Africa is thus committed to conserve these species at an international level.

Leatherback turtles (*Figure 3.13*, left) inhabit the deeper waters of the Atlantic Ocean and are considered a pelagic species. They travel the ocean currents in search of their prey (primarily jellyfish) and may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al*., 2004; Lambardi *et al*., 2008), thus making them difficult to observe from the surface and vulnerable to injury from vessel operations including seismic survey. They come into coastal bays and estuaries to mate, and lay their eggs on the adjacent beaches. Leatherback turtles from the east South African 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).

Loggerheads (*Figure 3.13*, right) tend to keep more inshore, hunting around reefs, bays and rocky estuaries along the African East Coast, where they feed on a variety of benthic fauna including crabs, shrimp, sponges, and fish. In the open sea their diet includes jellyfish, flying fish, and squid (www.oceansafrica.com/turtles.htm).

The green turtle is a non-breeding resident along the East Coast of South Africa, and together with loggerhead turtles are expected to occur only as occasional visitors along the South Coast. The hawksbill turtle occurs only as a visitor to our coast as it breeds in Madagascar and Mauritius. The Olive Ridley turtle is rare in South African waters occurring as occasional strays.

Both the leatherback and the loggerhead turtle nest on the beaches of the northern KwaZulu-Natal coastline between October and February, extending into March. The southern extremity of the nesting area is located over 400 km to the north of the proposed seismic area. Hatchlings are born from late January through to March when the Agulhas Current is warmest. Once hatchlings enter the sea, they move southward in the Agulhas Current and are thought to remain in the southern Indian Ocean gyre for the first five years of their lives, as there is an absence of turtles between 10 - 60 cm from the southern African East Coast. Beach strandings of juvenile loggerhead and leatherback turtles along the South African coast suggest that juvenile turtles occur in the Agulhas Current between Algoa Bay and Mossel Bay (Hughes 1974).

Since concerted turtle conservation efforts began in KwaZulu-Natal in the early 1960, the average number of nesting leatherback females has risen from only five in 1966 to over 90 in the early 2000s. The number of loggerhead turtles has also risen from less than 100 in the early 1960s to ~2,000 currently nesting annually within the Maputaland Marine Reserve (Mann-Lang 2000; www.southafricablog.co.za/archives/loggerhead-turtle/).

***Figure 3.12 Leatherback (left) and loggerhead turtles (right) occur along the East Coast of South Africa***



Source: Ketos Ecology 2009; www.aquaworld-crete.com

### *3.5.8 Seabirds*

Thirteen of the 60 species of seabirds known to, or thought likely to occur, along the South Coast also breed within the region (refer to *Table 3.4*), including Cape gannets (Algoa Bay islands), African penguins (Algoa Bay islands), Cape cormorants (a small population at Algoa Bay islands and mainland sites), whitebreasted cormorant, roseate tern (Bird and St Croix Islands), swift term (Stag Island) and kelp gulls. Although the Algoa Bay Islands do not fall directly within the proposed exploration areas, they are in close enough proximity for the seabird species to be encountered during exploration activities.

***Table 3.4 Breeding resident seabirds present along the South Coast***

| Common Name | Species Name | Global IUCN Status |
|---|---|---|
| African penguin | *Spheniscus demersus* | Endangered |
| Great cormorant | *Phalacrocorax carbo* | Least Concern |
| Cape cormorant | *Phalacrocorax capensis* | Near Threatened |
| Bank cormorant | *Phalacrocorax neglectus* | Endangered |
| Crowned cormorant | *Phalacrocorax coronatus* | Least Concern |
| Cape gannet | *Morus capensis* | Vulnerable |
| Kelp gull | *Larus dominicanus* | Least Concern |

| Common Name | Species Name | Global IUCN Status |
|---|---|---|
| Greyheaded gull | *Larus cirrocephalu* | 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 |
| Damara tern | *Sterna balaenarum* | Near Threatened |

Source: Adapted from CCA & CMS 2001

In the vicinity of the proposed exploration areas, sea-birds at times intensively target shoals of pelagic fish, particularly during the 'sardine run'. Small pelagic species such as anchovy and pilchard form important prey items for seabirds, particularly the Cape gannet, and the African penguin and the various cormorant species. Most of the breeding resident seabird species feed on pelagic shoaling fish species (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). Feeding strategies include surface plunging (gannets and terns), pursuit diving (cormorants and penguins), and scavenging and surface seizing (gulls). All these species feed relatively close inshore, although gannets and kelp gulls may feed further offshore. In particular, African penguins forage at sea with most birds being found within 20 km of the coast and to the south of Cape Recife, and thus inshore of the proposed Algoa Exploration Area.

Forty-six seabird species occur commonly along the East Coast (*Table 3.5*). As the East Coast provides few suitable breeding sites for coastal and seabirds, only three species (Grey-headed gull, Caspian tern and Swift tern) breed regularly along the coast (CSIR 1998). Many of the river mouths and estuaries along the East Coast, however, serve as important roosting and foraging sites for coastal and seabirds birds (Underhill & Cooper 1982; Turpie 1995).

***Table 3.5 Resident and fairly-common to common visiting seabirds present along the East Coast (from CSIR 1998).***

| Species name | Common name | Status |
|---|---|---|

| | | |
|---|---|---|
| *Diomedea exulans* | Wandering albatross | Non-breeding winter visitor |
| *Diomedea cauta* | Shy albatross | Non-breeding winter visitor |
| *Diomedea melanophris* | Blackbrowed albatros | Non-breeding winter visitor |
| | Yellownosed albatross | Non-breeding winter visitor |
| *Diomedea chlororhynchos* | Southern giant petrel | Non-breeding winter visitor |
| | Northern giant petrel | Non-breeding winter visitor |
| *Macronectes giganteus* | Pintado petrel | Non-breeding visitor, mainly in winter |
| | Greatwinged petrel | Non-breeding winter visitor |
| *Macronectes halli* | Softplumaged petrel | Non-breeding visitor, mainly in winter |
| *Daption capense* | Broadbilled prion | Non-breeding visitor, mainly in winter |
| *Pterodroma macroptera* | Whitechinned petrel | Non-breeding visitor, mainly in winter |
| | Cory's shearwater | Summer visitor |
| *Pterodroma mollis* | Great shearwater | Summer vagrant |
| *Pachyptila vittata* | Sooty shearwater | Non-breeding visitor, mainly in winter |
| *Procellaria aequinoctialis* | European storm petrel | Non-breeding visitor, mainly in summer |
| | Leach's storm petrel | Summer vagrant |
| *Calonectris diomedea* | Wilson's storm petrel | Non-breeding visitor, common year round |
| *Puffinus gravis* | Cape gannet | Common, follows 'sardine run' |
| *Puffinus griseus* | Arctic skua | Summer visitor from Palaearctic |
| *Hydrobates pelagicus* | Antarctic skua | Present all year, more abundant in winter |
| *Oceanodroma leucorhoa* | Kelp gull | Year-round visitor from South & West Coast |
| | Greyheaded gull | Coastal breeding resident |
| *Oceanites oceanicus* | Caspian tern | Coastal breeding resident |
| *Morus capensis* | Swift tern | Coastal breeding resident |
| *Stercorarius parasiticus* | Arctic tern | Summer visitor from Palaearctic |
| | Sandwich tern | Summer visitor from Palaearctic |
| *Catharacta skua* | Lesser crested tern | Visitor to the coast, mainly in summer |
| *Larus dominicanus* | Little tern | Palaearctic migrant, common in summer |
| *Larus cirrocephalus* | Common tern | Summer visitor from Palaearctic |
| *Hydroprogne caspia* | | |
| *Sterna bergii* | | |
| *Sterna paradisaea* | | |
| *Sterna sandvicensis* | | |
| *Sterna bengalensis* | | |
| *Sterna albifrons* | | |
| *Sterna hirundo* | | |

### 3.5.9 Marine Mammals

The marine mammal fauna of the South and East Coasts comprises between 28 and 38 species of cetaceans (whales and dolphins) known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur here (*Table 3.6*) and one seal species, the Cape fur seal (*Arctocephalus pusillus*) (Findlay 1989; Findlay *et al*., 1992; Ross 1984; Peddemors 1999). The offshore areas have been particularly poorly studied with almost all available information from deeper waters (>200 m) arising from historic whaling records. Information on smaller cetaceans in deeper waters is particularly poor. Of the migratory cetaceans listed in *Table 3.6*, the blue, sei and humpback whales are listed as Endangered and the southern right and fin whale as Vulnerable in the IUCN Red Data book.

The distribution of whales and dolphins on the South and East Coasts can largely be split into those associated with the continental shelf and those that occur in deep, oceanic waters. Species from both environments may, however, be found associated with the shelf (200 – 1,000 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 kilometres. The most common species within the proposed Exploration Areas (in terms of likely encounter rate not total population sizes) are likely to be the common bottlenose dolphin, long finned pilot whale, southern right whale and humpback whale.

Cetaceans comprise two basic taxonomic groups: the mysticetes (filter-feeding baleen whales) and the odontocetes (toothed predatory whales and dolphins). Due to large differences in their size, sociality, communication abilities, ranging behaviour and acoustic behaviour, these two groups are considered separately.

The majority of baleen whales fall into the family Balaenidae. Those occurring in the proposed Exploration Areas include the blue, fin, sei, minke, dwarf minke and two populations of Bryde's whale. Most of these species occur in pelagic waters, with only occasional visits into shelf waters. All of these species show some degree of migration either to, or through, the proposed exploration areas when en route between higher-latitude feeding grounds (Antarctic or Subantarctic) and lower-latitude breeding grounds. Depending on the ultimate location of these feeding and breeding grounds, seasonality off South Africa can be either unimodal (usually in June-August, e.g. minke and blue whales) or bimodal (usually May-July and October-November, e.g. fin whales), reflecting a northward and southward migration through the area. As whales follow geographic or oceanographic features, the northward and southward migrations may take place at difference distances from the coast, thereby influencing the seasonality of occurrence at different locations. Due to the complexities of the migration patterns, each species is discussed in further detail below.

*Bryde's Whales*

Two types of Bryde's whales are recorded from South African waters - a smaller neritic form (of which the taxonomic status is uncertain) and a larger pelagic form described as *Balaenoptera brydei*. The migration patterns of Bryde's whales differ from those of all other baleen whales in the region as they are not linked to seasonal feeding patterns. The inshore population is unique in that it is resident year round on the Agulhas Bank, only undertaking occasional small seasonal excursions up the East Coast during winter. Sightings over the last two decades suggest that the distribution of this

population has shifted eastwards, with sightings on the West Coast very rare compared to pre-1980s whaling records (Best 2001, 2007; Best *et al*. 1984). Although this is a very small population, which is possibly decreasing in size (Penry 2010), its current distribution implies that it is likely to be encountered in the proposed exploration areas.

The offshore population of Bryde's whale lives off the continental shelf (>200 m depth), and migrates between wintering grounds off equatorial West Africa (Gabon) and summering grounds off the South African West Coast (Best 2001). Its seasonality within South African waters is thus opposite to the majority of the balaenopterids, with abundance on the West Coast highest in January-February. This population of Bryde's whales is unlikely to be encountered in the proposed Exploration Areas.

*Sei Whales*

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 on the east coast highest in June (on the northward migration), and with a second larger peak in September. All whales were caught in waters deeper than 200 m with deepest more 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.

*Table 3.6* ***Cetaceans occurrence off the South and East Coasts of South Africa, their seasonality and likely encounter frequency with proposed seismic survey operations***

| Common Name | Species | Shelf | Offshore | Seasonality | Likely encounter freq. |
|---|---|---|---|---|---|
| ***Delphinids*** | | | | | |
| Common bottlenose dolphin | *Tursiops truncatus* | Yes | Yes | Year round | Monthly |
| Indo-Pacific bottlenose dolphin | *Tursiops aduncus* | Yes | | Year round | Monthly |
| Common (short beaked) dolphin | *Delphinus delphis* | Yes | Yes | Year round | Monthly |
| Common (long beaked) dolphin | *Delphinus capensis* | Yes | | Year round | Monthly |
| Fraser's dolphin | *Lagenodelphis hosei* | | Yes | Year round | Occasional |
| Spotted dolphin | *Stenella attenuata* | Yes | Yes | Year round | Occasional |
| Striped dolphin | *Stenella coeruleoalba* | | Yes | Year round | Occasional |
| Indo-Pacific humpback dolphin | *Sousa chinensis* | Yes | | Year round | Monthly |
| Long-finned pilot whale | *Globicephala melas* | | Yes | Year round | <Weekly |
| Short-finned pilot whale | *Globicephala macrorhynchus* | | Yes | Year round | <Weekly |
| Killer whale | *Orcinus orca* | Occasional | Yes | Year round | Occasional |
| False killer whale | *Pseudorca crassidens* | Occasional | Yes | Year round | Monthly |
| Risso's dolphin | *Grampus griseus* | Yes (edge) | Yes | Year round | Occasional |
| Pygmy killer whale | *Feresa attenuata* | | Yes | Year round | Occasional |
| ***Sperm whales*** | | | | | |
| Pygmy sperm whale | *Kogia breviceps* | | Yes | Year round | Occasional |
| Dwarf sperm whale | *Kogia sima* | | Yes | Year round | Occasional |
| Sperm whale | *Physeter macrocephalus* | | Yes | Year round | Occasional |

| Common Name | Species | Shelf | Offshore | Seasonality | Likely encounter freq. |
|---|---|---|---|---|---|
| ***Beaked whales*** | | | | | |
| Cuvier's | *Ziphius cavirostris* | | Yes | Year round | Occasional |
| Arnoux's | *Beradius arnouxii* | | Yes | Year round | Occasional |
| Southern bottlenose | *Hyperoodon planifrons* | | Yes | Year round | Occasional |
| Hector's | *Mesoplodon hectori* | | Yes | Year round | Occasional |
| Layard's | *Mesoplodon layardii* | | Yes | Year round | Occasional |
| Longman's | *Mesoplodon pacificus* | | Yes | Year round | Occasional |
| True's | *Mesoplodon mirus* | | Yes | Year round | Occasional |
| Gray's | *Mesoplodon grayi* | | Yes | Year round | Occasional |
| Blainville's | *Mesoplodon densirostris* | | Yes | Year round | Occasional |
| ***Baleen whales*** | | | | | |
| Minke | *Balaenoptera bonaerensis* | Yes | Yes | >Winter | Monthly |
| Dwarf minke | *B. acutorostrata* | Yes | | Year round | Occasional |
| Fin whale | *B. physalus* | | Yes | MJJ & ON, rarely in summer | Occasional |
| Blue whale | *B. musculus* | | Yes | MJJ | Occasional |
| Sei whale | *B. borealis* | | Yes | MJ & ASO | Occasional |
| Bryde's (inshore) | *B brydei (subspp)* | | Yes | Year round | Occasional |
| Pygmy right | *Caperea marginata* | Yes | | Year round | Occasional |
| Humpback | *Megaptera novaeangliae* | Yes | Yes | AMJJASOND | Daily |
| Southern right | *Eubalaena australis* | Yes | | JJASON | Daily |

Source: Adapted from S. Elwen, Mammal Research Institute, pers. comm., Best 2007

*Fin Whales*

Fin whales were historically caught off the South African East Coast, with a unimodal winter (June - July) peak in catches off Durban. However, as northward moving whales were still observed as late as August/September, the return migration may occur further offshore. 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 Southern Africa.

*Blue Whales*

Blue whales were historically caught in high numbers off Durban, showing a single peak in catches in June/July. Sightings of the species in the area between 1968-1975 were rare and concentrated in March to May (Branch *et al*. 2007). However, scientific search effort (and thus information) in pelagic waters is very low. The chance of encountering the species in the proposed exploration areas is considered low.

*Minke Whales*

Minke whales are present year-round with a large portion of this population consisting of small, sexually immature animals that primarily occur beyond 30 nautical miles from the coast during summer and autumn. Off Durban Minke whales are reported to increase in numbers in April and May, remaining at high levels through June to August and peaking in September (Best 2007).

*Southern Right Whales*

The most abundant baleen whales off the coast of South Africa are southern right and humpback whales. Southern rights migrate to the southern Africa subcontinent to breed and calve, where they tend to have an extremely coastal distribution mainly in sheltered bays (90percent <2 km from shore; Best 1990, Elwen & Best 2004). Winter concentrations have been recorded all along the southern and eastern coasts of South Africa as far north as Maputo Bay, with the most significant concentration currently on the South Coast between Cape Town and Port Elizabeth. They typically arrive in coastal waters off the South Coast between June and November each year, although animals may be sighted as early as April and as late as January. While in local waters, southern rights are found in groups of 1-10 individuals, with cow-calf pairs predominating in inshore nursery areas. From July to October, animals aggregate and become involved in surface-active groups, which can persist for several hours.

Best (2000) estimated that southern right population was increasing at approximately 7 percent per annum. The most recent abundance estimate for the South African Southern right whale population (2008) puts the population at approximately 4,600 individuals of all age and sex classes, which is thought to be at least 23 percent of the original population size (Brandão *et al*., 2011).

*Humpback Whales*

The majority of humpback whales on the South and East Coasts of South Africa are migrating past the southern African continent. The main winter concentration areas for Humpback whales on the east coast include Mozambique, Madagascar, Kenya and Tanzania. Three principal migration routes for Humpbacks in the south-west Indian Ocean have been proposed. On the first route up the East Coast, the northern migration reaches the coast in the vicinity of Knysna continuing as far north as central Mozambique. The second route approaches the coast of Madagascar directly from the south, possibly via the Mozambique Ridge. The third, less well established route is thought to travel up the centre of the Mozambique Channel to Aldabra and the Comore Islands (Findlay *et al*., 1994; Best *et al*., 1998). Humpbacks have a bimodal distribution off the East coast, most reaching southern African waters around April, continuing through to September/October when the southern migration begins and continues through to December. The calving season for Humpbacks extends from July to October, peaking in early August (Best 2007). Cow-calf pairs are typically the last to leave southern African waters on the return southward migration, although considerable variation in the departure time from breeding areas has been recorded (Barendse *et al*., 2010). Off Cape Vidal whale abundances peak around June/July on their northward migration, although some have been observed still moving north as late as October. Southward moving animals on their return migration were first seen in July, peaking in August and continuing to late October (Findlay & Best 1996a, b).

*Sperm Whales*

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, well-structured social system with adult males behaving differently from younger males and female groups. They live in deep ocean waters, occasionally coming into depths of 500-200 m on the shelf (Best, 2007). Seasonality of catches off the East Coast suggest that medium- and large-sized males are more abundant during winter, while female groups are more abundant in summer, although animals occur year round (Best, 2007). Although considered relatively abundant worldwide (Whitehead, 2002), no current data are available on density or abundance of sperm whales in African waters. Sperm whales feed at great depth, during dives in excess of 30 minutes, making them difficult to detect visually. The regular echolocation clicks made by the species when diving, however, make them relatively easy to detect acoustically using Passive Acoustic Monitoring (PAM).

*Smaller Odontocetes*

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 off the shelf of south and east South Africa. Beaked whales are all considered to be true deep water species usually being seen in waters in excess of 1,000 - 2,000 m depth (see various species accounts in Best 2007). Their presence in the area may fluctuate seasonally, but insufficient data exist to define this clearly. Of the smaller odontocetes, the common bottlenose dolphin (*Figure 3.13*, left) and humpback dolphins (*Figure 3.13*, right) are known to be resident on the shelf and offshore and are likely to be frequently encountered in the proposed exploration areas. Similarly, the long-finned pilot whale, which is usually associated with the shelf edge and is regularly reported by MMOs, fishermen and other observers (S. Elwen pers comms), is likely to be commonly encountered. False killer whales, killer whales, and the offshore form of the bottlenose dolphin are also likely to be encountered with some regularity in deeper waters (Findlay et al.,1992, Best 2007).

***Figure 3.13 Toothed whales that occur on the South and East Coasts include the Bottlenose dolphin (left) and the Indo-pacific humpback dolphin (right)***

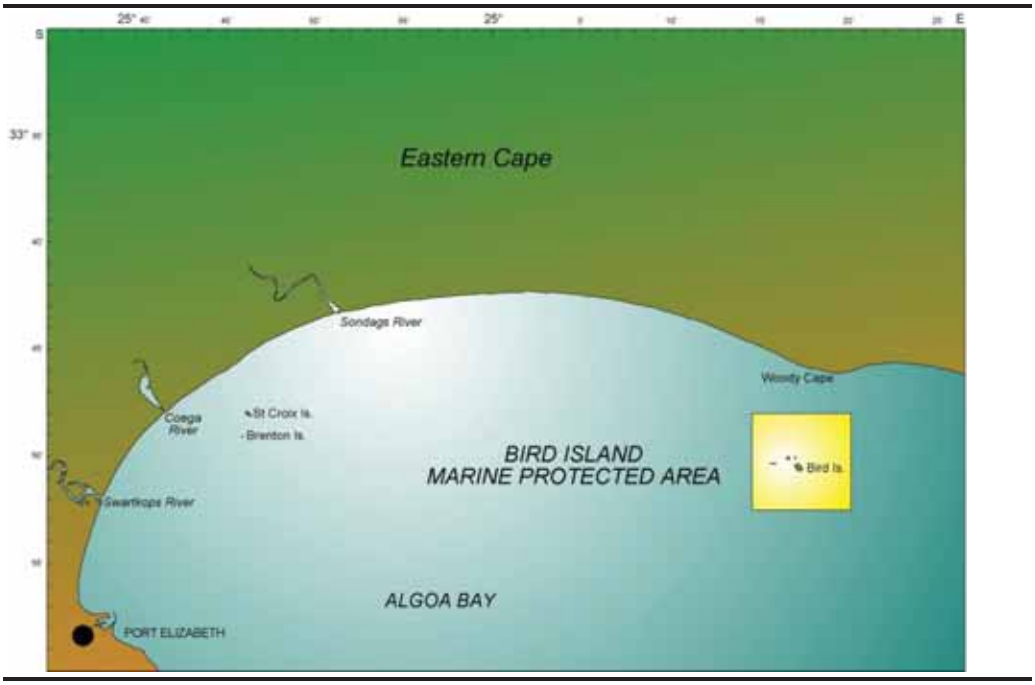


Source: www.fish-wallpapers.com; www.shutterstock.com

*Cape Fur Seal*

The Cape fur seal (*Arctocephalus pusillus pusillus*) is the only seal species that has breeding colonies along the South Coast (*Figure 3.15*), namely at Seal Island in Mossel Bay, on the northern shore of the Robberg Peninsula in Plettenberg Bay and at Black Rocks (Bird Island group) in Algoa Bay (refer to *Figure 3.14* below). The timing of the annual breeding cycle is very regular occurring between November and January, after which the breeding colonies break up and disperse. 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).

***Figure 3.14 Map Depicting the Location of the Bird Island Group***




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. The movement of seals from the three South Coast colonies are poorly known, however, although limited tracking of Algoa Bay animals has suggested these seals to be feeding in the inshore region south of Cape Recife. The diet varies with season and availability and includes pelagic species such as horse mackerel, pilchard, and hake, as well as squid and cuttlefish.

Historically the Cape fur seal was heavily exploited for its luxurious pelt. Sealing restrictions were first introduced to southern Africa in 1893, and harvesting was controlled until 1990 when it was finally prohibited. The protection of the species has resulted in the recovery of the populations, and numbers continue to increase. Consequently, their conservation status is not regarded as threatened.

***Figure 3.15 Colony of Cape fur seals***



Source: Dirk Heinrich

*Summary*

In summary, the majority of data available on the seasonality and distribution of large whales in the proposed exploration areas is largely the result of commercial whaling activities mostly dating from the 1960s. 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 with almost all data being limited to the continental shelf. Whaling data indicates that several other large whale species are also abundant on the South and East Coasts for much of the year: fin whales peak in May-July and October-November and sei whale numbers peak in May-June and again in August-October.

Of the migratory cetaceans, the blue, sei and humpback whales are listed as Endangered and the southern right and fin whale as Vulnerable in the IUCN Red Data book.

All whales and dolphins are given protection under the South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed (1), killed or fished. No vessel or aircraft may approach closer than 300 m to any whale and a vessel should move to a

(1) In the Regulations for the management of boat-based whale watching and protection of turtles as part of the Marine Living Resources Act of 1998 the definition of "harassment" is given as "behaviour or conduct that threatens, disturbs or torments cetaceans"

minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.

## 3.6 HUMAN UTILISATION

### 3.6.1 Fisheries

*Background*

The South African fishing industry consists of at least 20 commercial fishing sectors operating within the country's 200 nautical mile Exclusive Economic Zone (EEZ). The most economically valuable of these are the demersal trawl and long-line fisheries, targeting the cape hakes *Merluccius paradoxus* and *M. capensis*. Secondary commercial species landed in the hake-directed fisheries include an assemblage of demersal fish of which monk fish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*) are the most important. However, the largest fishery by volume is the small pelagic species using small pelagic purse-seine gear. This fishery targets sardine (*Sardinops sagax*), anchovy (*Engraulis encrasicolus*) and round herring (*Etrumeus whitheadii*). Other fisheries active on the South and West Coasts are the pelagic long-line fishery for tunas and swordfish, and the tuna pole and traditional linefish sectors (commercial and recreational). South Coast rock lobster (*Jasus lalandii*) is an important commercial trap fishery exploited close to the shoreline. The commercial sectors that operate in the vicinity of the proposed exploration areas are listed in *Table 3.7* below.

**Table 3.7 List of commercial fisheries that operate in the vicinity of the proposed exploration areas**

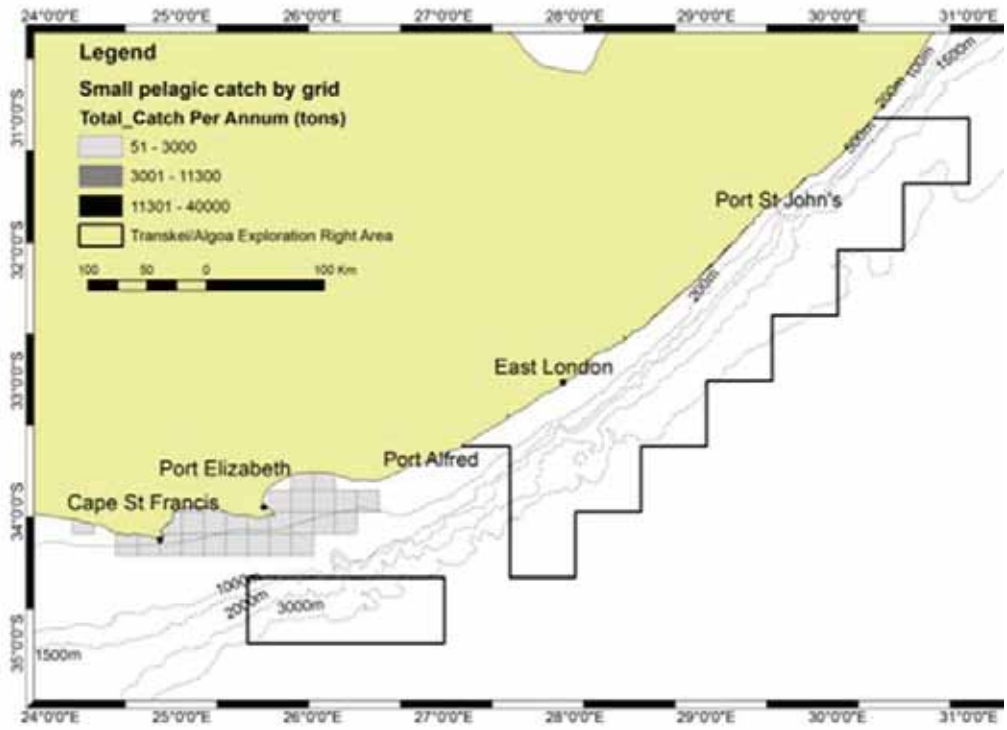
| No. | Fishery | Gear Type | Targeted Species |
|---|---|---|---|
| 1. | Small pelagic purse-seine | Purse-Seine | Sardine (*Sardinops sagax*), Anchovy (*Engraulis encrasicolus*), Round herring (*Etrumeus whitheadii*) |
| 2. | Demersal offshore trawl | Demersal trawl | Cape hakes (*Merluccius paradoxus*, *M. capensis*) |
| 3. | Mid-water trawl | Mid-water trawl | Horse mackerel (*Trachurus capensis*) |
| 4. | Demersal long-line | Demersal long-line | Cape hakes (*M. paradoxus*, *M. capensis*) |
| 5. | Demersal shark | Demersal long-line | Soupfin shark (*Galeorhinus galeus*), Smooth-hound shark (*Mustelus spp.*) |
| 6. | Large pelagic long-line | Pelagic long-line | Yellowfin tuna (*Thunnus albacares*), Bigeye tuna (*T. obesus*), Swordfish (*Xiphias gladius*), Mako shark (*Isurus oxyrinchus*), Blue shark (*Prionace glauca*) |
| 7. | South Coast rock lobster | Long-line trap | *Palinurus gilchristi* |
| 8. | Traditional line fish & Hake hand line | Hand line or rod-and-reel | Snoek (*Thyrsites atun*), Yellowtail (*Seriola lalandi*), Longfin tuna (*Thunnus alalunga*), Yellowfin (*Thunnus albacares*), Kabeljou (*Argyrosomus inodorus*), Geelbek (*Atractoscion aequidens*), sparidae, |

| | | | |
|---|---|---|---|
| | | | scombridae, sciaenidae |
| 9. | Squid Jig | Hand line jig | Squid *(Loligo vulgaris reynaudii)* |

*Small Pelagic Purse-Seine Fishery*

The small pelagic fishery is the largest South African fishery by volume and the second most important in terms of value. It operates predominantly inshore on the West Coast with some fishing activity in the inshore bay areas of the South Coast. Given the above mentioned geographic distribution, fishing effort is not expected to be conducted in the vicinity of the proposed exploration areas (refer to *Figure 3.16*). In light of this, no further assessment of this Fishery is considered necessary.

***Figure 3.16 Distribution of Small Pelagic Purse-seine Catches (tons per annum) with respect to the Proposed Exploration Areas (1987 – 2011)***




*Demersal Trawl Fishery*

The demersal trawl fishery is South Africa's most important fishery and, for the last decade, it has accounted for more than half of the income generated from commercial fisheries. Prior to 1978, a single demersal trawl fishery targeted the two Cape hake species off southern Africa. After this date, the fishery was formally separated into an offshore sector targeting deep-water hake (*M. paradoxus*) and an inshore sector targeting shallow-water hake (*M.*

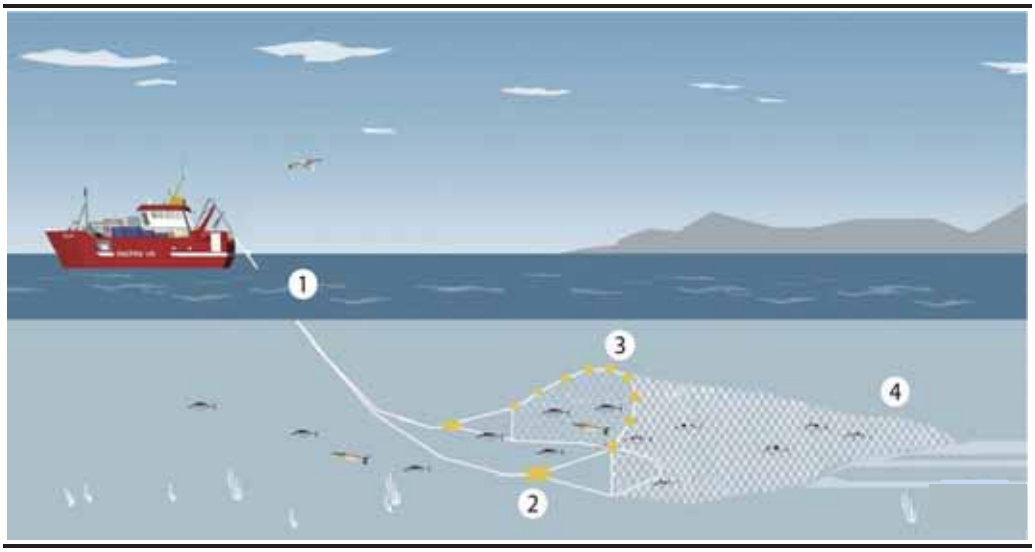
*capensis*) and Agulhas sole (*Austroglossus pectoralis*). The Total Allowable Catch (TAC) of hake for the demersal trawl fishery was set at 144 741 tons in 2012.

The deep-sea fleet is segregated into wet fish and freezer vessels which differ in terms of the capacity for the processing of fish offshore (at sea) and in terms of vessel size and capacity (shaft power of 750 – 3000 kW). Wet fish vessels have an average length of 45 m, are generally smaller than freezer vessels which may be up to 90 m in length. While freezer vessels may work in an area for up to a month at a time, wet fish vessels fish may only remain in an area for about a week before returning to port.

Trawl gear configurations are similar for both freezer and wet fish vessels. Typical trawl gear configuration consists of (refer to *Figure 3.17*):

1. Steel warps up to 32 mm diameter - in pairs up to 3 km long when towed;
2. A pair of trawl doors (500 kg to 3 tons each), which keep the mouth of the net open;
3. Net footropes which may have heavy steel bobbins attached (up to 24" diameter) as well as large rubber rollers ("rock-hoppers"); and
4. Net mesh (diamond or square shape) is normally wide at the net opening whereas the bottom end of the net (or cod-end) has a 130 mm stretched mesh.

***Figure 3.17 Schematic Diagram of Trawl Gear typically used by Deep-Sea Demersal Trawl Vessels***




Source: http://goodfishbadfish.com.au/

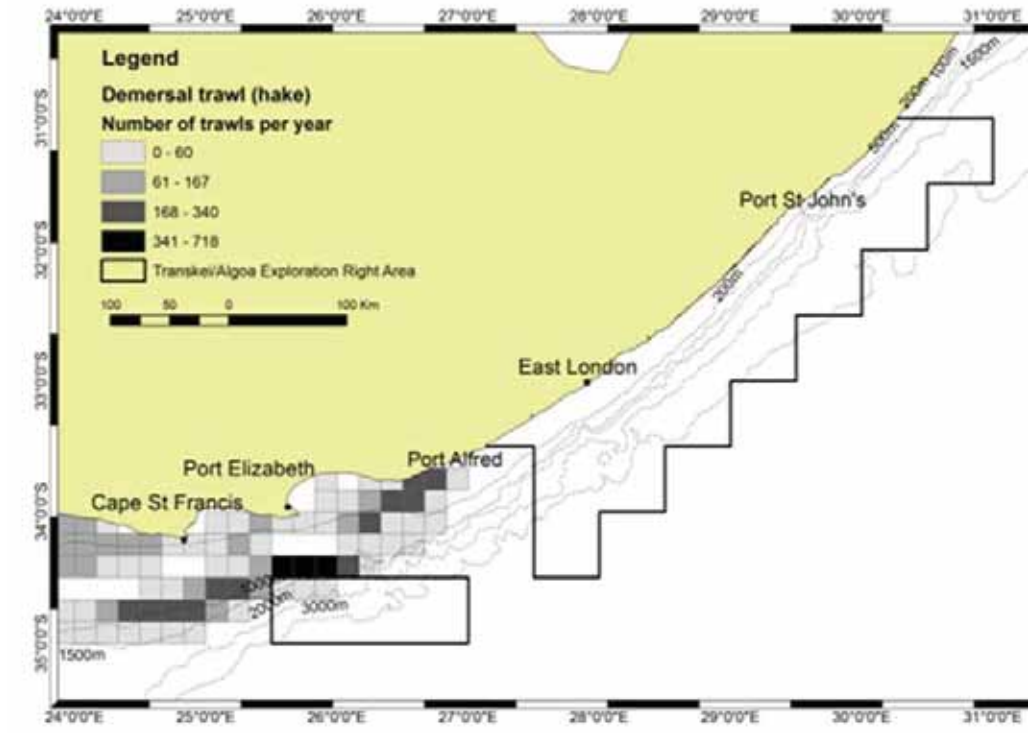
Generally, trawlers tow their gear at 3.5 knots for up to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net

opening may be up to 50 m in width and 10 m in height. The swept area on the seabed between the doors may be up to 150 m.

The majority of vessels licensed to conduct hake deep-sea trawling are registered at the ports of Cape Town and Saldanha Bay, with 15 of a total of 98 vessels registered at South and East Coast harbours. Although these vessels are restricted in manoeuvrability when gear is deployed the gear can be recovered within a period of 30-minutes or the vessel can take avoiding action at its trawl speed.

A small proportion of the trawling grounds overlap with the northern boundary of the Algoa Exploration Area, inshore of the 200 m isobath (see *Figure 3.18*). As such, it is possible that both freezer and wet fish trawler vessels would be encountered within the proposed Algoa Exploration Area and there is generally no seasonal differentiation in effort levels between these two vessels. Approximately 857 km² of trawling grounds coincide with this exploration area which is equivalent to approximately 0.6 percent of the total trawl ground available to the fishery. Over the period 2006 to 2011, 0.08 percent of the total effort of the demersal trawl fishery was conducted within this exploration area at an average of 27 trawls per year.

***Figure 3.18 Distribution of Demersal Trawling Activity over the Period 2006 to 2011 in relation to the Proposed Exploration Areas***




Source: CapFish, 2013

Trawling is non-selective and is associated with a higher level of bycatch compared to other fishing methods. Apart from the above-mentioned target

species, kingklip, panga, kabeljou, gurnard, chub mackerel, monkfish (*Lophius* sp), Cape dory (*Zeus capensis*), angel fish (*Brama brama*), squid, skates and rays and numerous other by-catch species are landed by the South African demersal trawling sector.

*Mid-Water Trawl*

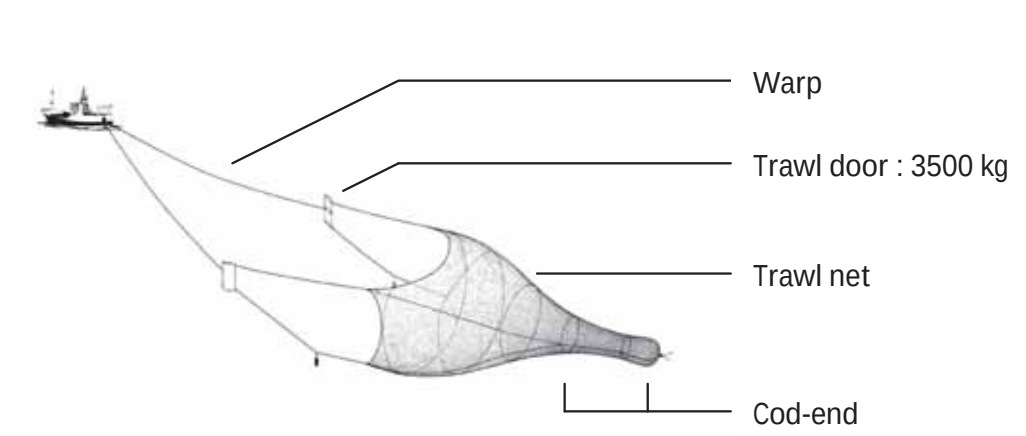
There are currently 15 rights holders within this fishing sector: however the majority of effort is undertaken by a single dedicated vessel, which operates all year round. A large factory vessel capable of sustained operation has made economically viable targeting of horse mackerel possible. The fishery targets adult horse mackerel (*Trachurus capensis*).

Mid-water trawling is defined in the Marine Living Resources Act (No. 18 of 1998) (MLRA) as any net which can be dragged by a fishing vessel along any depth between the sea bed and the surface of the sea without continuously touching the bottom. In practice, mid-water trawl gear does occasionally come into contact with the seafloor.

Mid-water trawling gear configuration is similar to that of demersal trawlers (refer to *Figure 3.19* below), except that the net is manoeuvred vertically through the water column. The towed gear may extend up to 1 km astern of the vessel and comprises trawl warps, a net and a cod-end. Trawl warps are between 32 and 38 mm in diameter. The trawl doors (3.5 t each) maintain the net opening which ranges from 120 to 130 m in width and from 40 m to 80 m in height. Weights in front of, and along the ground-rope provide for vertical opening of the trawl. The cable transmitting acoustic signal from the net sounder might also provide a lifting force that maximises the vertical trawl opening. To reduce the resistance of the gear and achieve a large opening, the front part of the trawl net is usually made from very large rhombic or hexagonal meshes. The use of nearly parallel ropes instead of meshes in the front part is also a common design.

Once the gear is deployed, the net is towed for several hours at a speed of 4.8 to 6.8 knots predominantly parallel with the shelf break. Given the size of the nets and the associated width of the net openings, the trawlers are severely restricted in their ability to manoeuvre, which can interfere with other surface navigation and vessels.

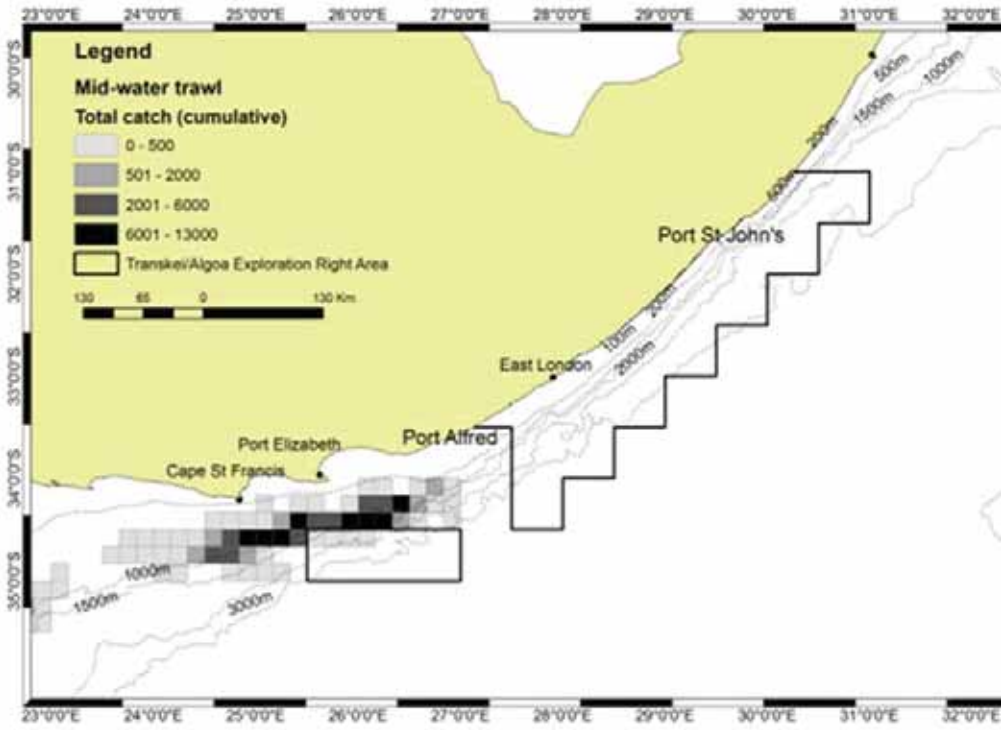
***Figure 3.19 Schematic Diagram Showing the Typical Configuration of Mid-water Trawl Gear***




Source: CapFish, 2013

As mentioned above, the fishery targets adult horse mackerel which aggregate in highest concentration on the Agulhas Bank. Shoals of commercial abundance are found in limited areas and the spatial extent of mid-water trawl activity is relatively limited when compared to that of demersal trawling sector. Fishing grounds are therefore condensed into three areas on the shelf edge of the South and East coasts. 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 (see *Figure 3.20*).

***Figure 3.20 Distribution of Fishing Effort of the Mid-water Trawl Fishery in the Vicinity of the Proposed Exploration Areas.***




Source: CapFish, 2013
Note: Data are presented on a 10' by 10' grid for the period 2000 to 2011.

The mid-water trawl fishery operates on the eastern extent of the South Coast (up to 28°E) in water depths greater than 100 m and therefore coincides with a small portion of the proposed Algoa Exploration Area. Approximately 4.4 percent of the mid-water trawl fishing grounds overlaps with the Algoa Exploration Area, which constitutes about 0.3 percent (or 430 kg) of the total cumulative catch for the years 2000 - 2011.

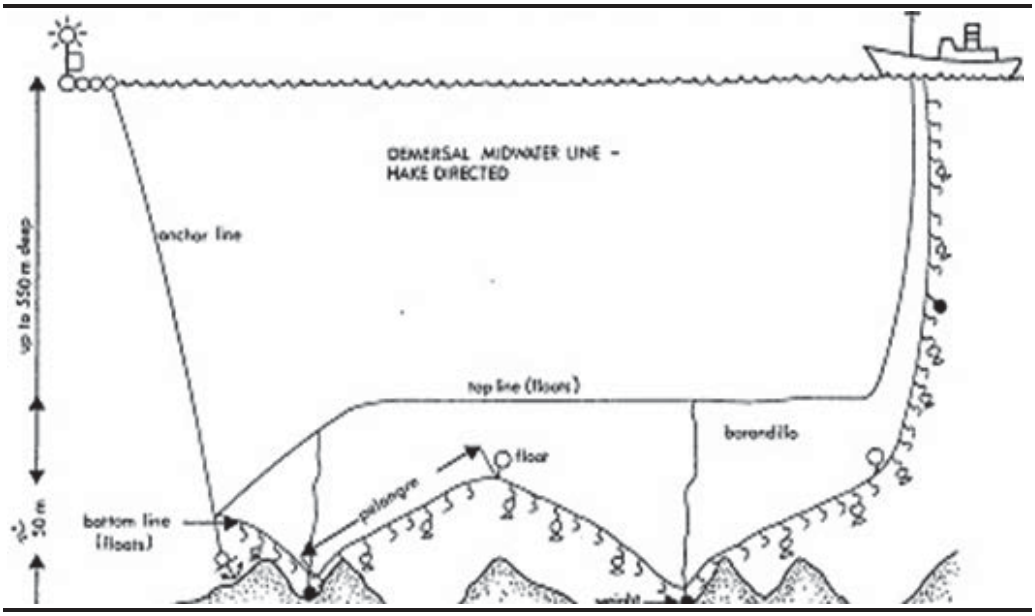
*Demersal Long-Line Fisheries*

The demersal long-line fishing technique is used to target bottom-dwelling species of fish. Two fishing sectors utilise this method of capture, namely the long-line fishery for Cape hakes and the shark long-line sector targeting only the demersal species of shark.

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 3.21). Steel anchors, of 40 to 60 kg are placed at the ends of each line to anchor it. These anchor positions are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16 mm diameter) is more buoyant than the bottom line, it is raised off the seafloor and minimises the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically 20 – 30

nautical miles in length. 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 5 – 9 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 1 knot) and can take six to ten hours to complete. During hauling operations manoeuvrability would be severely restricted and direct communications from the survey vessel would be required in order to keep vessels and gear clear of the survey vessel.

***Figure 3.21 Schematic Diagram showing a Typical Configuration of Long-line Gear used to Target Demersal Fish Species***



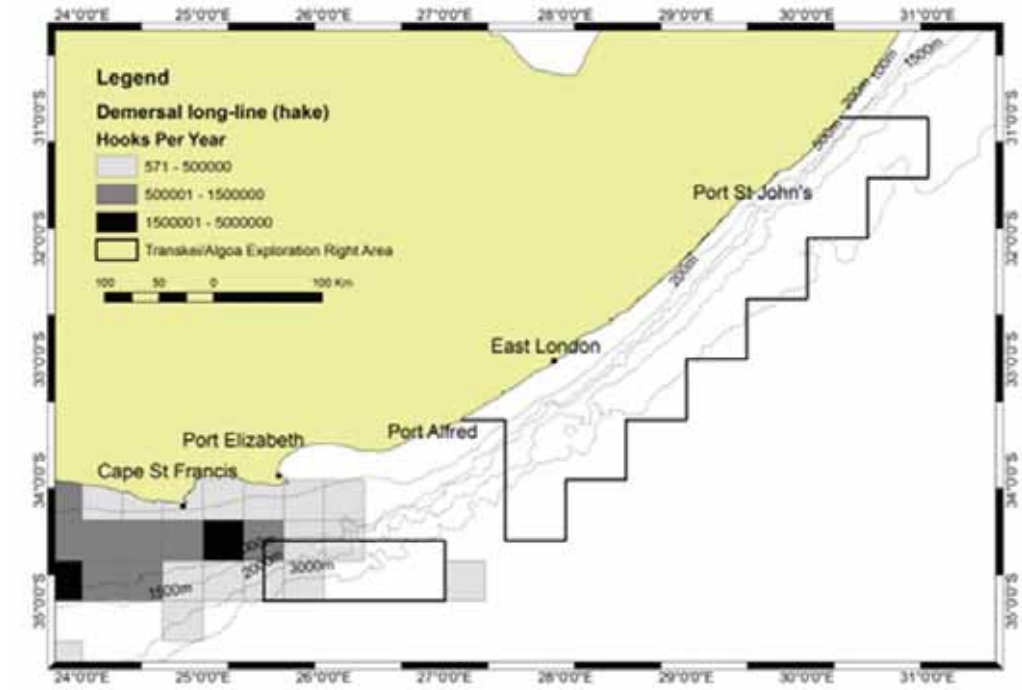

Source: CapFish, 2013

*Hake-Directed Long-line Fishery*

Like the demersal trawl fishery the target species of this fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. A total nominal catch weight of 9 493.8 tons was set for this fishery in 2012, which increased 10 percent from the previous year. The hake long-line fishery is a relatively new fishery in South Africa, having started in 1994 as an experimental fishery, with long-term commercial rights being allocated in 2004. Fishing takes place along the West and South-East coasts, in areas similar to those targeted by the demersal trawl fleet. The catch is landed predominantly prime quality hake for export to Europe. The catch is packed unfrozen on ice and the value is approximately 50 percent higher than that of trawled hake. There are currently 64 vessels licensed within the sector, operating from all major harbours, including Cape Town, Hout Bay, Mossel Bay and Port Elizabeth. Secondary points of deployment include St Helena Bay, Saldanha Bay, Hermanus, Gansbaai, Plettenberg Bay and Cape St Francis; however there is far less activity from these areas than from the main

harbours. Vessels vary from 18 m to 50 m in length and remain at sea for four to seven days at a time. The fishery is directed in both inshore and offshore areas. Inshore long-line operations are restricted by the number of hooks that may be set per line, while offshore operations may only take place in waters deeper than 110 m and is restricted to the use of no more than 20 000 hooks per line.

***Figure 3.22 Distribution of Fishing Effort of the Demersal Long-line Fisheries for Hake (2002 – 2011) in the Vicinity of the proposed Exploration Areas***




Source: CapFish, 2013

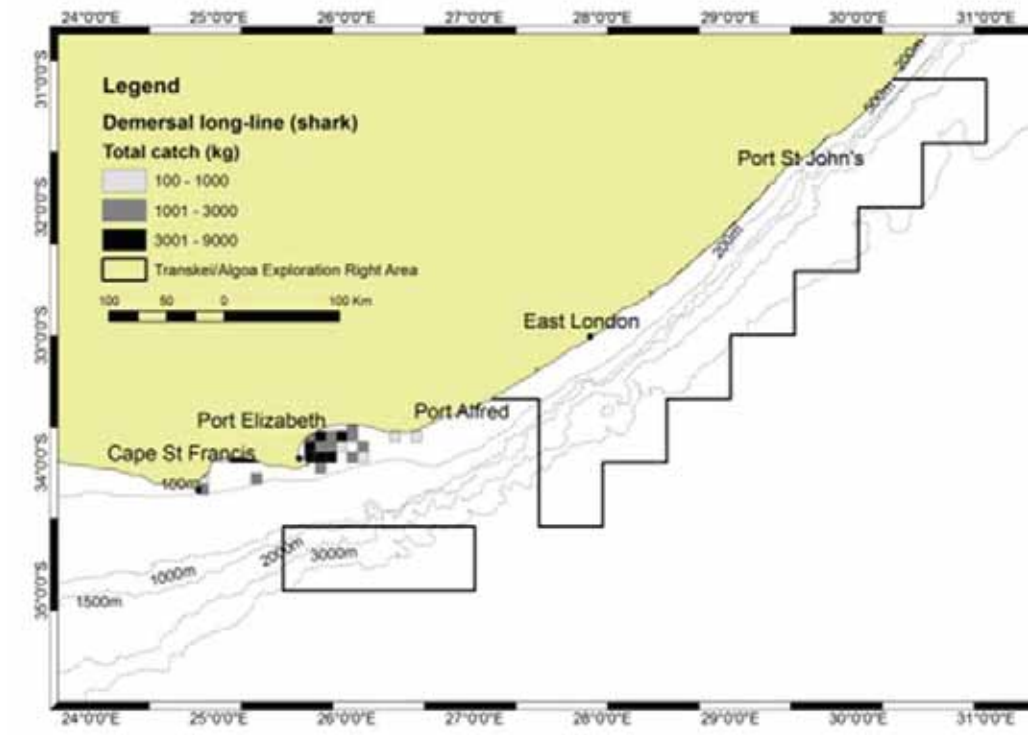
*Shark-Directed Long-Line Fishery*

Capture of demersal shark species occurs primarily in the demersal shark long-line fishery, whilst catches of pelagic shark species occurs primarily in the large pelagic sector that targets tuna and swordfish. Prior to 2006, both demersal and pelagic shark catches were managed as a single shark fishery. The demersal shark fishery targets soupfin shark (*Galeorhinus galeus*), smooth-hound shark (*Mustelus spp.*), spiny dogfish (*Squalus* spp), St Joseph shark (*Callorhinchus capensis*), *Charcharhinus* spp., rays and skates. Other species which are not targeted but may be landed include cape gurnards (*Chelidonichthys capensis*), jacopever (*Sebastichthys capensis*) and smooth hammerhead shark (*Sphyrna zygaena*). Catches are landed at the harbours of Cape Town, Hout Bay, Mossel Bay, Plettenberg Bay, Cape St Francis, Saldanha Bay, St Helena Bay, Gansbaai and Port Elizabeth and currently six permit holders have been issued with long-term rights to operate within the fishery. The fishery operates relatively close to shore, inshore of the 100 m isobath.

Demersal shark longline fishing is also not permitted in False Bay between Cape Hangklip and Cape Point, or in tidal lagoons, estuaries, and Marine Protected Areas (MPAs).

The demersal shark-directed longline fishing grounds do not coincide (see *Figure 3.23*) with the proposed exploration areas. As such, no further assessment of this fishery is considered necessary.

***Figure 3.23 Catch Distribution of the Demersal Long-line Fisheries for Shark (2005 – 2008) in the vicinity of the Proposed Exploration Areas***




Source: CapFish, 2013

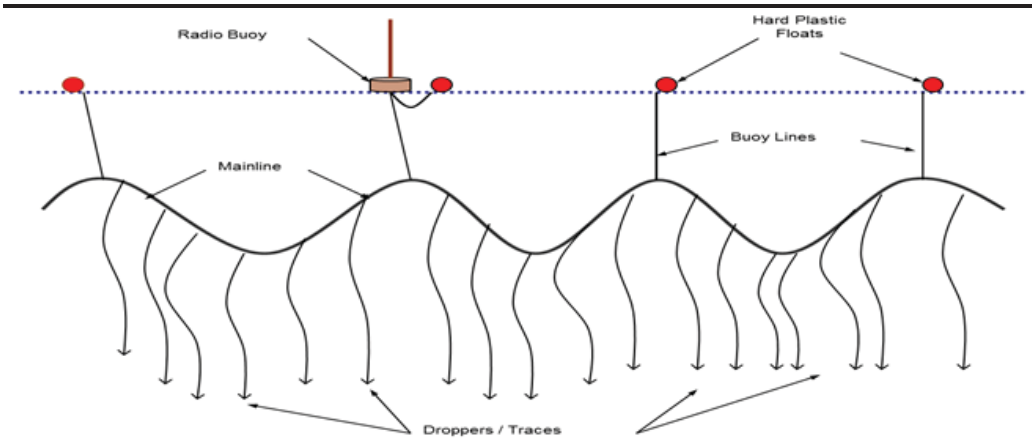
*Large Pelagic Long-Line Fishery*

The target species within the South African pelagic long-line sector are yellowfin tuna, bigeye tuna, swordfish and shark species (primarily mako shark). Due to the highly migratory nature of these species, stocks straddle the EEZs of a number of countries and international waters. As such, they are managed at an international level through country allocations and global effort control. It is at this level that Regional Fisheries Management Organisations (RFMOs) such as the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC) and the Commission for the Conservation of Southern Bluefin Tuna (CCBT) are instrumental in managing the pelagic long-line sector around the South African coast. Nominal reported landings of 2 136 tons were recorded

within the fishery for the year 2009 within the South African EEZ and on the high seas.

Twenty-nine foreign and South-African-flagged vessels operate within South African waters. Trip lengths range from three weeks to three months in duration. Although most vessels operate from the Cape Town harbour, the areas of operation are extensive within the entire South African EEZ. Tuna are targeted at thermocline fronts, predominantly along and offshore of the shelf break. Pelagic long-line vessels set a drifting mainline, up to 50-100 km in length, and are marked at intervals along its length with radio buoys (Dahn) and floats to facilitate later retrieval (see *Figure 3.24*). 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. Between radio buoys the mainline is kept near the surface or at a certain depth by means of ridged hard-plastic buoys, (connected via a "buoy-lines" of approximately 20 to 30 m). The buoys are spaced approximately 500 m apart along the length of the mainline. Hooks are attached to the mainline on branch lines, (droppers), which are clipped to the mainline at intervals of 20 to 30 m between the ridged buoys. The main line can consist of twisted tarred rope (6 to 8 mm diameter), nylon monofilament (5 to 7.5 mm diameter) or braided monofilament ~6mm in diameter. A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. During hauling a vessel's manoeuvrability is severely restricted, however, in an emergency situation; the line may be dropped to be hauled in at a later stage.

***Figure 3.24*** ***Typical Pelagic Long-line Gear Configuration Targeting Tuna, Swordfish and Shark Species***

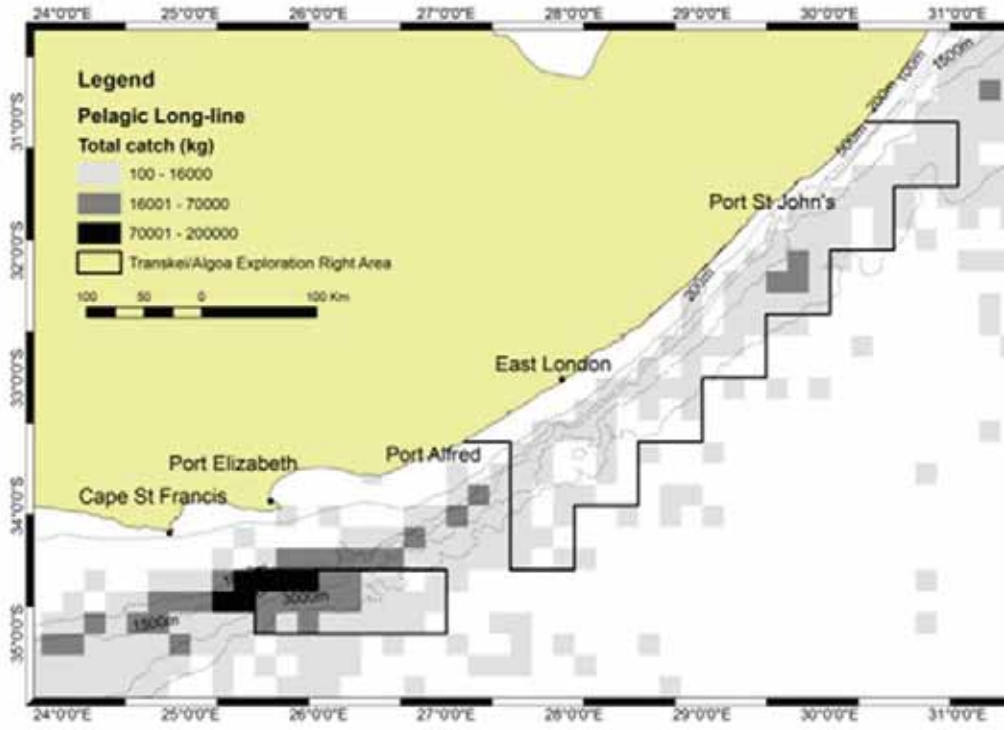



Source: CapFish, 2013
Note: The gear floats close to the surface of the sea and would present a potential obstruction to surface navigation.

Pelagic long-line effort extends along and offshore of the 200 m isobath. A high proportion of the pelagic long-line grounds occur within the proposed exploration areas (in both the Transkei and Algoa Exploration Areas) (see

*Figure 3.25*). Within the South African and foreign-flagged fleets combined approximately seven percent of the total national effort is conducted within this area (approximately 130 800 hooks per year), and six percent of the total national catch is taken by this fishery (approximately 85 tons per year).

***Figure 3.25 Distribution of Long-Line Fishing Effort Targeting Large Pelagic Species (Tuna, Shark and Swordfish) from 1997 to 2011 in relation to the Proposed Exploration Areas***



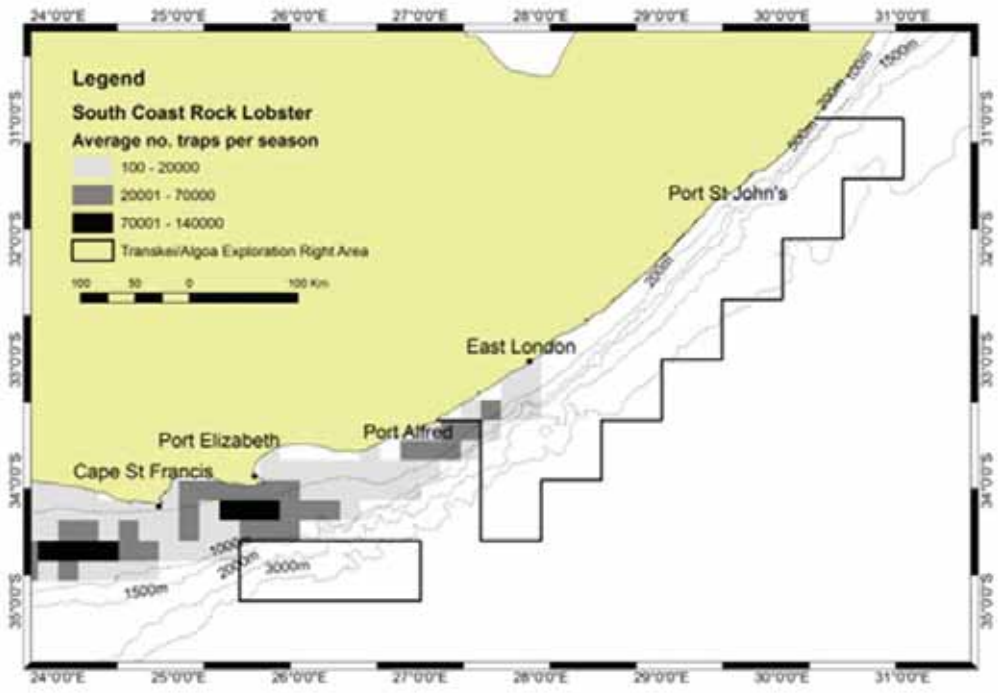

Source: CapFish, 2013

*South Coast Rock Lobster*

The South Coast rock lobster fishery is a deep-water long-line trap fishery. Barrel-shaped plastic traps set for periods ranging from 24 hours to several days. Each vessel typically hauls and resets approximately 2,000 traps per day in sets of 100 to 200 traps per line. They will set between ten lines and 16 lines per day, each of which may be up to 2 km in length. Each line will be weighted to lie along the seafloor and will be connected at each end to a marker buoy at the sea surface. Vessels are large, ranging from 30 m to 60 m in length. Those that have on-board freezing capacity will remain at sea for up to 40 days per trip, while those retaining live catch will remain at sea between seven and 10 days before discharging at port. The fishery operates year-round with the month of October showing relatively low activity within the fishery. There were seven vessels operating within the fishery in 2012.

South Coast Rock Lobster (*Palinurus gilchristi*) occurs on the continental shelf of the South Coast between depths of 50 m and 200 m. One area along the East coast (within the western portion of the Transkei Exploration Area) is commercially viable to fish, namely within 50 km of the shoreline between Port Elizabeth and East London (see *Figure 3.26*). The fishery is restricted by the Agulhas Current from operating far offshore, but would be expected to operate within the proposed Transkei Exploration Area, as mentioned above (refer to *Figure 3.26*). This area coincides with approximately five percent (2600 km$^2$) of the total South Coast rock lobster fishing grounds on the Agulhas Bank. Within the proposed exploration area approximately 21 400 traps were set between 2001 and 2011, which is three percent of the total effort conducted within South African waters by the South Coast rock lobster fishery. The catch of rock lobster taken from the area amounted to three percent of the total catch taken by the fishery between the years 2001 - 2011.

***Figure 3.26 Distribution of the South Coast Rock Lobster Trap Fishery in Relation to the Proposed Exploration Areas***




Source: CapFish, 2013

Note: Data are presented as the average annual number of traps hauled on a 10' by 10' grid basis for the period 2001 to 2011

*Traditional Line Fishery*

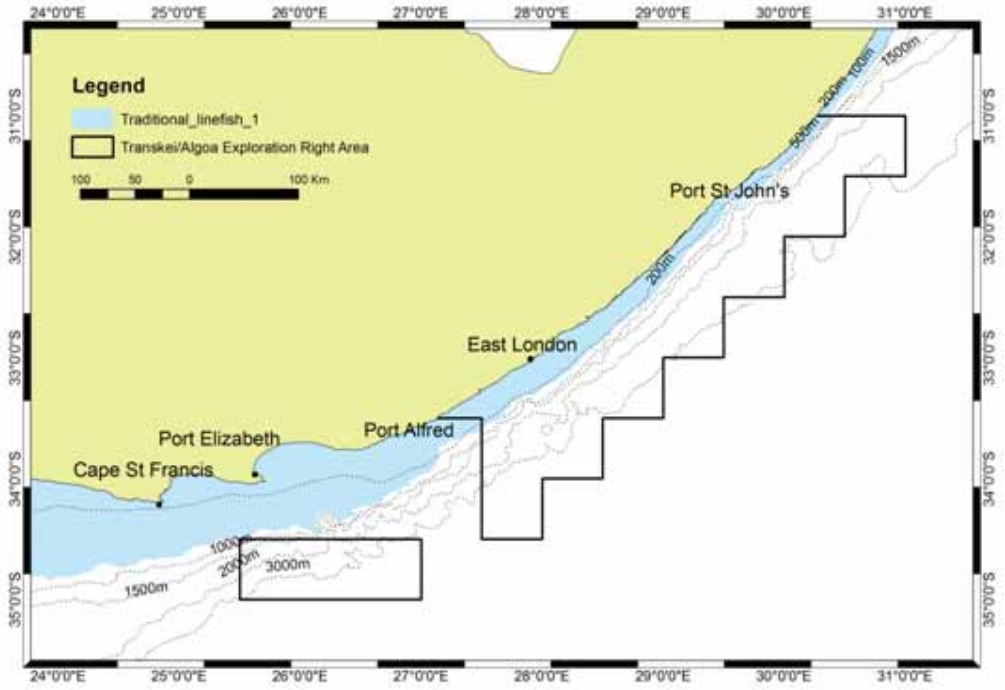
The traditional line fishery is based on approximately 35 species. Different assemblages of species are targeted according to the region in which they are being fished and include tuna species and a diversity of other species in the famillae (sparidae, serranidae, caragidae, scombridae and sciaenidae). On the West Coast the dominant species targeted is snoek (*Thyrsites atun*). This fishery is split between recreational, commercial and subsistence sectors,

jointly landing approximately 14 100 tons per annum (2009). Historically, the sector incorporated the tuna pole fishery and was ranked third according to volume of landings and overall economic value. Currently, the volume of fish caught by the traditional line fishery is much lower than many other commercial sectors, but is one of the most important in terms of the number of active participants. Almost all of the traditional line-fish catch is consumed locally.

The commercial fishery operates between Port Nolloth on the West Coast to Cape Vidal on the East Coast from the coast out to approximately the 100 m depth contour. Gear consists of hand line or rod-and-reel. Recreational permit-holders use ski boats (fast motor boats) or fish from the shore (anglers) whereas the commercial sector is purely boat-based. Subsistence permit-holders are shore-based and estuarine (purely based on the East Coast). It should be noted that the hake handline fishery (although currently not in operation) targets *M. capensis* on the south coast, in similar areas as the linefish sector. Line fishers are restricted to a maximum of ten hooks per line but a single fisherman may operate several lines at a time. Due to the diversity of the fishery there are many launch sites with an extensive operational range and is therefore managed on an effort rather than on a catch basis. There are currently about 450 commercial vessels operating extensively around the coast and many more ski boats used in the recreational sector which may be launched from a number of slipways and harbours.

Line-fish and hake hand-line activity is expected to occur predominantly in the proposed Transkei Exploration Area, particularly in the inshore regions (< 100 m), where the seismic survey vessel is likely to transit during inshore line changes. Line-fish data is not readily available at present; therefore known historical distribution of line-fish effort is shown in *Figure 3.27*.

***Figure 3.27 Approximate Range of Traditional Line and Hake Hand-line Fisheries in relation to the Proposed Exploration Areas***




Source: CapFish, 2013

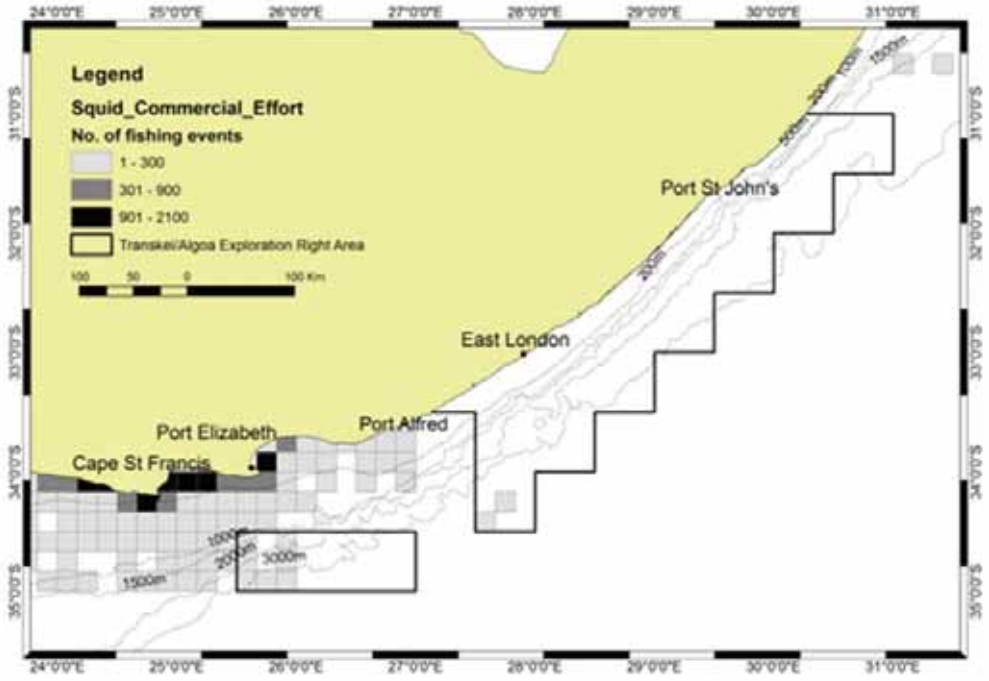
*Squid Jig*

Chokka squid (*Loligo vulgaris reynaudii*) is distributed from the border of Namibia to the East Coast of South Africa. Along the eastern extent of the South Coast adult squid is targeted (at depths of between 20 m and 120 m) in spawning aggregations that extend from Plettenberg Bay to Port Alfred (see *Figure 3.28*). The fishery is seasonal, with most effort conducted between November and March. The method of fishing involves hand-held jigs and bright lights which are used to attract squid at night. The catch is frozen at sea or at land-based facilities at harbours between Plettenberg Bay and Port Alfred.

The squid fishery is managed in terms of the Total Allowable Effort (TAE) allowed within the fishery and also sees an annual four week closure period between October and November during which time DAFF undertakes a survey on spawning aggregations in the bay areas. Fishing rights were issued to 121 companies for the period 2006 to 2013 with the number of crew and vessels active within the fishery listed as 2422 and 136 respectively. A maximum landed catch of 12 000 tons was recorded in 2003/4 with a levelling-off thereafter to 9 000 tons between 2005 and 2008. Currently the catch in the fishery approximates 6000 tons and the annual average catch value is about 180 million ZAR.

The distribution of fishing effort is mostly concentrated in the bay areas around Cape St Francis and Port Elizabeth (See *Figure 3.28*). Approximately, six percent (2565 km²) of the squid jig fishing grounds coincide with the Transkei/Algoa Exploration Area. The effort or number of fishing events that occur inside the proposed area amounts to 0.4 percent (25 events) of the total effort.

***Figure 3.28 Distribution of the Squid Jig Fishery in Relation to the Proposed Exploration Areas***




Source: CapFish, 2013

### *3.6.2 Shipping Transport*

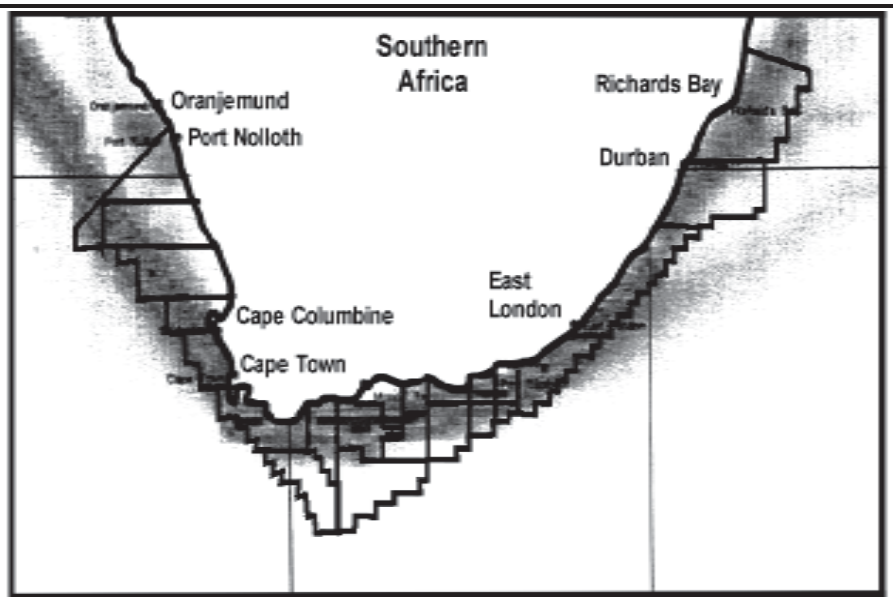
A large number of vessels navigate along the East Coast. *Table 3.8* and *Figure 3.29* and *Figure 3.30* illustrate the extent and distribution of shipping traffic along the coast of South Africa and the separation of east and west-bound traffic. This traffic is located relatively close to shore, and includes commercial and fishing vessels. North– and south-bound cargo vessels generally remain above the mid-shelf (100 m isobath). In contrast, tankers and bulk carriers remain further offshore, unless needing to move inshore to avoid extremely rough conditions that develop in the Agulhas Current. As depicted in *Figure 3.29*, the main shipping routes pass through the exploration area and its vicinity.

Maritime regulations require that tankers carrying more than a half percent of their deadweight tonnage should remain more than 12 miles off a line joining Cape Recife, Great Fish Point, Hood Point, Mbashe Point and South Sand Bluff. Should such tankers have to cross this line, they have to do so at right

angles. Important East Coast commercial harbours include Port Elizabeth, East London, Durban and Richards Bay.

During the austral winter season, vessels are advised to remain on course until they reach the boundary line of the Winter Zone, after which they should remain as close as possible to it. Charted Traffic Separation Schemes, which are International Maritime Organisation (IMO) adapted and other relevant information, are listed in the South African Annual Notice to Mariners No. 5, of 1999.

***Figure 3.29 Major Shipping Routes along the South Coast***




Source: CCA, 2001

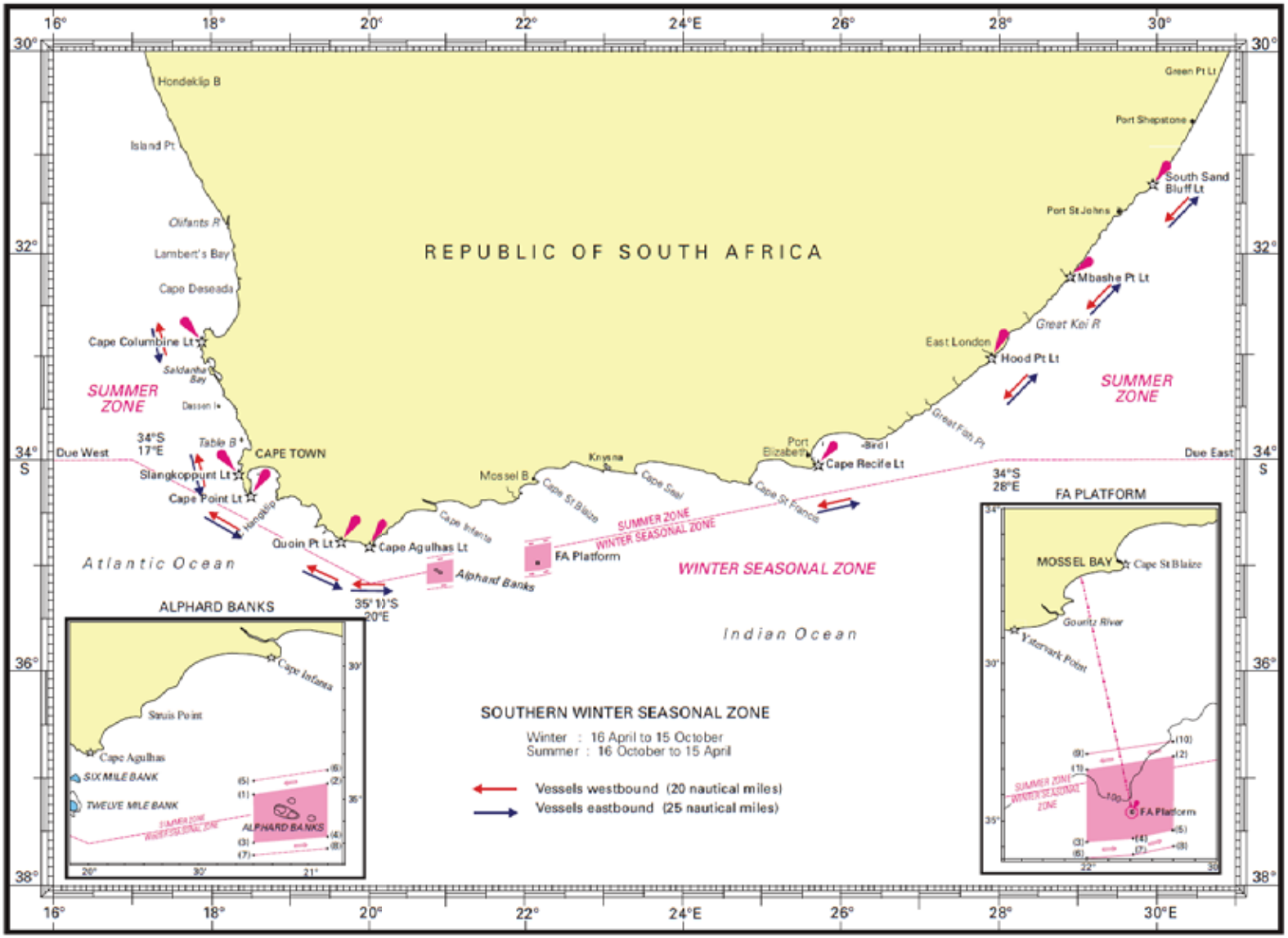
***Table 3.8 Number of Vessels calling at South African Ports and Sailing Past***

| Vessel type | No of Cape Point Roundings | No of Vessels calling in at Port | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cape Town | Durban | East London | Mossel Bay | Port Elizabeth | Richard's Bay | Saldanha |
| Bulk | 135 | 421 | 814 | 18 | | 86 | 1063 | 159 |
| Cargo | 113 | 961 | 1444 | 103 | 4 | 262 | 287 | 19 |
| Unknown | 128 | | | | | | | |
| Vehicle Carrier | 12 | 54 | 130 | 7 | | 26 | 13 | 1 |
| Container Carrier | 74 | 672 | 852 | 45 | | 376 | 25 | 2 |
| Miscellaneous | 7 | | | | | | | |
| Tanker | 140 | 217 | 570 | 70 | 30 | 87 | 199 | 36 |

| Vessel type | No of Cape Point Roundings | No of Vessels calling in at Port | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Vessels/ year | 609 | 2325 | 3810 | 243 | 34 | 837 | 1587 | 217 |

Source: Silvermine Maritime Intelligence, CCA, 2001

***Figure 3.30 Safe Shipping Routes around the Coast of South Africa***




Source: SA Notices to Mariner No. 10 of 2013

### 3.6.3 *Recreational Uses*

Recreational use of the East Coast marine environment involves both consumptive and non-consumptive uses. The former involves coastal users removing marine resources for their own consumption, while the latter involves sea users making use of the marine environment without removing any marine resources from the area.

*Consumptive uses*

This includes recreational shore and boat-based anglers (Brouwer et al., 1997) and spearfishers (Mann *et al*, 1997), divers collecting subtidal invertebrates, and exploiters of intertidal organisms. Most of the recreational exploitation of marine resources along the East Coast occurs within inshore waters in the vicinity of coastal towns and holiday resorts. Shore and boat-based fishers often target the same linefish species as the commercial anglers, although shore anglers and spearfishers also land species not caught by commercial. Skin divers collect rock lobsters (either *Jasus lalandii* or *Panulirus homarus*), perlemoen (*Haliotis midae*), mussels, limpets, red bait, alikreukel (*Turbo sarmaticus*) and sand mussels along the South Coast intertidal areas.

*Non-consumptive uses*

Non-consumptive utilisation of the marine environment includes water sports such as surfing, boating, SCUBA diving, nature watching and beach recreation. According to Jackson and Lipschitz (1984), 225 recreational sites are situated along the East Coast, with the majority being located near coastal settlements. Non-consumptive utilisation practices are typically undertaken for the aesthetic value of the region and in particular, the diversity of marine life. There are also several popular diving locations along the coast including Aliwal Shoal, Protea Bank, Sodwana Bay regions and surrounding reefs.

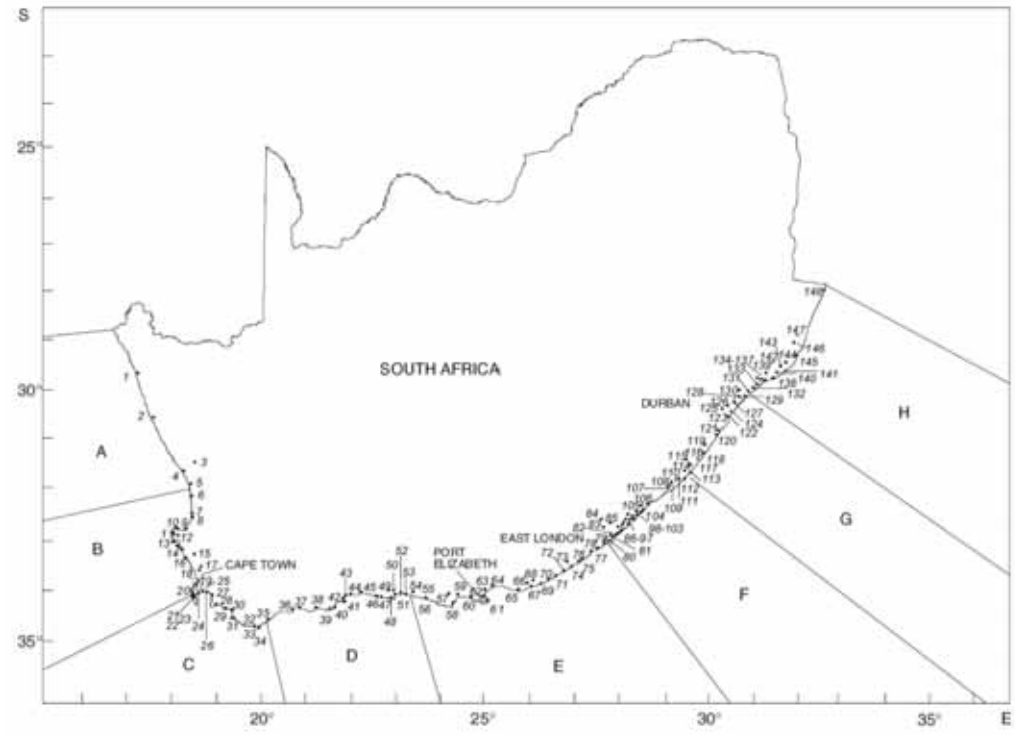
### 3.6.4 *Subsistence fishers*

The East Coast is home to a large poor rural population many of whom are directly reliant on the coast for their livelihoods (Clark *et al*., 2002). These subsistence fisher communities include predominantly low income local Xhosa or Pondo people who live in the eastern part of the country, generally in the traditional 'homelands' areas (1), including the Transkei, Ciskei and KwaZulu. Resultant high population densities and the virtual absence of infrastructure and any prospects for employment in these areas has meant that many of these people have been forced to adopt, or return to, a traditional subsistence lifestyle (Clark *et al*., 2002).

(1) Ten self-governing territories for different black ethnic groups were established as part of the policy of apartheid.

In 2002, it was estimated that there are about 147 fishing communities, an estimated 28,338 fisher households and 29,233 people who potentially could be considered as subsistence fishers in South Africa (Clark *et al*., 2002). Of these, approximately 75 percent were considered to be living along the East Coast, in areas such as the Transkei and KwaZulu Natal. Specific subsistence communities identified along the shoreline within the Transkei Exploration Area are shown in *Figure 3.31*.

***Figure 3.31 Map Showing the Eight Coastal Regions (A–H) and the Locations of Subsistence Fishing Communities***



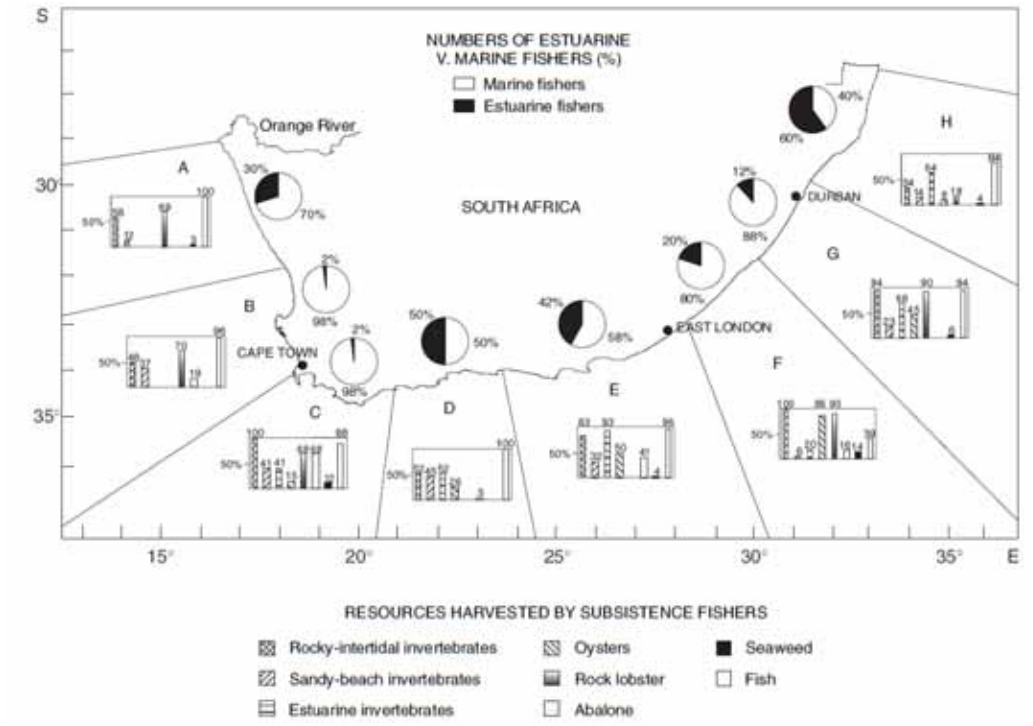

| Region E | | Region F | |
|---|---|---|---|
| 60. Cape Recife | 69. Fish River | 80. Qolora | 96. Cwebe |
| 61. Port Elizabeth Harbour | 70. Bira | 81. Ncizele | 97. Nkanya |
| 62. Swartkops | 71. Keiskamma West | 82. Debese | 98. Qatywa |
| 63. Colchester/Sundays | 72. Keiskamma East | 83. Kobonqaba | 99. Bulungulu |
| 64. Nankos | 73. Chulumna | 84. Maxambeni | 100. Mdikana |
| 65. Bushmans/Klipfontein | 74. Kidd's Beach | 85. Mazeppa | 101. Zitulele |
| 66. Marselle | 75. Cove Rock | 86. Mkawukazi | 102. Coffee Bay |
| 67. Kariega | 76. Fuller's Bay | 87. Ngadla | 103. Madakeni |
| 68. Port Alfred/Kowie | 77. East London | 88. Xazini | 104. Ndungunyeni |
| | 78. Gonubie | 89. Mahasana | 105. Sikolweni |
| | 79. Kei Mouth | 90. Kwa Bitsha | 106. Mtentu |
| | | 91. Nqabarana | 107. Skhombe |
| | | 92. Ntubeni | 108. Mtolane |
| | | 93. Mpume | 109. Mnyameni |
| | | 94. Mendwana | 110. Mpahlane |
| | | 95. Hobeni | 111. Mzamba |
| | | | 112. Nqeza |

Source: Clark et al., 2002.

Apart from harvesting the available line-fish the fishers also collect various invertebrates (eg mussels, oysters, winkles) and other benthic bait (eg red bait, mud/sand and penaid prawns) from the rocky shoreline and/or nearby estuaries. *Figure 3.32* provides an indication of the types of marine resources that are harvested by subsistence fishers within the proposed Transkei

Exploration Area. According to this study, subsistence fishers within the proposed Transkei Exploration Area predominantly harvest resources from marine habitats, as opposed to estuarine habitats. Both subsistence fishers from Area F (along the Transkei coastal region) and Area E (southern part of the Eastern Cape), harvest a high proportion of rocky intertidal invertebrates. However, while fishers in Area F harvest a relatively higher proportion of oysters and rock lobsters; fishers in Area E harvest a higher proportion of fish and abalone (refer to *Figure 3.33*).

***Figure 3.32 Proportion of Marine and Estuarine Subsistence Fishers and Typical Resources Harvested***




Source: Clark et al., 2002.

### *3.6.5 Mining and Prospecting Rights and Activities*

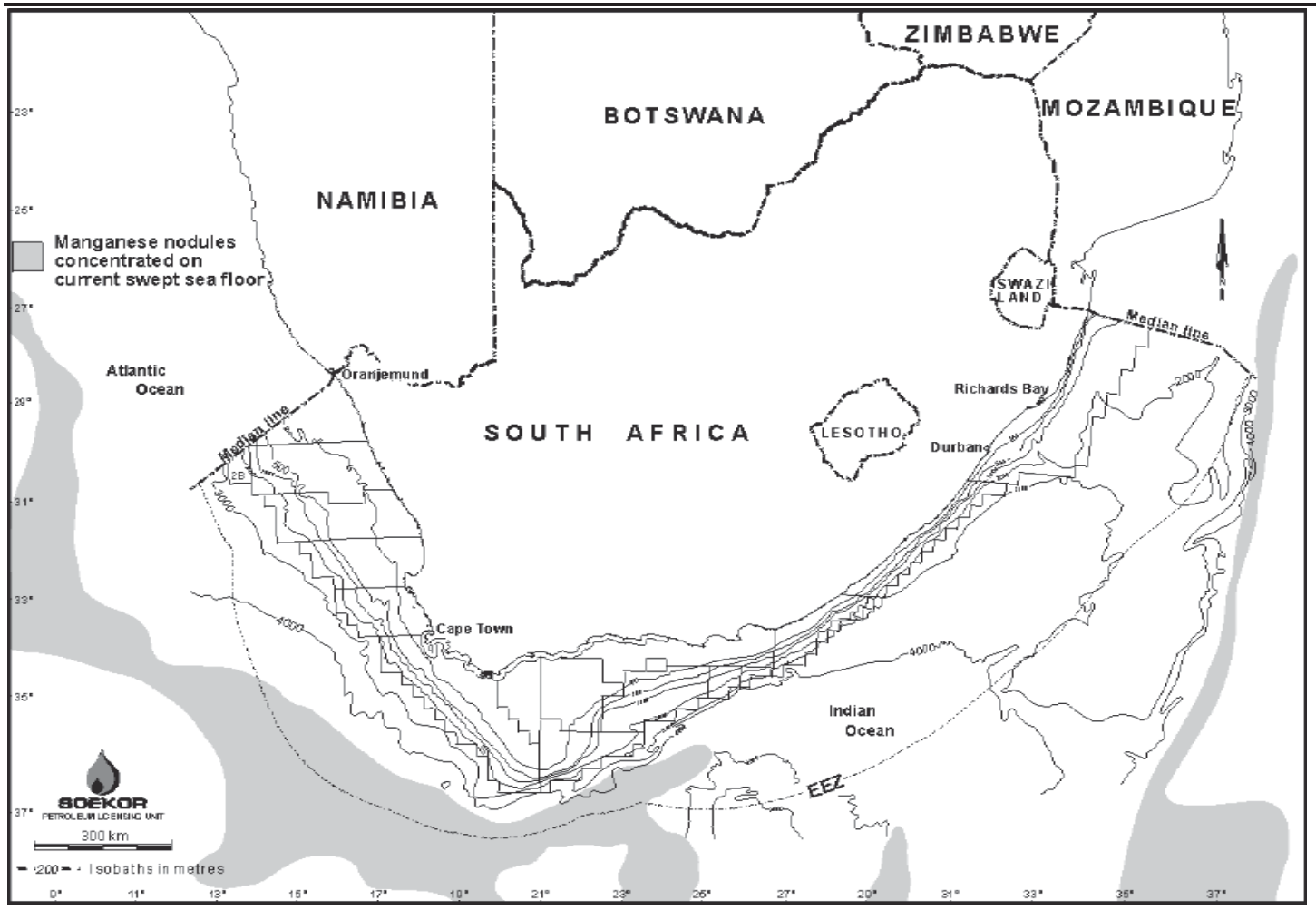
*Glauconite and Phosphorite Prospecting*

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 and South Coasts, but not on the East Coast.

*Prospecting for Manganese Nodules in Ultra-deep Water*

Manganese nodules (refer to *Figure 3.33*) enriched in valuable metals occur in deep water areas (> 3 000 m) on the East Coast (Rogers, 1995; Rogers and Bremner, 1991). However, nickel, copper and cobalt contents of the nodules fall below the current mining economic cut-off grade of 2 percent over most of the area. No prospecting permits have been applied for to date.

***Figure 3.33 Schematic of Manganese Nodules off Southern Africa***

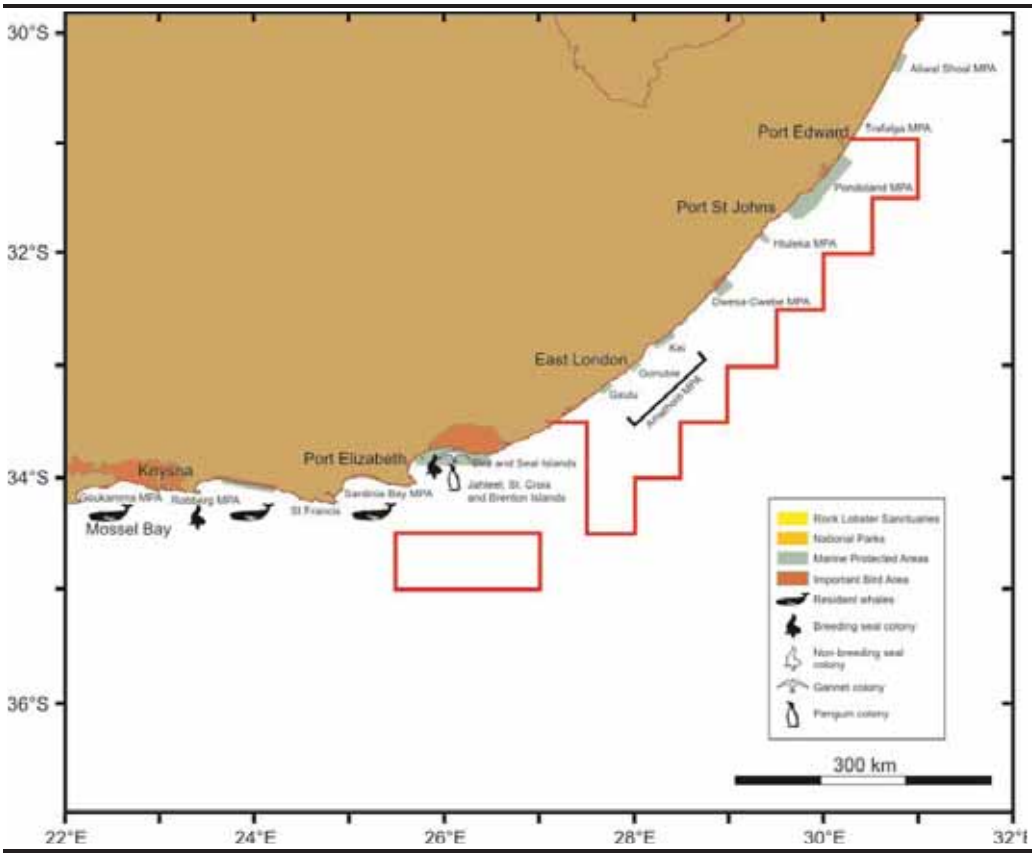



Source: Rogers, 1995 and Fuggle and Rabie, 1992 in CCA, 2001

### 3.6.6 Marine Protected Areas

Numerous marine protected areas (MPAs) exist along the South and East coasts (*Figure 3.34*). There are four MPAs on the Western Cape Province coast east of Cape Agulhas [(1)] and six MPAs along the Eastern Cape Province coast, four of which fall within the Transkei Exploration Area. These include the Amathole (Gxulu Gonubie, and Kei) MPA, and the Dwesa-Cwebe, Hluleka and Pondoland MPAs located on the Wild Coast. The two remaining MPAs include Sardinia Bay and the Bird Island Group. *Figure 3.34* also illustrates the location of seabird and seal colonies, seasonal whale populations, and marine protected areas within and adjacent to the Exploration Areas.

**Figure 3.34 Project - Environment Interaction Points on the Southeast Coast**




Source: Pisces Environmental Services, 2013.

*Amathole MPA*

The Amathole MPA consists of three separate marine areas. These lie between Christmas Rock and the Gxulu River mouth, Nahoon Point and Gonubie Point, and Nyara River mouth and the Kei River mouth. The coastline of these areas generally coincides with the Eastern Cape Province's terrestrial Nature Reserves.

(1) De Hoop, Goukamma, Robberg, and Tsitsikama

The MPA was declared to provide long-term protection to the marine habitat and biodiversity in the Amathole Region and a sanctuary for species that have experienced boat-based overexploitation. It was also declared to encourage scientific research that supports the protection and conservation of biodiversity and ecosystem processes, and to reduce the risks of habitat degradation.

At present, the MPA only includes sea areas (not estuaries). However, only shore-based angling, spearfishing and bait collection is allowed. Fishing vessels may cross the MPA, but may not fish, or stop the vessel except at authorised launch sites.

*Dwesa-Cwebe MPA*

The Dwesa-Cwebe Marine Protected Area (MPA) is a no-take MPA (1) located adjacent to the Dwesa Nature Reserve about half way between East London and Port St Johns in the Eastern Cape Province. The shoreline of the MPA is 14 km in length, and extends from the western bank of the Suku River mouth (Elliotdale District) to Human's Rock (Willowvale District). The MPA also includes the tidal portion of the Mbashe River, which divides the reserve. The MPA extends 6 nautical miles (approximately 11 km) seaward of the high water mark and has a total are of 19, 293 hectares.

The Dwesa-Cwebe MPA is situated on the transition zone of the temperate and sub-tropical bioregions. Both the reserve and MPA are of high ecological value, with the reserve holding one of the largest remaining areas of indigenous coastal forest in the Eastern Cape Province. Similarly, the MPA is also of high ecological importance, as it marks the transition in the Agulhas Current between tropical systems to the north-east, and cold water systems to the south-west. In particular, it is an important habitat for several fish species, especially large sparids (*Rhabdosargus thorpei*). It is also an important spawing area (one of the only two) for the white steenbras (*Lithognathus lithognathus*) and threatened red steenbras (*Petrus rupesrtris*). There are also a number of important estuaries that act as nursery grounds for a number of marine fish species.

*Hluleka MPA*

The Hluleka MPA is a narrow, no-take MPA, situated about 30km south east of Port St. Johns, between the Mnenu River in the north and a beacon just north of the Hluleka village in the south. Although the reserve is fenced, access to the MPA is possible via the coastline. The MPA extends for approximately 4.5 km along the coastline, and 6 nautical miles (approximately 11km) seaward of the high water mark. The MPA is approximately 4, 860 hectares in size.

(1) No marine living resource extraction is permitted.

The Hluleka MPA was initially proclaimed in 1991 under the Transkei Decree and then later re-proclaimed under the Marine Living Resources Act (18 of 1998).

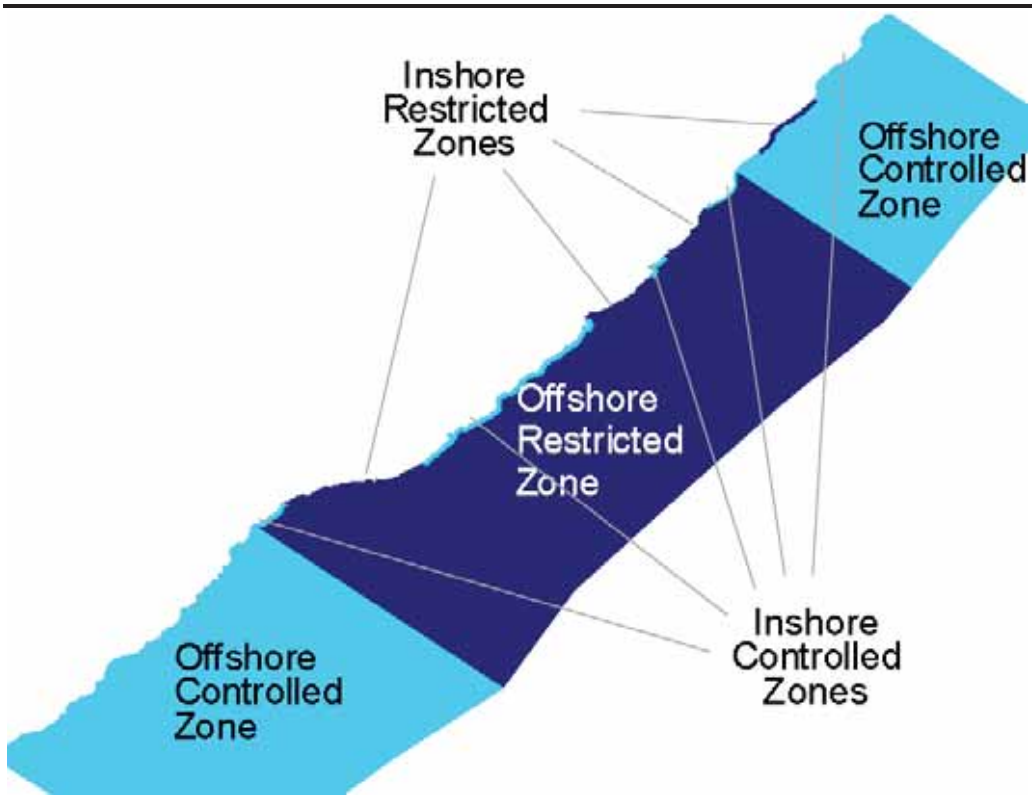
*Pondoland MPA*

The Pondoland MPA is South Africa's largest MPAs, stretching along the Eastern Cape Province coast for 90 km between the Mzamba River in the north and the Umzimvubu River in the south. It also extends offshore to the 1000 m isobaths (depth) which lies between 10 to 15 km offshore. The Pondoland has high levels of marine biodiversity, and many endemic species. This is supported by the wide variety of marine and coastal habitats, including rocky and sandy shores, sub-tidal reefs, and some of the most pristine estuaries in South Africa.

From a biodiversity perspective, the area provides a zone for the recuperation of certain overexploited linefish species including the red steenbras (*Petrus rupestris*), black musselcracker (*Cymatoceps nasutus*) and seventy-four (*Polysteganus undulosus*), as well as intertidal invertebrates such as the brown mussel (*Perna perna*), oyster (*Crassostrea margaritacea*) and limpet (*Helcion sp.*), that were historically heavily harvested.

The MPA is made up of different zones including restricted (i.e. no-take) and controlled (i.e. limited use) zones (*Figure 3.35*). Fishing is prohibited in the restricted zone which is situated between the Sikombe and Mbotyi Rivers to encourage the recovery of depleted linefish stocks.

***Figure 3.35 Pondoland MPA Zones***




Source: South African National Spatial Biodiversity Assessment, 2004

*Bird Island MPA*

Although the Bird Island MPA is located outside of the Exploration Areas, a brief description is included here due to its proximity to the proposed Algoa Exploration Area. For instance, species such as the Cape fur seal (*Arctocephalus pusillus pusillus)* and Cape Gannet (*Morus capensis*) feed in the Algoa Exploration Area.

The Bird Island group consisting of the Bird, Seal, Stag and Black Rock Islands is situated at the eastern side of Algoa Bay, off Woody Cape. The MPA was formed in 2004, and then included in Addo Elephant National Park in 2005. These islands (and St Croix Islands also in Algoa Bay) are classified as Important Bird Areas (IBA). Not only are they the only important seabird islands in 1800 km stretch of coastline between Dyer Island in the Western Cape Province and Inhaca Island in Mozambique, but they regularly host a significant population of internationally threatened seabird species (Barnes 1998). The islands are also home to five keystone species including the African penguin (*Spheniscus demersus*), cape gannet (*Morus capensis*), roseate (*Sterna dougallii*) and antarctic (*Sterna vittata*) terns, and the kelp gull (*Larus dominicanus*). In addition, the islands include a number of distinct habitats and endemic species of invertebrate, seaweed, and fish such as santer (*Cheimerius nufar*) and red roman (*Chrysoblephus laticeps*). Black Rocks also

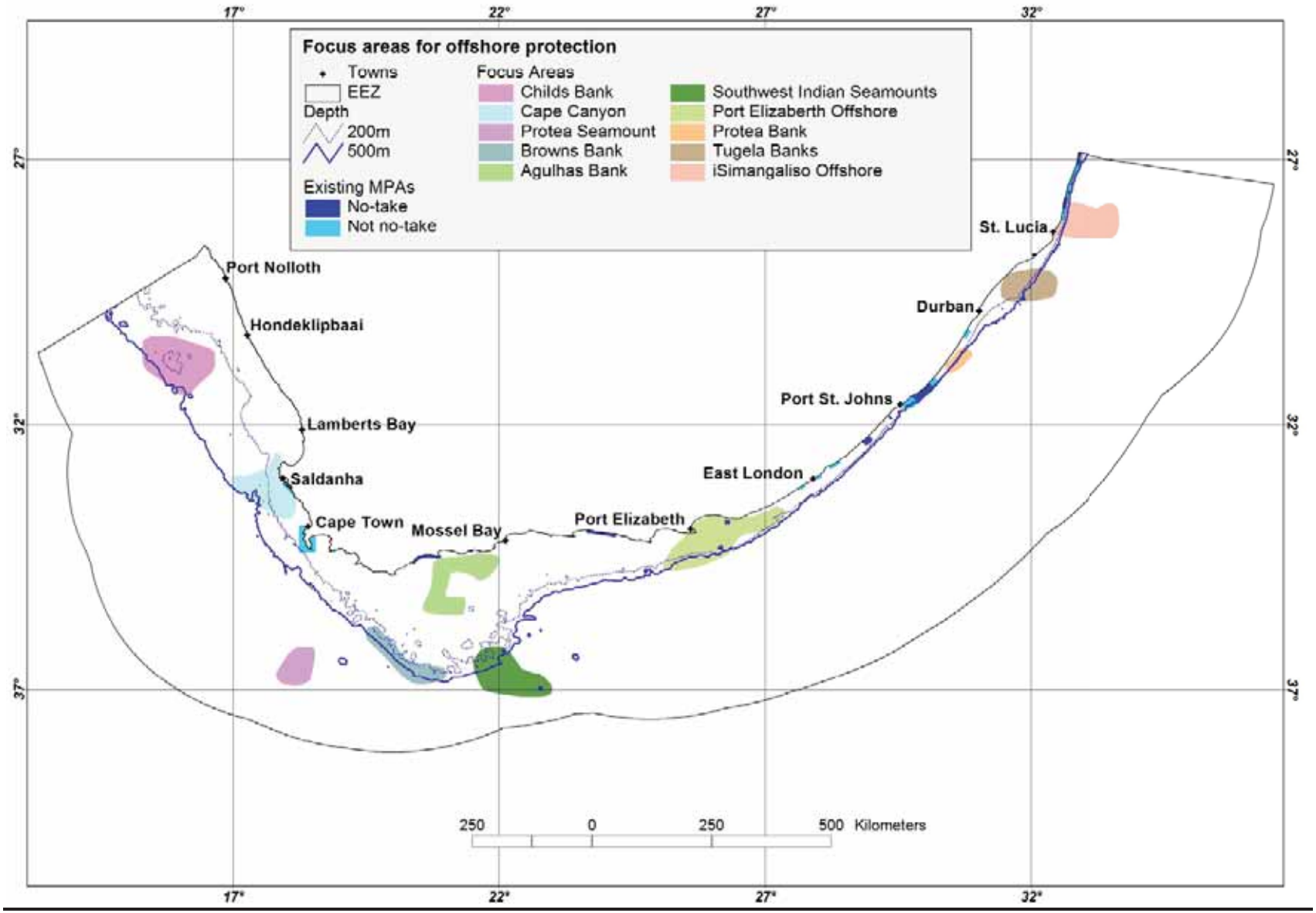
hosts an important seal colony and is a great white shark (*Carcharodon carcharias*) feeding area.

*The Offshore Marine Protected Area (MPA) Project*

The Offshore MPA project (SANBI, 2011) was established to address the inshore bias in South Africa's protected area system. Furthermore, it was envisaged that such a project could support ecosystem based management and spatial planning in the offshore environment and identify a potential network of offshore MPAs or other types of effective spatial management for this coastal zone (Sink and Attwood 2008).

As part of the Project, ten focus areas were identified for offshore biodiversity protection. The location of these specific focus areas is shown in *Figure 3.36.* Two of the identified focus areas fall partially within the proposed Exploration Areas. These include the shelf and shelf edge between Cape St Francis and Port Alfred, including the area offshore of Port Elizabeth (i.e. Port Elizabeth Offshore) and the area offshore of the KwaZulu-Natal south coast (i.e. Protea Banks). *Table 3.9* provides a summary of the key objectives, stakeholders and management considerations that apply to each of these offshore biodiversity protection focus areas.

*Figure 3.36 Ten Focus Areas for Offshore Biodiversity Protection through MPAs or other types of Spatial Management*




Source: Offshore Marine Protected Area Project (SANBI, 2011)

***Table 3.9 Key objectives, stakeholders and management considerations for each of the offshore biodiversity protection focus areas***

| Focus Area | Protection objectives | Affected stakeholders | Management considerations |
|---|---|---|---|
| Offshore Port Elizabeth | Offshore benthic habitat representation and protection;<br><br>Fisheries sustainability (kingklip, hake, linefish, squid);<br><br>Bycatch management; and<br><br>Protection of threatened species. | Inshore and offshore fisheries; and<br><br>Petroleum companies. | Seabed Protection zones, Fishery Management Areas and expansion of existing or proposed Marine Protected Areas.<br><br>Trade-off between irreplaceable offshore aspects and relatively high cost values in this area.<br><br>Suite of smaller appropriately zoned areas across this focus area could be appropriate (ie proposed Addo MPA and existing seasonal kingklip closure areas to be considered). |
| Protea Bank | Offshore benthic habitat representation and protection;<br><br>Pelagic habitats and Processes representation<br><br>Fisheries sustainability (linefish)<br><br>Threatened species (linefish) | Linefishery<br><br>Recreational fishers<br><br>Scuba divers<br><br>Large pelagic fishery (if offshore of 20 nm) | A zoned Marine Protected Area with the potential to provide for non-consumptive resource use.<br><br>The presence of 4 submarine canyons, deep reefs and 7cold water coral records highlight the need for effective seabed protection in this area although there is evidence that this area is important for pelagic processes (high frequency of fronts) and sharks.<br><br>This area could contribute to reef types that are currently underprotected in the bioregion and could help recovery of overexploited linefish.<br><br>Conflict between divers and fishers needs to be addressed but there is currently some voluntary effort to stop fishing in some areas. |

Source: Adapted from SANBI, 2011

At this stage, these focus areas only represent preliminary delineations for the spatial management of South Africa's offshore, based on best available information. As such, practical proposed boundaries for each focus area will need to be properly determined (in subsequent stages) through finer-scale interrogation of available spatial data and further stakeholder consultation. Despite this, it is important to take note of such developments, as it may have future implications for the proposed project. In this regard, specific types of spatial management measures that could be implemented in such areas could

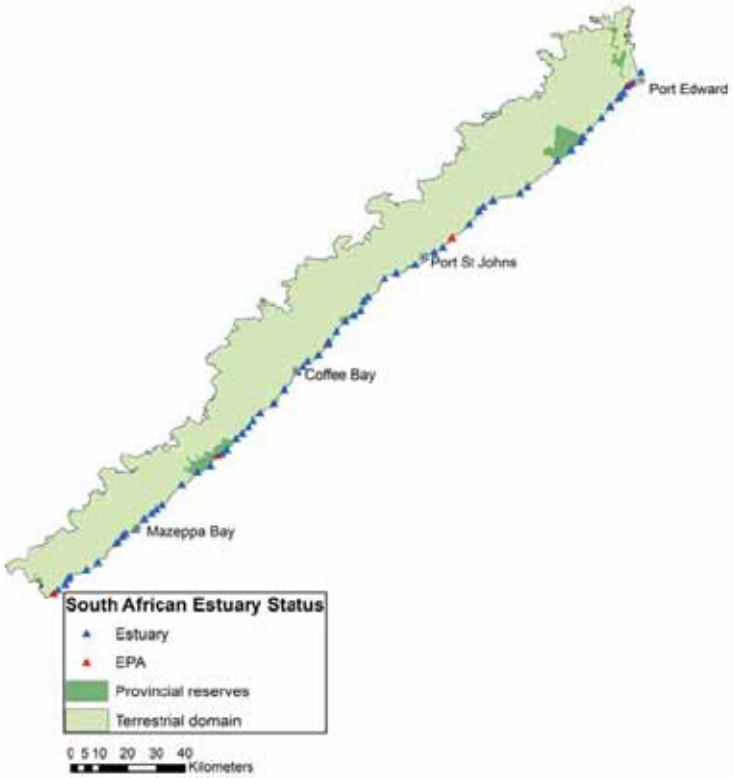
include, amongst others, zoned Marine Protected Areas or Fisheries Management Areas promulgated through South Africa's Marine Living Resources Act.

*Estuaries*

There are some 188 estuaries located along the East Coast region, between Gonubie (near East London) and Isipingo (near Durban). *Figure 3.37* below shows the location of estuaries and estuary protected areas (EPAs) located along the 'Wild Coast', within the Eastern Cape coastal region. These are all found within the boundary of the proposed Transkei Exploration Area.

Estuarine environments are considered to be valuable habitats, as they provide essential ecosystem services, such as nursery functions to coastal fisheries, freshwater flows to the marine environment, replenishment of nutrients and organic material to coastal habitats, flood and sea storm protection, carbon sequestration, safe bathing areas and cultivation of plants for biofuels without freshwater (Van Niekerk & Turpie, 2012). They are also considered to be resilient systems by nature, because their dynamic nature means that fauna and flora that inhabit these ecosystems are generally adapted to living in conditions of extreme change. As such, those species that can tolerate the estuarine environment are often very successful and abundant in their chosen environment (e.g. sand/mud prawns, mullet and bottom feeding fish or fish that eat plankton).

***Figure 3.37 Estuaries along the Wild Coast. The Estuaries in Red are Estuary Protected Areas (EPAs).***




Source: Reyers & Ginsburg, 2005.

A large proportion of the Estuaries along the East Coast (particularly those found along the 'Wild Coast' (1)) have been identified nationally as being of high biodiversity and ecological importance (i.e. the Mngazana and Mbashe estuaries). This relates to the pristine nature of many of the estuaries found along this coastline. In particular, Mngazama estuary (found along the 'Wild Coast') has been rated in the top 20 estuaries in South Africa, while another 9 have been rated within the top 50 estuaries in South Africa (Reyers & Ginsburg, 2005). *Table 3.10* provides a list of the key estuaries of the 'Wild Coast', which are listed in terms of their overall conservation importance.

***Table 3.10 Key Estuaries of the Wild Coast.***

| Estuary | Type | Size (ha) |
|---|---|---|
| Mngazana | Permanent | 224.9 |
| Mbashe | Permanent | 132 |
| Mtata | Permanent | 168.8 |
| Mzimvubu | River mouth | 151 |
| Xora | Permanent | 150.6 |
| Nxaxo/Ngqusi | Permanent | 159.5 |
| Great Kei | Permanent | 222.4 |
| Mzamba | Permanent | 70.94 |
| Mtentu | Permanent | 52.93 |
| Qora | Permanent | 89.63 |
| Mtakatye | Permanent | 116.8 |
| Mdumbi | Permanent | 76.07 |
| Mntafufu | Permanent | 24.07 |
| Mbotyi | Temporary | 50.39 |
| Nqabara | Permanent | 109.7 |
| Qolora | Temporary | 22.9 |
| Mtamvuna | Temporary | 63.53 |
| Mnenu | Temporary | 90.52 |
| Ntlonyane | Temporary | 41.34 |
| Msikaba | Permanent | 15.13 |

Limited research has been undertaken in recent years to determine the biodiversity make-up of the estuaries found within this coastal region. In this regard, the National Biodiversity Assessment (Van Niekerk & Turpie, 2012) acknowledges that existing research is outdated and that new studies urgently need to be undertaken in a once-off effort that is comparable with that of earlier surveys. Despite this, a short summary of the key biophysical elements associated with the Mngazana Estuary (one of the key estuaries located in the proposed Transkei Exploration Area), are provided below.

Mngazana Estuary

The Mngazana Estuary (*Figure 3.38*) is a permanently open estuary (approximately 6 km in length) that is located south of Port St Johns, along the Eastern Cape coastline. The full length of the estuary is approximately 6 km

(1) The 'Wild Coast' is a section of the coast of the Eastern Cape, South Africa. The region stretches from East London in the south to the border of KwaZulu-Natal in the north.

in length; however this is subject to tidal exchanges (USAID, 2005). The estuary itself is regarded as one of the most important estuaries in the Eastern Cape, as it forms part of a 140 hectare stand of mangroves, which have been identified to comprise the third largest stand in South Africa.

***Figure 3.38 Aerial Photograph of the Mngazana Estuary***



Source: http://www.ecdc.co.za/

Mngazana plays host to a diverse number of both invertebrate and fish communities. This includes temperate, tropical and subtropical species, predominating in the lower, middle and head reaches, respectively. De Wet (2004) reports 209 invertebrate and 62 fish species, of which many are juveniles of tropical species, had been identified within the estuary up to the date of the study (2004). Furthermore, three species of Red Data listed crabs have been identified in the estuary (Sgwabe *et al*., 2004).

The vegetation of the Mngazana Estuary comprises a number of plant communities, with the mangrove swamp as the main feature. There is also sea-grass and salt-marsh communities, with dune forests along the east bank of the estuary mouth.

The fauna in the vicinity of the Mngazana Estuary is poorly documented (De Wet, 2004). It is thought to correlate with fauna predominantly found in the region, including small mammals like water mongoose, bush buck, bush pigs and blue duiker (De Wet 2004). Finally, over 100 species of birds have been recorded, including rare species such as the Mangrove kingfisher (Sgwabe *et al*., 2004).

### 3.6.7 Heritage Sites

*Archaeological sites*

There are over 2000 shipwrecks along the South African coastline (Gribble, 1997). Many of these are located in the Algoa and Transkei Exploration Areas which is rich in Maritime and Underwater Cultural Heritage (MUCH). Xhosa and Zulu mythologies and intangible heritage include several references to water, particularly in terms of ancestor and origin lore. Furthermore, the Eastern Cape formed the front line of contact between European settlers and indigenous Africans from the mid-18th Century and hosts numerous wreck sites as a result. It is no enigma as to the origin of the Wild Coast name. For centuries mariners have battled through this section of ocean. Rough seas, rogue waves, historically poor maps and unforgiving shorelines have resulted in the loss of copious ships. Some of South Africa's most well know shipwrecks, including the *Waratah* (1909), the English East Indiaman *Grosvenor* (1782) the Dutch East Indiaman *Stavenisse* (1686) and several Portuguese trade vessels engaged in the *carreira da India* lie within the exploration areas. As a result, exploration and sampling in the area should be approached with caution and care.

The earliest known shipwreck within the proposed Transkei Exploration Area is the Portuguese carrack *Sao Joao* (1552) near Port Edward. This does not exclude the possibility of earlier, unrecorded wrecks being located in the Exploration Area. Arab traders and explorers were active in southern Mozambique at least as early as the 13th Century and may have sailed deep into the current South African waters. Shipwrecks have occurred at frequent intervals since 1552, the most recent being the *BBC China* wrecked in 2004.

Most of the known wrecks on the East Coast are situated in fairly shallow water (within the 15 m depth contour) close to the shoreline (Turner, 1988), and many older than 60 years have been recorded (see Part C for List of Recorded Shipwrecks). This is important as wrecks older than 50 years old are important archaeological sites, and are thus declared national monuments (Gribble, 1997). Further, if any shipwreck remains which are regarded as archaeological are to be disturbed, a permit is required from the South African Heritage Resources Agency (SAHRA). The list in *Part C* is based on the last version of the SAHRA National Database of shipwrecks and was compiled by various researchers from a wide range of sources. From this list regions or areas of sensitivity can be identified.

Because most of the sites described on the shipwreck list in *Part C* have been documented only through survivor accounts, archival descriptions and eyewitness reports, many remain uncharted and undiscovered, it is not possible, therefore, to provide accurate location data. Many of the sites are located in relation to geographical landmarks, cities and other wreck sites.

Although the exact location of vessels cannot be provided, areas of particular sensitivity are as follows:

- The southern portion of the Transkei Exploration Area from north of Port Alfred to Gonubie contains the largest proportion of wreck sites.

- The area from the 15m depth contour to the shore encompasses the majority of sites since most vessels were lost through being driven ashore during storms or through poor navigation.

- Areas where 16th and 17th Century Portuguese shipwrecks are located, namely Port Edward, Msikaba River mouth, Port St Johns, Mtata River mouth, Double Mouth to Hagga-Hagga, Cannon Rocks near Woody Cape, Bonza Bay and the Cefane River mouth.

- Areas where Dutch East India Company shipwrecks may be located, namely Coffee Bay and the Mtana River mouth.

- Port Grosvenor. The wreck of the Grosvenor (1782) lies just offshore of this small holiday village.

The deep water of the proposed Algoa Exploration Area is less sensitive; however the possibility of shipwreck discovery cannot be excluded.

### *3.6.8 Other*

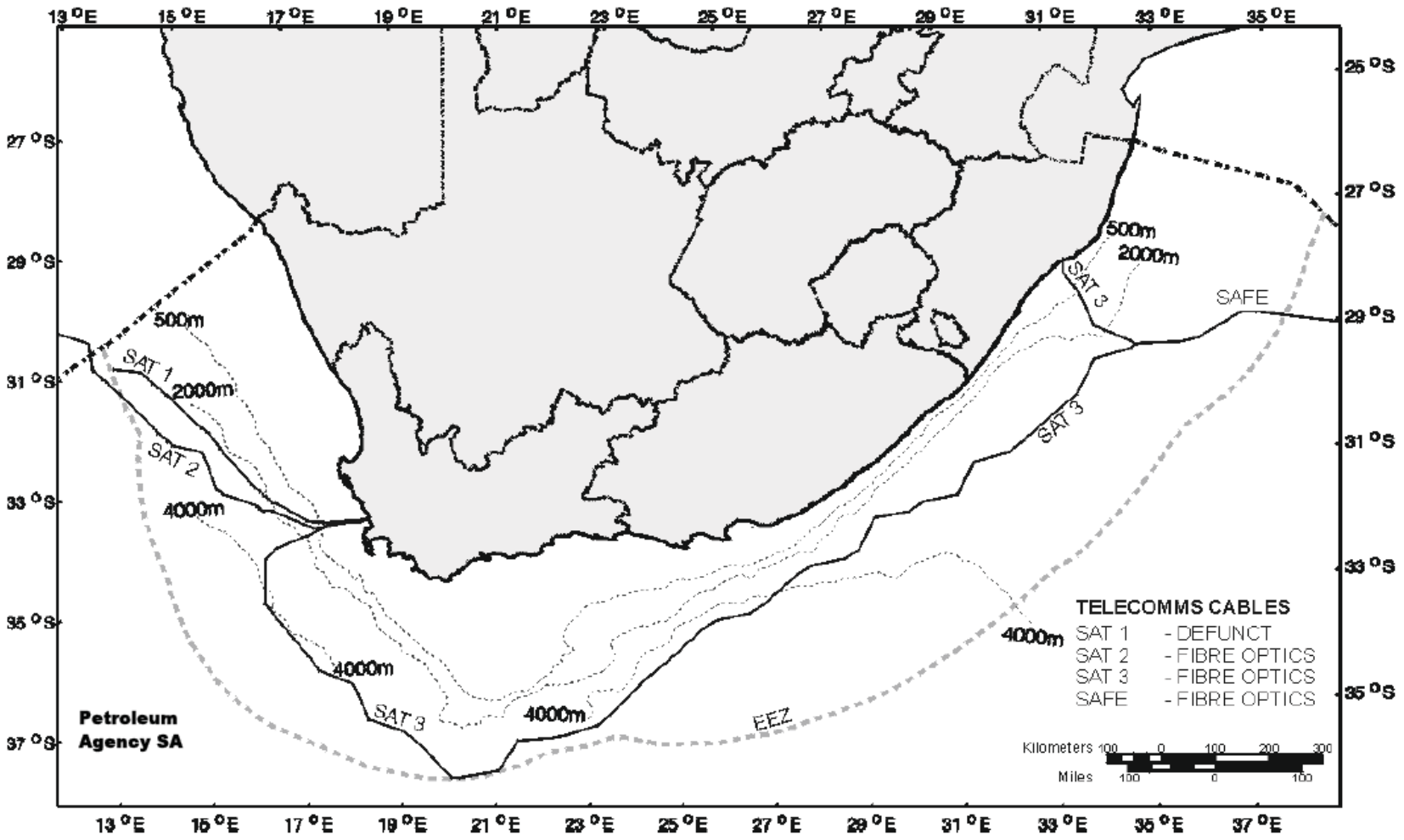
*Undersea Cables*

During 2001 Telkom installed a fibre optics cable, SAT-3, between Melkbosstrand on the West Coast and Mtunzini on the East Coast (*Figure 3.39*). Where seafloor conditions permitted, the SAT-3 cable was buried 0.7 m below the seafloor from the landing points to 1000 m water depth. There is an activity exclusion zone applicable to the telecommunication cables one nautical mile each side of the cable in which no anchoring is permitted. Although the SAT-3 passes through the exploration areas, the same exclusion zone would apply the use of sediment sampling for exploration purposes.

There are a number of additional undersea cables landing along the South African Coast; WACS on the west coast (Yzerfontein, Western Cape) and EASSY and Seacom on the east coast (Mtunzini in northern Kwazulu-Natal) respectively and will not affect the Exploration Areas.

Possible connections between the landings at Yzerfontein and Mtunzini are planned with connections to Port Elizabeth and East London, however the details of these have not as yet been confirmed.

***Figure 3.39*** ***Schematic Diagram of the Location of Undersea Cables***




Source: Telkom SA

*Mariculture Industries*

According to the Department of Agriculture, Forestry and Fisheries (2011), mariculture production in South Africa has increased by 56percent since 2001, with a total tonnage in 2010 around 2,000 tons from 33 marine aquaculture farms (Refer to *Figure 3.40*). Although the Western Cape Province accounts for 89 percent of total production (by weight) (Figure 3.41), the remaining 11percent is produced in the Eastern Cape Province, within three subsectors, namely, abalone (*Haliotis midae*), finfish (various edible species) and oysters (*Crassostrea margaritacea*). The Northern Cape and KwaZulu-Natal Provinces account for less than 1percent

Four mariculture farms are located within the proposed Transkei Exploration Area, and one mariculture farm (oyster) is located just to the west of the Exploration Area, near to the town of Port Alfred. The farms in the Exploration Areas include three finfish farms and an abalone farm (see *Figure 3.40*).

***Figure 3.40 Farms in Operation during 2010 and the Distribution of Cultured Marine Aquaculture Species in each Province***

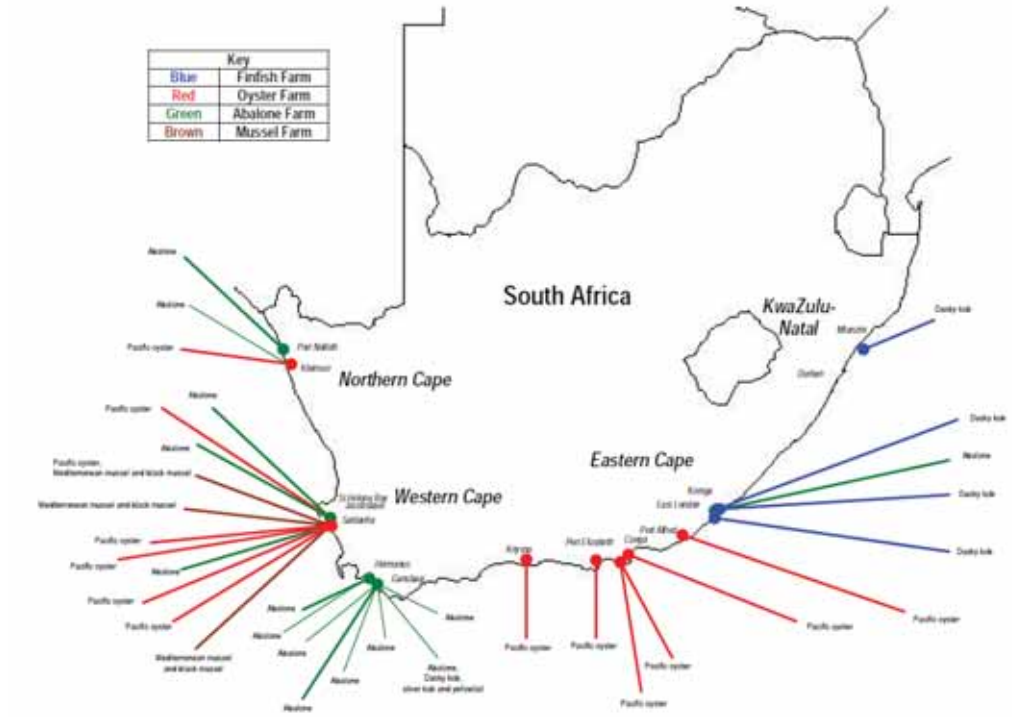
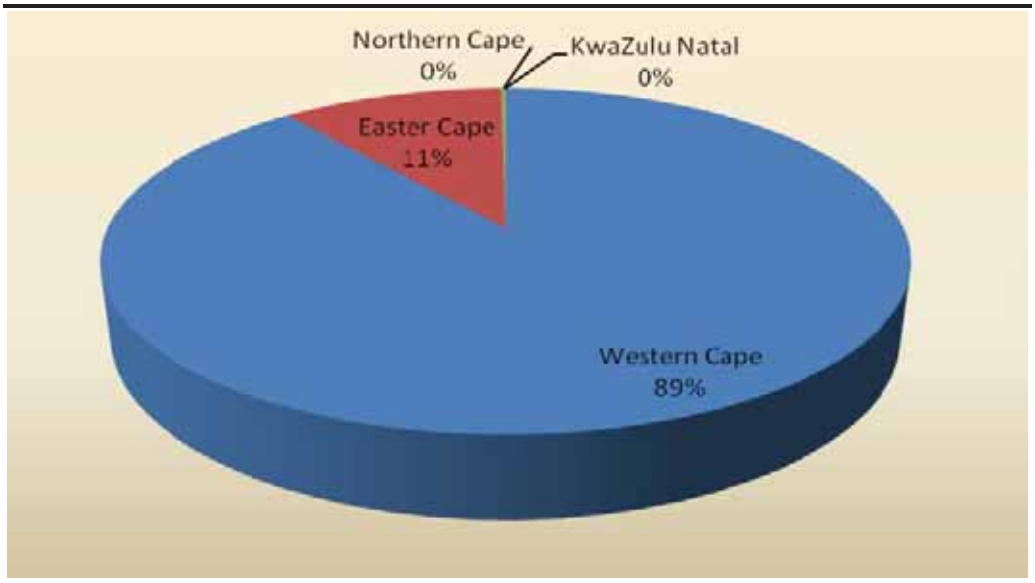


***Figure 3.41 Mariculture per Province***




Source: Aquaculture Technical Services in DAFF, 2011

*Marine Outfall/intake Pipes*

There are 63 sewage outfall pipes located along the South African Coast. Due to inadequate treatment, they are responsible for marine pollution and pose a threat to human health (DAFF, 2010). The most important pipeline in the vicinity of the exploration areas includes the sewerage outfall at Port Elizabeth that discharges 60,000 $m^3$/day of treated water through a 100 m pipeline. Other less important outfalls are those off Cape Recife, Drift Sands and Fishwater Flats in Port Elizabeth, and the West Bank/ Hood Point outfall. The proposed Exploration Activities are unlikely to interfere with any water discharge infrastructure.

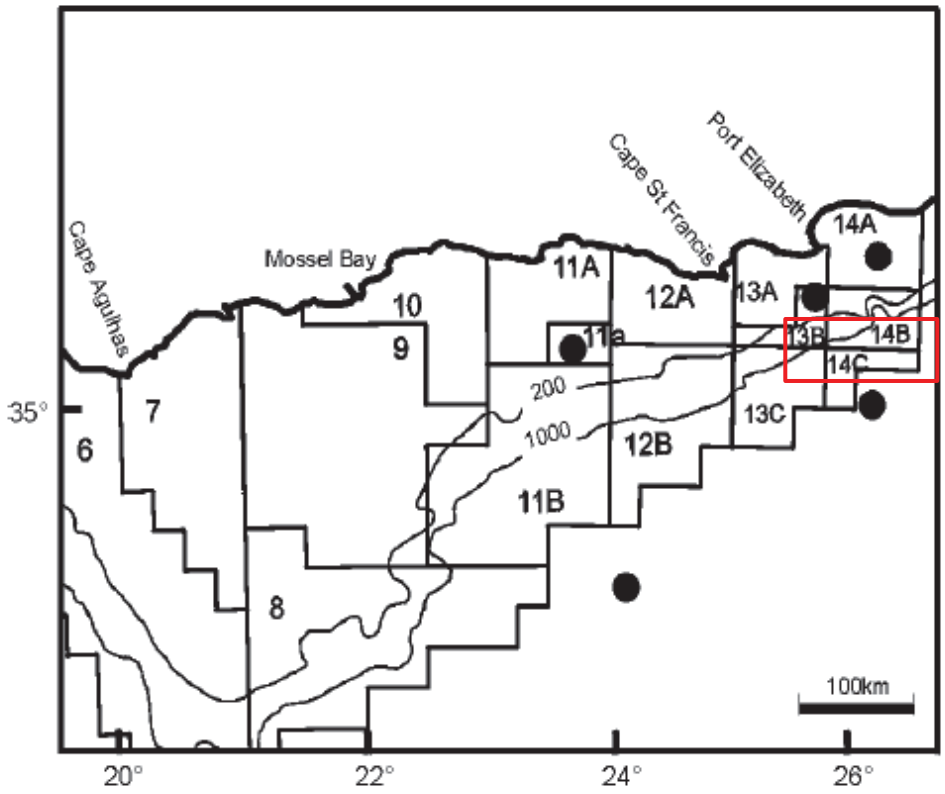
*Ammunition Dump Sites*

*Figure 3.42* and *Figure 3.43* depict the location of the ammunition dump sites along the East Coast. Trawlers and seismic vessels are advised to exercise the greatest caution in these areas. Nautical charts of the bay (e.g. INT 7531 SAN 1024 'Approaches to Port Elizabeth') warn mariners of projectiles and badly corroded mustard gas containers have been reported in the area between Cape St Francis and Bird Island out to depths of 400 m. Further information for the remaining sections of the East Coast is currently unavailable.

Details of ammunitions dumping areas are given on the relevant SAN charts which indicate an ammunition dump within the exploration areas (*Figure 3.42).* Caution should be taken when conducting seabed sampling in the western portion of the Algoa Exploration Area which is located between two ammunition dump sites (red box), and in the vicinity of a third ammunition dump site situated about 100 km offshore of East London. These dumps will not be physically impacted by the seismic activities as they are located on the

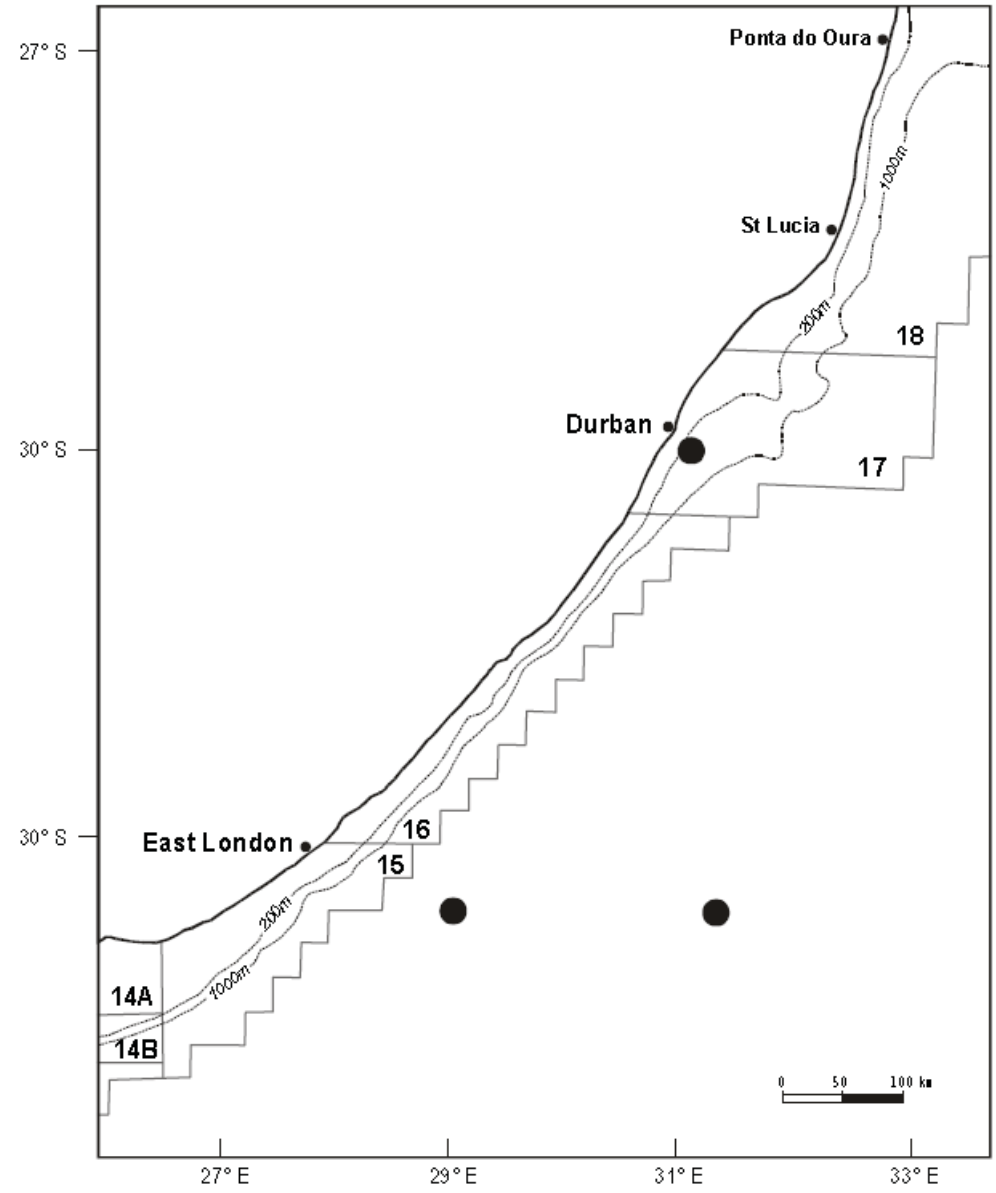
seafloor. Seismic surveys have also been used to identify marine ammunition dumping sites in other parts of the world (Koch *et al*, 2008) and it is therefore assumed that the risks of explosion are low. Confirmation of the benign effects of seismic noise on ammunition dumping sites, or additional mitigation measures are suggested within the EMPr should seismic surveys be required directly over the munitions dumping site.

***Figure 3.42 Location of Ammunition Dump Sites along the South Coast***




Source: CCA, 2001

*Figure 3.43 Location of Ammunition Dump Sites along the East Coast*




Source: CCA, 2001

### 3.6.9 Summary

Salient features related to the baseline environmental conditions within the East Coast area in general, and the proposed exploration areas, in particular, are presented below:

- The main features affecting weather patterns are the mid-latitude cyclone and South Atlantic and Indian Ocean anticyclone cells.
- Easterly winds predominate during austral summer and westerly winds during austral winter.

- The majority of waves (reaching a maximum of 10 m high), although westward-traveling, develop under prevailing easterly winds during summer and autumn.
- Water temperatures vary seasonally and in relation to the distance offshore, increasing offshore towards the centre of the Agulhas Current.
- Faunal communities within the offshore marine habitat are comparatively homogenous, largely as a result of the greater consistency in water temperature at depths around the South African coastline, than in the shallower coastal waters.
- There are numerous intertidal and shallow subtidal reefs that support a wide diversity of marine flora and fauna and a relatively high percentage of endemic species.
- Two important benthic habitats (i.e. Port Elizabeth Offshore Area and the Protea Banks) have been identified within the proposed exploration areas.
- Biological communities occurring in the proposed exploration areas comprise plankton, fish and marine mammal diversities, which often displaying considerable temporal and spatial variability (even at small scales).
- Only three species of birds (Grey-headed gull, Caspian tern and Swift tern are thought to breed regularly along the East Coast, within the proposed exploration areas (CSIR 1998). Despite this, many of the river mouths and estuaries along this coastline serve as important roosting and foraging sites for a variety of other seabirds.
- The continental shelf waters support greater and more variable concentrations of plankton biomass than offshore waters, with species composition varying seasonally.
- Numerous commercially important fish species are found within the proposed exploration areas, including kingklip, hake, anchovy and pilchards. Squid and rock lobsters are also prevalent within these parts.
- There are between 28 and 38 species of cetaceans (whales and dolphins) that are known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur in the region and one seal species, the Cape fur seal (*Arctocephalus pusillus*).
- Of the migratory cetaceans that may pass through the proposed exploration areas the blue, sei and humpback whales are listed as "Endangered" and the Southern Right and Fin whales as "Vulnerable".
- During the winter months of June to August, the penetration of northerly-flowing cooler water along the Eastern Cape coast and up to southern KwaZulu-Natal effectively expands the suitable habitat available for pilchards, resulting in a 'leakage' of large shoals northwards along the coast in what has traditionally been known as the 'sardine run'. The shoals can attain lengths of 20-30 km and are typically pursued by Great White Sharks, Copper Sharks, Common Dolphins, Cape Gannets and various other large pelagic predators.
- The demersal trawl, mid-water trawl and demersal long-line, handline, rock lobster and squid jig fisheries all have proportions of fishing grounds

that overlap with small portions of the proposed exploration areas. Particularly the western part of the proposed Algoa Exploration Area.

- A high proportion of the pelagic longline fishery grounds occur within the proposed exploration areas, in both the Transkei and Algoa Exploration Areas.
- There is a high distribution of shipping traffic within the proposed exploration areas. This traffic is located relatively close to shore, and generally includes commercial and fishing vessels.
- There is a high presence of recreational uses along the coastline, predominantly within inshore waters in the vicinity of coastal towns and holiday resorts.
- The East Coast, particularly the Transkei coastal area, is home to a large poor rural community that is directly reliant on the coast/marine resources to supplement their livelihoods.
- There are four MPAs that extend a few nautical miles from the shoreline within the proposed exploration areas, including the Amathole, Dwesa-Cwebe, Hluleka and Pondoland MPAs.
- There are some 188 estuaries located along the East Coast region, between Gonubie (near East London) and Isipingo (near Durban).
- The coastal region is considered to be rich in maritime and underwater cultural heritage.
- Four mariculture farms are located within the proposed Transkei Exploration Area, and one mariculture farm (oyster) is located just to the west of the project area, near to the town of Port Alfred.

# 4 CONSULTATION WITH INTERESTED AND AFFECTED PARTIES

This Chapter describes the process that was followed to notify, consult, and consider the input of Interested and Affected Parties (I&APs).

## 4.1 CONSULTATION PROCESS

The consultation process followed was in accordance with the requirements contained within the Minerals and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA), the MPRDA Regulations GN 527 of 2004, and the generic EMPr guideline and template documents.

The following describes the activities that were undertaken as part of the consultation process.

### 4.1.1 Identification of Interested and Affected Parties

Potential Interested and Affected Parties were identified through analysis of potential stakeholder and based on stakeholders engaged in previous similar studies in the area. A listing of I&APs was created for use in the consultation programmes. The list included government authorities (local and regional), Non-Governmental Organisations (NGO), Community-Based Organisations (CBO) and industry groups (including the fishing industry). The list was further expanded through feedback and suggestions received following consultation and disclosure activities.

A full list of I&APs identified is provided in *Appendix B-3*.

### 4.1.2 Description of Consultation Activities

*Background Information Document*

A Background Information Document (BID) was prepared providing an overview of the proposed exploration activities and locations. The information was provided in a non-technical format. The BID also provided instruction for submitting comments and input for consideration in the EMPr process.

See *Appendix A* for a copy of the BID that was distributed.

The BID was distributed via electronic mail to all I&APs that had been identified. It was also made available on the project information website:

http://www.erm.com/TranskeiAlgoa-EMPR

*Public Notification and Initial Comment Period*

The general public was notified about the proposed activities and of the consultation process through public notice. Adverts were placed on Friday, 22 March 2013 in the *Times*, *Die Burger* (Eastern Cape), *The Herald* and the *Daily Dispatch* informing the broader public about the proposed exploration activities. Copies of the adverts are provided as (*Appendix B-1*). The adverts provided details of the consultation process and provided information on how members of the public could provide input.

A period of 21 calendar days (22 March 2013 to 12 April 2013) was allowed for I&APs to submit issues or concerns for consideration in the compilation of the EMPr. This period also allowed for members of the public to register as I&APs and/or submit issues or concerns. Further I&APs were identified through this process.

*Comment and Response Process*

Receipt of comments received during the initial comment period was formally acknowledged to the sender and comments were registered. Where possible at that time, a response or additional information was provided.

Copies of electronic mail correspondence received during the initial comment period are provided in *Appendix B-2* and a list of I&APs identified through this process is provided in *Appendix B-3*.

Issues raised and comments submitted during the initial comment period have been compiled into a Comments and Responses Report attached as *Appendix B-4*.

*Comment Period*

The draft EMPr was made available to I&APs for a period of 30 calendar days (24 May – 24 June 2013) on the project website:

http://www.erm.com/TranskeiAlgoa-EMPR

Notification of availability was sent directly to all I&APs. Copies of electronic mail correspondence received during this comment period are provided in *Appendix B-2.*

The EMPr has been updated based on comments received during the comment period. All comments received on the EMPr during the comment period have been compiled and documented in the Comments and Responses

report and the updated document will be submitted to PASA as *Appendix B-4* of this report.

*Consultation Meetings*

During the comment period a series of face-to-face engagements were conducted including *group meetings* (in an open house format) and *focused group meetings* (in a standard meeting format) as part of the stakeholder engagement process. All I&APs on the stakeholder database were notified of and invited to the group meetings.

Three group meetings were held, one each in Port Elizabeth (3 June 2013), East London (4 June 2013) and Port St Johns (5 June 2013). In addition, two focused group meetings were held with:

- Provincial Environmental Authorities (Eastern Cape Parks and Tourism Agency and Department of Economic Development, Environmental Affairs and Tourism) in East London (4 June 2013); and
- Two traditional monarchs and their senior advisors were met in Mthatha, as well as Richard Stephenson who is mandated to represent the 4 of the Transkei Kingdoms regarding this project. (1)

## 4.2 SUMMARY OF ISSUES RAISED

The issues presented in this Section have been summarised from the issues raised and comments submitted by I&APs during the initial comment period (*Appendix B-2*). In summary the issues raised pertained to:

- Potential for impacts on sensitive marine fauna;
- Potential for impacts on fishing;
- Potential for adverse impacts on marine heritage resources in the area; and
- Proximity to the sensitive Marine Protected Areas (MPA).

Detailed comments and responses can be found in the Comments and Response Report in *Appendix B-4*.

(1)The Royal Monarchs Council has subsequently been formed which represents the following Kingdoms:

- Thembuland- King Zwelibanzi Dalindyebo;
- Western Pondoland – King Mangaliso Ndamase; and
- Xhosaland – King Zwelonke Sigcau.

### *4.2.1 Sensitive Marine Fauna*

A number of I&APs expressed concern that the proposed exploration activities, in particular seismic surveys, would result in the disturbance of the sensitive marine life in the area.

The baseline description of the sensitive marine fauna within the survey block and potential impacts on marine mammals and seabirds are discussed and assessed in *Chapter 3* and *Chapter 6* respectively. A number of mitigation measures will be adopted specifically to address potential impacts to marine fauna.

### *4.2.2 Fishing*

A number of stakeholders raised concern regarding the potential impacts to fish and fishing in the area. Stakeholders referenced concerns raised by Norwegian fisherman. A study has been undertaken by Det Norske Veritas (1) which concludes that seismic activities on the Norwegian continental shelf have little effect on fish. Studies show there is negligible direct physical damage, but that there may be a behavioural change in the vicinity of the seismic source. Seismic surveys will have an impact on fish behaviour, but the reported magnitude of the area covered by this impact is variable.

A specialist fisheries impact assessment has been undertaken in order to assess the potential impact to fishing in the exploration areas. Baseline information is provided in *Chapter 3* and the impact assessment in *Chapter 6*. Mitigations that will be adopted to avoid or reduce impacts to fish and fishing are detailed in *Chapter 6* and the Implementation Plan in *Part B*.

### *4.2.3 Marine Heritage Resources*

The South African Heritage Resources Agency (SAHRA) expressed concern over the possible impacts of the proposed exploration activities on maritime heritage resources in the exploration area. Numerous historic shipwrecks have occurred in the area, mainly closer to shore.

In response a specialist maritime archaeologist was contracted to provide an opinion on the proposed project and its potential impacts on marine archaeology. The potential impacts on heritage resources are discussed and assessed in *Chapter 5*.

(1) Effects of seismic surveys on fish, fish catches and sea mammals Report for the Cooperation group - Fishery Industry and Petroleum Industry Report no.: 2007-0512 written by John Dalen, Institute for Marine Research; Egil Dragsund, Arne Næss, DNV; Olav Sand, University of Oslo, 24 April 2007

### *4.2.4 Public Participation Process*

Concern was raised by one I&AP regarding the need for robust public consultation. This party felt the Background Information Document (BID) did not constitute a full consultation process.

In response, the full public consultation process was outlined. This included the distribution of the BID to relevant stakeholders, advertising in key national and regional newspapers, and notification that further consultation would take place during the draft EMPr comment period. The party was also encouraged to identify additional I&APs that should be included on the process. Further consultation activities (as outlined above) were also held in early June.

## *4.3 GRIEVANCE MECHANISM*

A grievance mechanism will be developed to address exploration-related individual and community concerns and grievances. This mechanism is an important element of the stakeholder engagement process as it creates opportunities to identify problems and develop solutions with communities. The objective will be for the operator to receive record, respond to and address any complaints made due to exploration activities. The grievance process will allow complaints to be responded to as quickly as possible, avoiding escalation of the issue, reducing potential adverse impact to the local population and maintaining a positive attitude towards the exploration activities. The grievance process will be based on five steps:

1. Advertising and communicating the process to stakeholders;
2. Receiving and registering grievance;
3. Reviewing and investigating grievance;
4. Resolution, response and close-out;
5. Monitoring and evaluation.

# 5 SOCIO-ECONOMIC IMPACT ASSESSMENT

## 5.1 PROPOSED EXPLORATION ACTIVITIES

The direct and potential positive and adverse impacts of proposed exploration activities on socio-economic activities are presented in this Chapter. These are discussed together for all phases of the proposed project.

Identified and described in this Chapter are impacts on the:

- Economy;
- Job Creation;
- Tourism Activities;
- Diving and Underwater Related Recreational Activities;
- Sites of Historic, Archaeological and Cultural Interest including Shipwrecks; and
- Recreation.

### 5.1.1 *Impacts on the Economy*

Direct revenues will be generated as a result of the exploration work programme. Revenue generating activities are related to the actual operations and include: refuelling; vessel or gear repair; port dues; helicopter services; hire of local vessels for chase or support vessels; employment of environmental services such as Marine Mammal Observers (MMOs) and environmental consulting work. Due to the short duration and the relatively small amounts of additional revenue generated, the exploration work programme is predicted to have a negligible positive impact on the macro economy of the region.

While fishing is an important economic activity in the Exploration Areas (see *Chapter 6* for detailed discussion on the impacts on fishing) and certain fisheries could be more impacted than others, after mitigation the overall impacts on commercial, subsistence and recreational fishing (displacement of fishing activities, change in catch sizes and disturbance of fishing gear) are considered to be of low significance. Due to the short duration of the fishing impacts, there are unlikely to be impacts on employment, and the economic impact of decreased catch is also expected to be negligible as it is expected to be short term. The overall adverse economic impact of the proposed exploration activities is therefore deemed to be of negligible significance.

### *5.1.2 Job Creation*

New job creation associated with the proposed project will be limited as the proposed exploration work activity will be of relatively short duration (duration of a typical seismic survey is 90 to 120 days). In addition, the crew undertaking the proposed exploration activities will predominantly be made up of specialists trained to conduct such work aboard the specially designed and contracted vessels. These specialists are typically foreign nationals that are engaged full time for similar exploration work around the world. Limited short-term employment will be created for local South Africans to provide environmental management support (MMO, FLO) and crew for support vessels and aircraft.

In terms of impacts on governmental institutions, the proposed project will not require the creation of new functions, the reallocation of existing functions, or the creation of new institutions in the Department of Mineral Resources (DMR), PASA or any other government department.

While the new direct and indirect job opportunities that will be created represent a positive impact associated with the Project, they will only be short-term and limited in nature. As a result, the overall positive impact of the proposed project on job creation is judged to be of negligible significance.

### *5.1.3 Impacts on Tourism Activities*

Tourism in the Exploration Areas includes recreational fishing, water sports (such as diving and boating), nature watching, charter flights, beach recreation and other tourism-related recreational activities (which can be done in one's private capacity). There are also a number of local tourism operators, offering boat-based tours and diving trips, particularly within and around the proposed Transkei Exploration Area.

The impacts on tourism during the exploration work programme could be as a result of airborne geophysics acquisition, the multi-beam bathymetric survey and the seismic survey activities. The proposed activities may have some behavioral impacts on marine fauna such as whales, although activities would be undertaken outside of their migration season/s. See *Chapter 6* for more information on the assessment of impacts on marine fauna and the associated mitigation measures. The seismic surveys could also have impacts of medium significance on the dive and fishing tourism industry, although the exact standoff distances for divers and fishers will depend on source levels to be utilised in the survey (refer to *Section 5.1.4* below).

A seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be implemented, within which there will be no firing of airguns. No exploration activities will occur within the MPAs (i.e. Amathole, Dwesa-Cwebe, Hluleka and Pondoland MPAs).

The tourism operators in the region operate primarily in the inshore areas. As the exploration vessels and aircraft will enter into the coastal zone in some areas and will be, at closest, approximately 5 - 10 km from the coast, mitigation measures will need to be established in these areas to avoid any disturbance to either activity. Tourism and exploration vessels could temporarily occupy the same region in the coastal area, which stretches from Port Elizabeth in the west to Ramsgate in the east and incorporates several MPAs. Taking such factors into account, the overall impact on marine tourism activities prior to mitigation is considered to be of low significance. See *Chapter 6* for more information on the assessment of impacts of the proposed exploration and associated mitigation measures.

**Mitigation of Impact on Tourism Activities**

- A communication plan with regards to the exploration activities timing and potential impacts should be developed. This should involve local newspaper advertisements and a notice to mariners prior to the commencement of the exploration activities. The communication plan should include information on the grievance mechanism as outlined in *Chapter 4*. As far as possible, direct notification of tourism operators in the area between Jeffery's Bay in the west, to Port Shepstone in the east should be undertaken prior to the exploration activities.

**Residual Impact on Tourism Activities**

- Given suitable management and adherence to the above mentioned mitigation measures, the disturbance to marine tourism activities as a result of the proposed exploration activities would likely be of low significance.

### *5.1.4 Impacts on Diving and Underwater Related Recreational Activities*

The proposed core sampling activities are expected to result in the disturbance and loss of benthic macrofauna through removal of sediments, placement of the trigger weight and penetration of the heat flow probe. This would result in potential crushing of benthic epifauna within the trigger weight footprint and immediate surroundings. This is expected to have impacts of negligible significance for divers (and their observance of marine fauna), owing to the highly localised nature of such activities, the distance from the shoreline (> 5 - 10 km) at which they will be undertaken, the limited amount of samples to be taken (total cumulative area of 0.4 $m^2$ and removing a maximum of 3.6 $m^3$ of sediment) and the rapid recolonisation that will occur from adjacent undisturbed sediments following the sampling/measurement.

The impacts of exploration activities on sensitive diving and under-water recreational activities would therefore be primarily restricted to the effects of increased underwater noise as a result of the seismic and bathymetric surveys.

Recreational diving in or near the Exploration Areas is typically in waters less than approximately 30 m and thus relatively close inshore (generally within approximately 5km of the coastline). Survey vessels may interact with this area however seismic airguns will not be fired within 10 km of the coastline. Risk to close exposure is therefore limited. There is the potential that noise would propagate to areas where diving occurs. The following describes potential effects.

Three types of injury to humans could result from exposure to high underwater sound levels:

- Shifts of hearing threshold: repeated or continual exposure to high level sound results in a gradual deterioration of hearing through permanent threshold shifts (1) (PTS) or temporary threshold shifts (TTS).

- Tissue damage: tissue damage usually arises from the near instantaneous increase in pressure, which forms shock waves of explosive pulses. As rise times are not rapid in non-explosive seismic sources (such as those that will be generated during the seismic surveys), tissue damage from such sources is likely to be negligible.

- Acoustically induced decompression sickness: Crum and Mao (1996) suggested that significant acoustically induced bubble formation could be expected at received levels of over 210 dB.

Much of the limited information available on the impact of underwater noise on humans is from military sources. The U.S. Navy has conducted two studies of relevance (see www.surtass-lfa-eis.com):

- The Applied Research laboratory of the University of Texas carried out 437 tests on 87 divers over the period 1993 to 1995. Divers were subject to a nine 100 second 50 percent duty cycle 160 dB pulses of varying frequency above 160 Hz. The study did not induce any long term effects on major organ systems and concluded that sound pressure levels of below 160 dB would "not be expected" to cause physiological damage to a diver.

- Studies conducted by the U.S. Office of Naval Research (ONR) and the U.S. Naval Submarine Medical Research Laboratory (NSMRL) in conjunction with a consortium of university and military laboratories

(1) Permanent Threshold Shift (PTS) refers to an increase in the threshold of hearing that is permanent, not temporary. It is an unrecoverable deafening due to physiological damage to the hearing organs that does not diminish with time. PTS may occur as a result of long-term exposures and/or extremely loud noises. Repeated exposures that cause to temporary threshold shift (TTS) can induce PTS as well.

developed guidance for safe exposure limits for recreational and commercial divers to low frequency sound, particularly SURTASS Low Frequency Active Sonar (LFAS). The studies concluded that the maximum intensity used during tests (received level of 157 dB) did not produce physiological evidence of damage in human subjects. A two percent "very severe" aversion reaction was recorded in divers at a level of 148 dB. The NSMRL therefore determined (by scaling back the intensity by 3 dB (a 50 percent reduction in signal strength) that a received level of 145 dB would provide a suitable margin of safety for divers. Consequently, in June 1999, NSMRL set interim guidance for the operation of low frequency underwater sound sources in the presence of recreational divers at 145 dB. This guidance has been endorsed by both the Navy's Bureau of Medicine and Surgery and the Naval Sea System Command (British Ministry of Defence, 2004).

Richardson et al (1995) also noted a number of vertigo and discomfort effects to human divers from underwater sounds. The underwater seismic array emissions are expected to be in the order of 220 - 250 dB re 1µPa at 1 m at source. Richardson et al (1995) noted that in water depths of 25 to 50 m deep, airgun arrays are often audible to ranges of 50-75 km and that detection ranges can exceed 100 km with efficient propagation or in deep water. Application of such attenuation rates suggest that seismic sounds could be heard by divers for considerable distances from source. Despite these detection ranges, the distances from source (i.e. airgun) to receptor (i.e. human diver) levels in which physical damage could occur is a much smaller range and the UK Diving Medical Advisory Committee (DMAC) guidance on the Safe Distance from Seismic activities does not call for mitigation unless diving and seismic activities will occur within 10km of each other. In shallow water (20 to 110m deep) basic cylindrical spreading modeling suggests that the limit for human detection would be met at around 56 km from the source. However, this does not include the effect of bottom attenuation, which could affect the result by a factor of five.

There are numerous dive sites along the East Coast where recreational diving and spearfishing takes place: Kwelera Nature Reserve, Nahoon Reef, Orient Beach and Danger Point in East London; as well as various informal places along the Transkei coastline. There are also tourism operators who offer diving tours in the region.

Over and above potential pathological injury, a reduced diving experience may result from exposure to increased background noise resulting from the proposed surveys, particularly in the coastal area between Port Alfred and Port Edward, where the seismic vessel is expected to be firing its airguns at closest, 10 km off the coast. The overall potential impacts of the exploration activities on recreational diving before mitigation are deemed to be **low – medium** and **low** after mitigation.

**Mitigation of Impact on Diving and Underwater Related Activities**

- A detailed communication plan, including a grievance procedure, with regards to the survey timing and potential impacts should be developed. This plan should also list the contact details of dive operators and spearfishing organisations in the region and these groups should be contacted before the commencement of the proposed surveys.
- Should it be shown that diving and seismic activities may occur within 10km of each other, more detailed discussions with dive operators and spearfishing organisations will be required in order to as far as possible avoid diving within 10 km of seismic activities.
- If diving within 10 km of the seismic survey is unavoidable the UK Diving Medical Advisory Committee (DMAC): Safe Distance from Seismic Surveying Operations (DMAC 12 Rev. 1 – July 2011) document guidance should be followed.

**Residual Impact on Diving and Underwater Related Activities**

- Given suitable management, the significance of pathological impact of seismic surveys on divers would likely be negligible. Due to the low noise levels and the temporary nature of the impact residual impacts on diving, including the overall diving experience, are deemed to be of low significance.

### *5.1.5 Impacts on Sites of Historic, Archaeological and Cultural Interest including Shipwrecks*

The proposed core sampling activities and heat flow probe (used for surface heat flow measurements) are expected to result in localized disturbance of the seabed. This could also disturb any heritage resources found within in the trigger weight footprint.

No impact on archaeological or culturally sensitive sites is envisaged in relation to seismic survey activities. In this regard, the seismic activities, including the generation of noise bubbles from the airguns and the deployment of the geophone streamers, occurs no deeper than 25 m from the surface of the sea and will not impact any of the archaeologically sensitive receptors which are primarily located on the seabed.

Whilst the exact location of vessels cannot be provided, there are a number of areas that can be regarded as having a high incidence of shipwrecks. These include the following:

- The southern portion of the Transkei Exploration Area from north of Port Alfred to Gonubie contains the largest proportion of wreck sites.

- The area from the 15m depth contour to the shore encompasses the majority of sites since most vessels were lost through being driven ashore during storms or through poor navigation.

- Areas where 16th and 17th Century Portuguese shipwrecks are located, namely Port Edward, Msikaba River mouth, Port St Johns, Mtata River mouth, Double Mouth to Hagga-Hagga, Cannon Rocks near Woody Cape, Bonza Bay and the Cefane River mouth.

- Areas where Dutch East India Company shipwrecks may be located, namely Coffee Bay and the Mtana River mouth.

- Port Grosvenor where the wreck of the *Grosvenor* (1782) lies just offshore of this small holiday village.

- The deep water of the Algoa Exploration Area is less sensitive, but the possibility of shipwreck discovery cannot be excluded.

Despite the high potential for shipwrecks in the Exploration Areas, the disturbance as a result of the piston coring will be limited to the area directly below the coring infrastructure, which means that the impact will be highly localised (i.e. confined to the core/probe footprint). These impacts can therefore be avoided by surveying and demarcating no go areas for piston coring. As long as proper mitigation measures (described below) are implemented to ensure that coring/probes are taken outside of identified heritage sites, the impact can confidently be rated as being insignificant.

**Mitigation of Impact on sites of historic, archaeological and cultural interest including Shipwrecks**

- Avoid undertaking any coring/probing activities within areas of the seabed where known resources of historic, archaeological and/or cultural interest have been identified (specifically shipwrecks).
- Where the activity sequencing allows, analysis of data of the non-interventive surveys should be done by a specialist archaeologist to confirm the presence of any shipwrecks and demarcate areas to be avoided for the piston coring of the seabed.
- The neutral observer on board should remain aware of the potential for marine coring/probing activities to disturb and even destroy potentially significant heritage resources. They should be present during coring/ probing activities. Should any shipwrecks or sections of shipwrecks be identified in the vicinity of where such activities are being undertaken, HWC and/ or SAHRA should be notified. These authorities should also be notified should any heritage resources show up in removed seabed samples.

### *5.1.6 Impacts on Recreation*

The impacts of the exploration activities on recreational fishing activities are discussed in *Chapter* 6. The mobilisation of the exploration vessels would result in negligible increase in marine traffic in the area, and therefore no impact on recreational activities. However, some impacts to recreational users of the marine environment could occur along much of the inshore areas within the Transkei Exploration Area coastal area, where the seismic vessel is expected to be, at closest, approximately 5 km from the coast during line turns, no airgun firing will occur within 10km of the coastline.

Recreational uses of the marine environment include surfing and related practices, wind surfing, boating, diving, nature watching and beach recreation along the shores of major towns/holiday resorts along the Transkei and KwaZulu Natal coastlines. The above mentioned recreational practices are mostly undertaken near coastal settlements (i.e. Port St Johns, Coffee Bay, Hole in the Wall) and within the specified nature reserves.

A seismic buffer zone of 10 km from the coast, and 2 km around MPAs will be implemented within which there will be no firing of airguns. No exploration activities will occur within the Marine Protected Areas.

Due to the short duration of the exploration activities (particularly the seismic surveys), the distance such vessels and activities will be from the shoreline (> 5 km) and alternative sites available for such activities, the impacts on recreational activities are deemed to be low prior to mitigation.

**Mitigation of Impact on Recreational Activities**

- A communication plan, including a grievance procedure, with regards to the timing and potential impacts of exploration activities should be developed. This should involve local newspaper advertisements and prior notification of the relevant stakeholders, particularly management of recreational sites in the coastal area closet to the survey.
- As far as possible activities within 10km of the coastline in the Transkei Exploration Area should avoid the December/January school holiday period.

**Residual Impact on Recreational Activities**

- Given suitable management, the significance of disruption to recreational activities in the region would likely be low after mitigation.

# 6 ENVIRONMENTAL IMPACT ASSESSMENT

This Chapter identifies and assesses the actual and potential environmental impacts of the proposed exploration activities associated with different stages of the project. In addition, measures to mitigate negative impacts and enhance positive impacts (DEAT, 2003) are described.

As discussed in *Chapter 2*, the activities to be undertaken during the proposed exploration are as follows:

- Airborne geophysics survey using fixed wing aircraft to identify geological structural trend and prospective areas of structural development and to address depth to basement/magnetic sources
- Acquisition and or licensing, processing and interpretation of 2D or 3D seismic data
- Measurement of surface heat flow to determine thermal regime and calibrate thermal models.
- Determination of seabottom bathymetry using a multibeam echosounder to look for hydrocarbon seepages and constrain boundary conditions
- Sampling and analysis of the seabed and water column to identify seabed and near surface features indicative of natural hydrocarbon seepage.

The potential impacts associated with airborne geophysics, multi-beam bathymetry and the seabed sampling programme are briefly discussed, as these activities are expected to have relatively low impact. The impacts of seismic surveys are assessed in more detail.

## 6.1 AIRBORNE GEOPHYSICS SURVEY

### 6.1.1 Background

The impacts associated with airborne geophysics data acquisition are related to the use of fixed wing aircrafts in the marine and coastal environments. There is the potential for disturbance to marine fauna from the noise generated by the aircraft's engines and movement.

Fixed-wing aircrafts will be used to acquire airborne high-resolution gravity gradiometry data. The survey generally includes relatively low flight altitudes (typically at a 120 m terrain or sea level clearance) and relatively close line spacing of generally no more than 1 km parallel spaced lines.

A sound wave propagating from an aircraft engine must enter the water at an angle of incidence of 13° or less from the vertical for the wave to continue propagating under the water's surface. At greater angles of incidence, the water surface acts as an effective reflector of the sound wave and allows very little penetration of the wave below the water (Urick, 1983). Water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. For low-altitude flights, such as those proposed, sound levels reaching the water surface would be higher, but the transmission area would be smaller. As an aircraft gains altitude, sound reaching the water surface diminishes, but the possible transmission area increases.

Underwater sound from aircraft over flights has been modelled for some airframes. Eller and Cavanagh (2000) modelled underwater sound pressure level as a function of time at various depths (2, 10, and 50 m) for F/A-18 Hornet aircraft subsonic over flights (250 knots) at various altitudes (300, 1,000, and 3,000 m). For the worst modelled case of an F/A-18 at the lowest altitude (300 m), the sound level at two meters below the surface peaked at 152 dB re 1 µPa, and the sound level at 50 meters below the surface peaked at 148 dB re 1 µPa. When F/A-18 flight was modelled at 3,000 meters altitude, peak sound level at 2 meters depth dropped to 128 dB re 1 µPa.

Underwater sounds from aircraft are strongest just below the surface directly under the aircraft. When the aircraft is overhead, levels decrease with increasing aircraft altitude or increasing receiver depth. The level and frequency content of the aircraft sounds propagating in the water are strongly affected by water depth and bottom conditions. The lateral distance at which the aircraft noise becomes undetectable varies with local ambient noise conditions, water depth, and bottom reflectivity, but is generally less than the corresponding distance in the air. Hence, underwater noise from a passing aircraft is generally brief in duration, especially when compared with the duration of audibility in the air.

### *6.1.2 Impacts on Seal and Bird Breeding Colonies*

Indiscriminate or direct flying over seabird or seal colonies or flying low level parallel to the coast where birds and seals occur could have a disturbance impact on breeding success, or even lead to resultant mortalities of juveniles. In terms of seabirds that occur within and around the proposed Exploration Areas, this could result in temporary abandonment of nests by the adults and thus exposure of eggs and chicks leading to increased predation risk. Although 46 species of seabird occur commonly on the East Coast, only three species breed regularly along the coast (grey-headed gull, Caspian tern and swift tern). In addition, many river mouths and estuaries along the East Coast (refer to *Section 3.6.6*) are important roosting and foraging grounds for coastal seabirds occupying these areas (Underhill & Cooper 1982; Turpie 1995).

In addition to risk to birds, low altitude flight paths over seal colonies might cause stampedes of animals to the sea, resulting in trampling of pups and nesting seabirds within seal colonies.

There is a seal breeding colony located at Black Rocks (Bird Island group) in Algoa Bay. This is located approximately 80 km inshore of the Algoa Exploration Area. The timing of the annual breeding cycle is very regular, generally occurring between November and January. As such, properly planned flight paths should significantly negate/avoid such disturbances (refer to *Mitigation Table* below).

Fixed wing aircrafts and helicopters could have a **direct negative** impact (behavioural and disturbance) on both seal and breeding bird colonies, if the aircraft flight path crosses a breeding colony at an altitude of less than 500 m (based on literature review). Such impacts would be **local** in extent and **temporary** in nature, as they would only impact the affected colony. However, they may have wider ramifications over the range of affected species and are thus deemed to range from **low** to **high** intensity. Despite this, the limited number of seal and bird breeding colonies found within the proposed Exploration Areas, means that the likelihood of the impact occurring is considered to be **unlikely**. In light of this, the impact of airborne geophysics acquisition on coastal birds and seals is considered of **low** to **medium** significance before mitigation and **negligible** with mitigation.

### *6.1.3 Impacts to Cetaceans during Breeding and Mating Season*

Available data indicates that the expected frequency range and dominant tones of sound produced by fixed-wing aircraft and helicopters overlap with the hearing capabilities of most toothed whales (odontocetes) and baleen whales (mysticetes) (Richardson *et al*. 1995; Ketten 1998). Determining the reactions of cetaceans to over flights is difficult, however, since most observations are made from either the disturbing aircraft itself (Richardson & Würsig 1997), or from a small nearby vessel. Reactions to aircraft flyovers vary both within and between species, and range from no or minimal observable behavioural response (Belugas: Stewart *et al*. 1982, Richardson *et al*. 1991; Sperm: Clarke 1956, Gambell 1968, Green *et al*. 1992), to avoidance by diving, changes in direction or increased speed of movement away from the noise source (Gray: Withrow 1983; Belugas: Richardson *et al*. 1991, Patenaude *et al*. 2002; Sperm: Clarke 1956; Fritts *et al*. 1983, Mullin *et al*. 1991, Würsig *et al*. 1998; Minke: Leatherwood *et al*. 1982; Bowhead: Patenaude *et al*. 2002; Humpbacks: Smultea et al. 1995), separation of cow-calf pairs (Gray: Withrow 1983), increased surface intervals (Belugas: Awbrey & Stewart 1983; Stewart *et al*. 1982; Patenaude et al. 2002), changes in vocalisation (Sperm whales: Watkins & Schevill 1977, Richter *et al*. 2003, 2006) and dramatic behavioural changes including breaching and lobtailing (Minke: Leatherwood *et al*. 1982; Sperm: Fritts et al. 1983; Bowhead: Patenaude *et al*. 2002; Beluga: Patenaude *et*

*al*. 2002), and active and tight clustering behaviour at the surface (Sperm: Smultea *et al*. 2007).

Most authors established that the reactions resulted from the animals presumably receiving both acoustic and visual cues (the aircraft and/or its shadow). As would be expected, sensitivity of whales to disturbance by an aircraft generally lessened with increasing distance, or if the flight path was off to the side and downwind, and if its shadow did not pass directly over the animals (Watkins 1981; Smultea *et al*. 2007). Smultea *et al*. (2007) concluded that the observed reactions of whales to brief over flights were short-term and isolated occurrences were probably of no long-term biological significance. Furthermore, Stewart *et al*. (1982) suggested that disturbance could be largely eliminated or minimised by avoiding flying directly over whales and by maintaining a flight altitude of at least 300 m. However, repeated or prolonged exposures to aircraft over flights have the potential to result in significant disturbance of biological functions, especially in important nursery, breeding or feeding areas (Richardson *et al*. 1995), such as the proposed Exploration Areas.

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. 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. It is also an offence in terms of the Sea Birds and Seals Protection Act, 1973 (No. 46 of 1973) to wilfully disturb seals on the coast or on offshore islands. Aircraft operators will therefore need to take measures to avoid interaction with whales.

Low altitude flights are therefore determined to have a **direct negative** impact on cetaceans if encountered, specifically during breeding and mating seasons. This impact would be **temporary** in nature and confined to those cetaceans that are using coastal waters in close proximity to the aircraft. Taking these factors into account, the significance of the potential impact on cetaceans is considered to be of **low** to **medium** significance, if aircraft flight paths cross any of these areas at an altitude of less than 300 m. However, should the mitigation measures, as described below, be implemented, the residual impact would be expected to be of **negligible** significance to cetaceans species.

**Mitigation of impacts related to the use of fixed-wing aircrafts and helicopters**

- Avoid planning airborne geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November). As no

seasonal patterns of abundance are known for odontocetes occupying the proposed Exploration Area, a precautionary approach to avoiding impacts throughout the year is recommended.

- As far as possible, flight paths must be pre-planned to avoid flying over seal and seabird colonies, coastal reserves or marine islands.
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should be avoided.
- Aircraft shall not approach to within 300 m of whales 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.
- All pilots should be briefed on ecological risks associated with flying at a low level parallel to the coast.

## 6.2 *MULTI-BEAM SEABED BATHYMETRY SURVEY*

The multi-beam bathymetry survey would be undertaken over the majority of the Exploration Areas, in order to produce a digital terrain model of the seafloor. The survey vessel would be equipped with a multi-beam echo sounder to obtain swath bathymetry, and a sub-bottom profiler to image the seabed and the near-surface geology.

Multi-beam technology is a complex sonar array that allows surveying of the seafloor at a resolution and accuracy sufficient to image the typical scale of active seafloor seeps. The multi-beam system provides depth-sounding information on either side of the vessel's track across a swath width of approximately two times the water depth, thereby allowing for highly accurate imaging and mapping of seafloor topography in the form of digital terrain models. The multi-beam echo sounder emits a fan of acoustic beams from a transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1 µPa at 1 m. The sub-bottom profiler emits an acoustic pulse from a transducer at frequencies ranging from 3 kHz to 40 kHz and typically produces sound levels in the order of 206 db re 1 µPa at 1 m.

Active sonar systems operate at frequency ranges >10 kHz, producing levels of sound pressure ranging from about 200 dB re 1µPa to 240 dB re 1µPa. Although these higher frequency sounds attenuate more rapidly in seawater than do lower frequency sounds, and are typically well beyond the hearing abilities of marine animals, they do have the potential to impact marine fauna. There are significant differences in the effects of seismic and multi-beam/side-scan surveys. Despite having similar sound levels to seismic surveys, the

higher frequency emissions utilised in normal multi-beam operations tend to be dissipated to safe levels over a relatively short distance. The anticipated radius of influence of multi-beam sonar would thus be significantly less than that for an airgun array used in seismic surveys. Hence the most likely scenario for injury to an animal by acoustic equipment would be if the equipment were turned on full power while the animal was very close (Anon 2007).

In 2003, the German Federal Environmental Agency (UBA) placed restrictions on the use of multi-beam systems in Antarctic waters, with the argument that marine mammals could theoretically be ensonified by the fan-shaped sonar beam, potentially resulting in a temporary threshold shift (TTS) or permanent threshold shift (PTS), and leading to disorientation. However, the statistical probability of crossing a cetacean with a narrow multi-beam fan several times, or even once, is very small. In contrast, the US National Marine Fisheries Service (NMFS) believed that marine mammals were unlikely to be harassed or injured from the multi-beam sonar or the sub-bottom profiler as the multi-beam sonar had an anticipated radius of influence significantly less than that for an airgun array. It is thus generally understood that in open coastal waters the effects of multi-beam sonars on marine fauna are negligible (O'Brein *et al*. 2005).

Multibeam surveys are therefore assessed to have an impact of **negligible** significance on marine fauna. Although the impacts associated with this activity are considered insignificant some mitigation measures have been established as precaution against impacts on marine fauna. The UK Joint Nature Conservation Committee (JNCC) guidelines (these have been adapted for the specific context) for marine sonar operations are included as mitigation below.

**Mitigation of impacts related to marine sonar operations**

- Use of the lowest practicable power levels to achieve the required result.
- On-board Marine Mammal Observers should scan the area for the presence of cetaceans within 500 m of the working vessel for approximately 30 minutes before commencement of the survey.
- Where equipment allows, use "soft starts" for a period of at least 20 minutes to give adequate time for marine mammals to leave the vicinity.
- Care should be taken with survey line lay outs to avoid restricting the ability of cetaceans to avoid the source.
- Equipment should be shut down if cetaceans are identified within a distance of the vessel defined by the power source, directionality and propagation characteristics.
- No exploration activities to occur within Marine Protected Areas (MPAs).
- Avoid planning multi-beam surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding

grounds into low latitude waters (beginning of June to end of November), and avoid blocking of migration paths by sonar operations.

## 6.3 *SEABED SAMPLING PROGRAMME*

The proposed core sampling activities are expected to result in the disturbance and loss of benthic macrofauna through removal of sediments and potential crushing of benthic epifauna within the trigger weight footprint. In the case of the heat flow probe, penetration of the probe into the seabed may lead to disturbance of benthic macrofauna in the 6-cm diameter footprint of the probe.

Assuming a core diameter of 100 mm, each drop-core sample will remove a surface area of ~0.008 $m^2$. Core barrels are typically 6 – 9 m in length thus resulting in the removal of 0.048 $m^3$ or 0.072 $m^3$ of sediment, respectively per sample at maximum penetration. It is proposed to take in the order of 50 cores, thereby impacting a total cumulative area of 0.4 $m^2$ and removing a maximum of 3.6 $m^3$ of sediment.

Benthic fauna typically inhabit the top 20 - 30 cm of sediment and thus removal of the sediment samples will result in the elimination of the benthic faunal and epifaunal biota in the sample footprint. Considering the available area of similar habitat on the Exploration Area, this reduction in benthic biodiversity is negligible.

Depending on the texture of the sediments at the target sites, slumping of adjacent unconsolidated sediments into the area of coring could be expected over the very short-term. Although this may result in localised disturbance of macrofauna associated with these sediments and alteration of sediment structure, on the other hand it also serves as a means of natural recovery. Studies have shown that some mobile benthic animals are capable of actively migrating vertically through overlying sediment thereby significantly affecting the recolonisation of impacted areas and the subsequent recovery of disturbed areas of seabed (Maurer *et al*. 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger *et al*. 2000; but see Harvey *et al*. 1998; Blanchard & Feder 2003).

Natural rehabilitation of the seabed following dredging (and as would be expected following core sampling) through a process involving influx of sediments and recruitment of invertebrates, has been demonstrated for the southern African continental shelf (Penney & Pulfrich 2004; Steffani 2007b, 2009a, 2009b, 2010a, 2010c). Recovery rates of impacted communities are variable and dependent on the sampling approach, sediment influx rates and the influence of natural disturbances on succession communities. Ellis (1996) gives typical recovery rates for different grained deposits based on several

sources (see *Table 6.1*). These average time scales conform to those from other studies (see Newell *et al*. 1998).

***Table 6.1 Timing for Recovery of Seabed Habitats after Dredging (after Ellis 1996).***

| Sediment type | Recovery time |
|---|---|
| *Fine-grained deposits*: muds, silts, clays, which can contain some rocks and boulders | 1 year |
| *Medium-grained deposits*: sand, which can contain some silts, clay and gravel | 1-3 years |
| *Coarse-grained deposits*: gravels, which can contain some finer fraction and some rock and boulders | 5 years |
| *Coarse-grained deposits*: gravels with many rocks and boulders | >5 years |

Taking this all into account, while the **direct negative** impact of sediment removal is unavoidable, the associated impact will be **localised** (i.e. confined to the core footprints), with a small total cumulative area affected. Overall, the impact of core sampling activities on the seabed and associated benthic fauna is considered to be of **negligible** significance.

Some disturbance or loss of adjacent benthic biota could also be expected as a result of the placement on the seabed of the trigger weight, and the penetration into the sediments of the heat flow probe. Epifauna and infauna beneath the footprint of the weight may be smothered or crushed resulting in a small reduction in benthic biodiversity. Furthermore, crushing is likely to primarily affect soft-bodied species, as some molluscs and crustaceans may be robust enough to survive (see for example Savage *et al*. 2001).

The resultant impacts to benthic biota will be **permanent** in nature**.** Despite this, they will be highly **localised** and **short-term** in nature as recolonisation will occur rapidly from adjacent undisturbed sediments. In light of this, the impact is assessed to be of **medium** to **high** intensity. The potential impact is consequently also deemed to be of **negligible** significance.

## *6.4 IMPACT ASSOCIATED WITH SURVEY VESSELS AND SUPPORT VESSELS*

Impacts relating to the use of marine vessels for exploration activities are relevant to all activities where vessels are used (multi-beam bathymetry, sea and seabed sampling programme and seismic surveys). These are discussed below.

*Air Quality*

Emissions to the atmosphere during the exploration activities may include exhaust gases from the combustion of hydrocarbon fuels in generators, motors, and engines, and the burning of wastes.

The atmospheric emissions from the survey vessels are expected to be similar to those from similar vessels of comparable tonnage (approximately 3 000 tonnes), except with the addition of the emissions from the compressors used to operate the airguns. This would include relatively low amounts of sulphur dioxide, nitrogen oxides and particulate matter.

The volume of solid waste incinerated on board, and hence also the volume of atmospheric emissions would be minimal and incineration must comply with the relevant MARPOL 73/78 (1) standards intended to control emissions to the air.

The potential impact of emissions to the atmosphere during exploration operations would be mostly limited to the proposed Exploration Areas and is considered to be of **negligible** significance with or without the implementation of mitigation measures.

*Water Quality*

All survey vessels must comply with international agreed standards regulated under MARPOL 73/78 and relevant South African legislation for the disposal of waste. These regulations are intended to control release of pollutants to the marine environment.

The impacts on water quality after mitigation are deemed to be of **negligible** significance.

## 6.5 SEISMIC SURVEYS

A matrix of the environmental impacts at the various stages of seismic survey activities are given in *Table 6.3*. The phases of the seismic survey are as follows:

- Establishment Phase - this phase includes the finalisation of the seismic contractors, the hiring and training of staff, mobilisation of the seismic vessel and chase vessel, travel to the seismic acquisition area, testing of equipment, deployment of the geophone array (just before the vessel reaches the seismic acquisition area and planned seismic lines) and preparation for beginning firing of the airguns.
- Operation Phase - during this phase, the seismic survey vessel undertakes the actual survey, as described in *Chapter 2*. The majority of potential impacts will be associated with this phase.
- Decommissioning and Post-Closure Phases - this phase includes the gathering, dismantling and loading of the seismic lines and geophones, demobilisation of the seismic vessel and any chase vessels, travel from the

(1) The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978.

seismic acquisition area back to the port and disposal of any generated waste during the seismic activities.

The following sections provide a summary of the findings as appropriate to seismic activities for the various phases of operation.

### *6.5.1 Establishment Phase*

This phase includes the finalisation of the seismic contractors, the hiring and training of staff, mobilisation of the seismic vessel and chase vessel, travel to the seismic acquisition area, testing of equipment, deployment of the geophone array (just before the vessel reaches the seismic acquisition area and planned seismic lines) and preparation for beginning firing of the airguns.

*Geology, Sediment and Oceanography*

No impact will occur as staff and vessel mobilisation do not have physical impacts on the geology, sediments, and physical oceanography of the seabed or coastline. The seismic activities, including the deployment of the geophone streamers occur no deeper than 30 m from the surface of the sea.

*Physical Nature of Surrounding Areas*

No impact is envisaged, as the staff and vessel mobilisation and preparation for the seismic surveys do not have any direct effect on the physical nature of the receiving marine or coastal environment.

*Air Quality*

Emissions to the atmosphere during the establishment phase will result mainly from movement of the seismic vessel onto site and from the burning of wastes. Refer to *Section 6.4* for more detail on specific emission sources.

The impact on air quality would be **negligible** and emission would be no greater than those emitted from another vessel of similar size during normal operation.

*Water Quality*

All survey vessels must comply with international agreed standards regulated under MARPOL 73/78 and relevant South African legislation for the disposal of waste.

The impacts on water quality after mitigation are deemed to be **negligible**.

*Fauna and Flora*

No impact on flora or fauna is envisaged as the vessel would be steered as an ordinary vessel to the proposed Exploration Areas.

*Marine Transport Routes and Fishing*

Any impacts on marine traffic and commercial or recreational fishing would be related to interference with (caused by) the streamers. The seismic equipment and geophone array will not be deployed until the vessel is close to the operational area, just before operation (firing of the airgun). The operator will provide details of the seismic survey plan to mariners and fishing operators in advance of the initiation of seismic activities and to other mariners by notice through the SAN Hydrographic office and to the public via advertisement in advance to allow commercial and recreational fishers to plan their fishing activities in the area.

As a result, movement of the seismic vessels onto site is expected to have a **negligible** impact on transport routes after mitigation.

*Mariculture Activities*

There will be no impact on mariculture activities. The mobilisation of the vessel would result in no particular increase in marine traffic levels in the area and no significant changes to the physical nature of the area which may impact mariculture activities.

*Mining Activities*

There will be no impact on mining activities as no mining activities are currently being undertaken within the proposed Exploration Areas.

*Communication Infrastructure*

Although the SAT3 cable (the only undersea cable which currently runs along this section of the South and East Coast) is located within the proposed Algoa Exploration Area, no sediment sampling will be undertaken during the establishment phase. Furthermore, there is an exclusion zone applicable to the telecommunication cables one nautical mile each side of the cable in which no anchoring is permitted. As long as this requirement is strictly adhered to, no effects of seismic vessel movements during the establishment phase on submarine fibre optic cables, linkage boxes or repeaters are expected.

### *6.5.2 Operational Phase*

During the operational phase, the survey vessel travels along the planned seismic lines at a speed of between 4 to 6 knots towing streamers up to 12 000 m in length with an attached array of hydrophones. The airgun sound source (2 D) or array of airguns (3 D), are attached approximately 300 m behind the vessel at a depth of 5-10 m below the surface and produces sound of 220-230 dB re 1 mPa @ 1m (single airgun) or 250 dB re 1 mPa @ 1m (airgun array) mainly within the 0 - 120 Hz bandwidth.

The seismic vessel will need to turn at the end of the seismic line and will discontinue shooting, turn in an arc, and then resume shooting once on the next seismic line.

*Geology and Sediment*

There will be no impact on the seafloor or underlying rocks during the operational phase. The seismic survey activities occur offshore and within the uppermost 25 m of the water column. The seismic pulses generated are not of sufficient energy to have an impact on the geology or sediment of the seabed.

*Physical Oceanography*

There will be no effects on physical oceanography other than that for any other vessel at sea. The movement of the seismic vessel, the towing of the hydrophones and the seismic noise do not have any effect on the physical oceanography of the area.

*Physical Nature of Surrounding Areas*

The normal controlled operations of the seismic vessel will not alter the physical characteristics of the coastline or seabed. There are no impacts on the physical nature of the surrounding areas.

*Air Quality*

In order to support various operations, fuel oil will be used in turbines, generators, compressors and other equipment associated with the survey vessel. Use of fuel in combustion processes will produce combustion gases such as oxides of nitrogen and sulphur. Manufacturer's instructions for the operation and maintenance of the equipment will be followed so that equipment operation can be carried out efficiently. This will also assist in maintaining emissions such as carbon dioxide and carbon monoxide to minimum possible levels.

These gases will be emitted to the atmosphere and emissions have the potential of causing **short-term** changes in the air quality of the area, but due to the small amounts and easy dispersion, this would be of **negligible** significance.

**Mitigation of Impacts on Air Quality**

- Regular maintenance of motors and generators to ensure that equipment is operated and maintained in good working order, to manufacturer's specification.

**Residual Impacts on Air Quality**

- Air quality impacts are regarded as negligible given the short duration of the seismic survey.

*Water Quality*

Wastes, discharges and emissions that will be generated during the proposed seismic survey will include liquid effluents including deck drainage, drainage from machinery spaces and sewage, kitchen and other solid waste and hazardous wastes. Untreated drainage will be limited to rainwater and sea spray run-off from uncontaminated areas and this would have a **negligible** impact on the water quality and on the ecology of the receiving waters. All other drainage would be treated in accordance with the MARPOL convention, as described below, before being released into the sea. The following mitigation measures are proposed to help minimise pollution.

**Mitigation of Impacts on Water Quality**

- All survey vessels must comply with international agreed standards regulated under MARPOL 73/78 and relevant South African legislation for the disposal of waste, specifically:
- Drainage from machinery spaces will be treated according to MARPOL 73/78 limits (so that it does not contain more than 15 mg/l of oil)
- Oily drainage from all other areas will be treated and stored on the vessel prior to discharge at an appropriate facility for the shallow water area and discharged to sea for the deep water areas
- All other discharges will be treated according to MARPOL 73/78 limits (average monthly oil content is does not exceed 40 $mg.l^{-1}$). The instantaneous oil content of all discharges will not exceed 100 mg/l.
- No plastics or garbage will be discharged to sea. These will either be burnt in trash baskets on-board the vessel or be segregated, quantified and accounted for prior to disposal at dedicated facilities.
- Food wastes will be macerated and discharged offshore, more than 12 nautical miles (21.6 km) from the nearest land or island, or brought to shore for disposal.
- Sewage discharges will either be treated and disinfected in an approved treatment plant and discharged more than 12 nautical miles (21.6 km) from shore (mainland and islands), or contained and discharged at dedicated facilities.
- Hazardous waste (used lubricating oil, filters, batteries etc) will be disposed at dedicated onshore hazardous waste disposal facilities.

**Residual Impacts on Water Quality**

The overall residual impacts of emissions and waste generated on air and water quality are considered to be **negligible**.

*General Impacts on Fauna and Flora*

Characteristics of Seismic Noise

Seismic explorations use high intensity sound to create an image of the structure and nature of soil layers of the ocean floor (Green Jr. and Moore 1995, Hildebrand 2005). Airgun arrays are primarily responsible for the production of sound during these seismic operations. In this regard, the airguns used in modern seismic surveys produce some of the most intense non-explosive sound sources used by humans in the marine environment (Gordon *et al*. 2004).

The transmission and attenuation of seismic sound is probably of equal or greater importance in the assessment of environmental impacts than the produced source levels themselves, as transmission losses and attenuation are very site specific, and are affected by propagation conditions, distance or range, water and receiver depth and bathymetrical aspect with respect to the source array. In water depths of 25 - 50 m airgun arrays are often audible to ranges of 50 -75 km, and with efficient propagation conditions such as experienced on the continental shelf or in deep oceanic water, detection ranges can exceed 100 km and 1,000 km, respectively (Bowles *et al*. 1991; Richardson *et al*. 1995; see also references in McCauley 1994). The signal character of seismic shots also changes considerably with propagation effects. Reflective boundaries include the sea surface, the sea floor and boundaries between water masses of different temperatures or salinities, with each of these preferentially scattering or absorbing different frequencies of the source signal. This results in the received signal having a different spectral makeup from the initial source signal.

In shallow water (< 50 m) at ranges exceeding 4 km from the source, signals tend to increase in length from < 30 milliseconds, with a frequency peak between 10-100 Hz and a short rise time, to a longer signal of 0.25-0.75 seconds, with a downward frequency sweep of between 200 - 500 Hz and a longer rise time (McCauley 1994; McCauley *et al*. 2000). Similarly, sound pressure levels of airgun arrays at the source (1 m) are in the region of 230-258 dB re 1 µPa-m (McCauley, 1994; Richardson *et al*, 1995, both in CCA, 2001). Also despite the fact that most of the energy of the pulses is of relatively low frequency (50 – 100 Hz), airgun array pulses can contain some energy up to 500 - 1000 Hz (Richardson *et al*, 1995, in CCA, 2001). Analysis of broadband spectra of seismic survey airgun emissions has shown considerable energy at around 22 kHz (90 dB re 1 µPa2 Hz-1 at 750 m).

In contrast, in deep water received levels vary widely with range and depth of the exposed animals, and exposure levels cannot be adequately estimated using simple geometric spreading laws (Madsen *et al.* 2006). These authors found that the received levels fell to a minimum between 5 - 9 km from the source and then started increasing again at ranges between 9 – 13 km, so that absolute received levels were as high at 12 km as they were at 2 km, with the complex sound reception fields arising from multi-path sound transmission.

For an organism to respond to sound, the sound has to exceed that of the ambient noise, which has either non-biological or biological origins. McCauley (1994) (in CCA, 2001) noted that non-biological underwater noise has three principal sources, namely wind (including waves and the surf zone), rain and anthropogenic causes. Noise increases with increasing wind speed, with most of the noise being generated by bubble oscillations within waves (Cato, 1978, Banner and Cato, 1988, both in CCA, 2001). Rain produces broad-frequency spectra sounds, increasing with the intensity of the downpour.

Shipping sounds cover a wide range of spectra, and include extremely loud noises when the source is in close proximity. *Table 6.2* summarises the sources of marine noise and provides some expected ranges in relation to the proposed activities.

***Table 6.2 Comparison of Underwater Noise Types***

| Source | Frequency and Strength |
|---|---|
| Wind | 1Hz - 25 kHz; 95 dB at 100-200 Hz (Force 12) |
| Rain | Broad spectrum; 80 dB-m (heavy rain) |
| Ships (depending on vessel size) | 1 Hz - 1 kHz; 150 - 200 dB-m |
| Invertebrates | 2-10 kHz; < 140 dB-m |
| Fish | 100 Hz - 5 kHz; < 140 dB-m |
| Mammals | 12 Hz – 160 kHz |
| Drilling (from fixed platform) | 5 Hz – 1.2 kHz; 119-127 dB |
| Drilling (from semi-submersible) | 29-70 Hz; 125 dB |
| Seismic survey | 0-120 Hz, 220-230 dB-m |

Source: ERM, 2005

Underwater biological noises are produced by a wide variety of marine organisms, particularly during reproduction, displays of territoriality and echo-location. Marine invertebrates, for example rock lobster *Panulirus spp* (McCauley, 1994, in CCA, 2001) and snapper shrimp *Alpheus spp* (Cato and Bell, 1992, in CCA, 2001), generally utilise frequency spectra greater than 2 kHz. Sounds produced by fish have a wider frequency range, from 100 Hz to about 5 kHz. Marine mammals demonstrate the greatest range of frequencies during sound production, ranging from 12 Hz in large baleen whales such as blue whale *Balaenoptera musculus* (Watkins *et al*, 1987, in CCA,

2001) to 160 kHz in harbour porpoises *Phocoena phocoena* (Mohl and Andersen, 1973, in CCA, 2001).

For a sound signal to be detected, it must contain sufficient energy to exceed any ambient noise present at frequencies near the signal frequency. The signal to noise ratio (at the receiver) is determined by the source level, the transmission through air or water, the ambient noise level and the sensitivity of the receiver.

In summary, the impact of noise on marine fauna is largely dependent on the received levels of noise against the background or ambient noise that is present, and the hearing sensitivity of the receiver. The received level is dependent on a number of parameters including the source characteristics (level and frequency), the transmission or propagation loss and the receptive capabilities of the animal. The transmission or propagation loss of sound through water obviously results in sound levels decreasing with distance from the source. Consequently, the distance of the receiver from the source probably has the greatest influence on the sound levels that are perceived.

Generic Impacts of Noise on Marine Biota

Three distance zones can be defined around a sound source in terms of the influence of the sound on marine fauna. These are:

(i) the zone of pathological injury;
(ii) the zone of behavioural response; and
(iii) the zone of audibility (where the sound is audible but has no detectable effect on the animal or its behaviour).

A fourth zone, the zone of masking, exists but is difficult to quantify (Richardson *et al*. 1995, in CCA, 2001).

The potential effects of noise on marine organisms can be categorised as follows:

- Behavioural changes: These are often hard to detect, but generally involve a cessation of normal activities and the commencement of avoidance or 'startle' behaviour as a result of the detection of sound from marine construction activity. Continued exposure often results in habituation to the sound, followed by a recommencement of normal behaviour.

- Interference with and masking of sounds: Interference and masking of sounds produced by animals for communication purposes is also difficult to assess, but is likely to result in the temporary cessation of sound production, or a muffling of sounds.

- Physical damage or injury: These could arise from the differential rate of transmission of sound pressure waves through tissues of varying densities. The effect is particularly marked at interfaces between tissues and gas-filled cavities, for example, the swim-bladders of fishes or the lungs of mammals. The sound-receiving apparatus of most organisms is generally comprised of sensory hair cells, which are extremely sensitive to vibrations. Over-stimulation of these could potentially lead to pathological injury (including disorientation, stunning and any associated predation).

- Shifts of hearing threshold: Repeated or continual exposure to high level sound results in a gradual deterioration of hearing through permanent threshold shifts (PTS) or temporary threshold shifts (TTS).

- Acoustically induced decompression sickness: Crum and Mao (1996) suggested that significant acoustically induced bubble formation could be expected at received levels of over 210 dB.

The significance (if applicable) of these effects for the different groups of marine fauna encountered within and surrounding the proposed Exploration Areas are discussed below.

*Impacts on Phytoplankton and Zooplankton (including Ichthyoplankton)*

As the movement of phytoplankton and zooplankton is largely limited by currents and they are not able to actively avoid the seismic vessel, they are likely to come into close contact with associated sound sources. Despite this, phytoplankton are not known to be affected by seismic surveys and are unlikely to show any significant effects of exposure to airgun impulses outside of a 10 m distance. As such, although high level seismic sounds such as seismic firing could result in pathological injury or mortality of plankton, the documented effects of impulsive seismic type sounds on plankton are limited to the extreme vicinity (within 10 m) of the source (Kosheleva 1992; McCauley 1994).

Zooplankton is comprised of meroplankton (organisms which spend a portion of their life cycle as plankton, such as fish and invertebrate larvae and eggs) and holoplankton (organisms that remain planktonic for their entire life cycle, such as siphonophores, nudibranchs and barnacles). As discussed in *Chapter 3*, the abundance and spatial distribution of zooplankton is highly variable and dependent on factors such as fecundity, seasonality in production, tolerances to temperature, length of time spent in the water column, hydrodynamic processes and natural mortality. The amount of exposure to the influence of seismic airgun arrays is thus dependent on a wide range of variables. Despite this, zooplankton densities are generally considered to be low and patchily distributed within the proposed Exploration Areas.

Some invertebrate members of plankton have gas-filled flotation aids, which may make them more receptive to the sound effects associated with seismic airgun arrays. With respect to this, the range of effects may extend further for these species than for other species of plankton. However, for a large seismic array, a physiological effect out to 10 m from the array is considered a generous value with known effects demonstrated to 5 m only (Kostyuchenko 1971). McCauley (1994) concludes that when compared with total population sizes or natural mortality rates of planktonic organisms, the relative influence of seismic sound sources on these populations can be considered insignificant. In this regard McCauley (1994) states that the wash from ships propellers and bow waves can be expected to have a similar, if not greater, volumetric effect on plankton than the sounds generated by airgun arrays.

Regeneration time of phytoplankton is rapid (although subject to nutrient availability) so that a region vacated by mortality would be rapidly re-colonised by phytoplankton, the impact on plankton as a result of seismic noise is therefore considered negligible. Re-colonisation times of a water column by zooplankton, however, would depend on a number of variables, including seasonality of zooplankton spawning, water movement, vertical migration of plankton species and proximity of breeding adult populations and the impacts on zooplankton would thus vary with these parameters.

Potential impacts of seismic pulses on plankton and fish eggs and larvae would include mortality or physiological injury in the immediate vicinity of the airgun sound source. Impacts will thus be of high intensity at very close range (< 5 m from the airguns) only, and no more significant than the effect of the wash from ships propellers and bow waves. However, as plankton distribution is naturally temporally and spatially variable and natural mortality rates are high, any impacts would thus be of **low** to **negligible** intensity across the survey area and for the duration of the survey only (**short-term**). The potential impact of seismic noise on plankton is consequently deemed to be of **negligible** significance both with and without mitigation.

**Mitigation of Impacts on Phytoplankton and Zooplankton (including Ichthyoplankton)**

Dalen *et al*. (1996) recommended that seismic survey activities should avoid areas of concentrated spawning or spawning migration paths by 50 km, particularly areas subjected to repeated, high intensity surveys.

For the current proposed seismic survey, there is potential overlap of the target area with the spawning grounds of various pelagic and demersal species (i.e. anchovy, pilchards and kingklip). Various reef fish are also reported to spawn on deep-water reefs along the South Coast and undertake spawning migrations eastwards along the coast to KwaZulu-Natal. Despite this, considering the spatial extent of the spawning areas and the limited time

of the proposed survey, active avoidance of the spawning grounds is not deemed necessary.

As such, no mitigation measures for potential impacts on plankton and fish egg and larval stages are feasible or deemed necessary.

*Impacts on Invertebrates*

Although some marine invertebrates have mechanoreceptors or statocyst organs that are sensitive to hydroacoustic disturbances, most do not possess hearing organs that perceive sound pressure. Potential impacts of seismic pulses on invertebrates include physiological injury and behavioural avoidance of seismic survey areas. Masking of environmental sounds and indirect impacts due to effects on predators or prey has not been documented.

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, such as less than 15 m away (Richardson *et al*. 1995). This implies that only surveys conducted in very shallow water will have any detrimental effects on invertebrates associated with the seabed. Species of potential concern in the proposed survey area are the commercially fished deep-water rock lobster (*Palinurus gilchristi*), which occurs on rocky substrate in depths of 90 - 170 m, and the squid (*Loligo vulgaris reynaudii*) which typically occurs in waters of > 100 m. However, adult squid also occur in dense spawning aggregations at depths between 20 - 130 m around Algoa Bay and further south. These spawning aggregations are a seasonal occurrence reaching a peak in November and December, and would thus likely fall outside of the timing of the seismic survey (1). However, as the survey in the Algoa Exploration Area would be conducted at depths between 200 - 4000 m, the received noise at the seabed would be within the far-field range, and outside of distances at which physiological injury of these invertebrates would be expected.

Although causative links to seismic surveys have not been established with certainty, giant squid strandings coincident with seismic surveys have been reported (Guerra *et al*. 2004). The animals showed no external damage, but all had severe internal injuries (including disintegrated muscles and unrecognisable organs) indicative of having ascended from depth too quickly.

(1) This period lines up with the end of the cetacean exclusionary period.

Given the **short-term** duration of the seismic survey, the water depths at which the surveys will predominantly take place (i.e. > 50 m), the potential impact of seismic noise on physiological injury or mortality of invertebrates is deemed of **low** to **negligible** intensity across the proposed Exploration Areas. As such, for the survey duration this impact is considered to be of **negligible** significance both with and without mitigation.

No mitigation measures for potential impacts on marine invertebrates and their larvae are feasible or deemed necessary.

Behavioural avoidance

Similarly, there is 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 the received noise at the seabed would be within the far-field range, and outside of distances at which avoidance of benthic invertebrates would be expected, the potential impact of seismic noise on invertebrate behaviour is consequently deemed of low to negligible intensity across the survey area and for the survey duration and is considered to be of negligible significance both with and without mitigation.

Squid are reported to significantly alter their behaviour at an estimated 2 to 5 km from an approaching large seismic source (McCauley *et al*. 2000), so avoidance of airgun sounds by squid during their spawning aggregations may occur. However, although avoidance for squid is deemed to be of medium intensity across the survey area and for the survey duration of the operational phase (short-term), the impacts on invertebrates in general are considered to be of **negligible** significance both without and with mitigation.

**Mitigation of Impacts on Invertebrates**

- The survey will utilise "soft starts" to enable invertebrates to move away from and avoid the seismic noise sources. "Soft starts" refer to the practice of increasing the source level of a sound source array gradually rather than to commence firing all sound sources at full volume, after a period when seismic sources have been silent or about to start. This procedure intends to allow any marine fauna that are close to the array to move away before they are exposed to noise emissions at full power. Prior to the start of seismic shooting, sound levels will be increased gradually by 6dB per minute over a period of at least 20 minutes.

**Residual Impacts on Invertebrates**

Overall residual impacts on invertebrates are considered to be negligible.

*Impacts on Fish*

Fish hearing has been reviewed by numerous authors including Popper and Fay (1973), Hawkins (1973), Tavolga *et al.* (1981), Lewis (1983), Atema *et al.* (1988), and Fay (1988). Fish have two different systems to detect sounds namely:

1) the ear (and the otolith organ of their inner ear) that is sensitive to sound pressure; and
2) the lateral line organ that is sensitive to particle motion.

Certain species utilise separate inner ear and lateral line mechanisms for detecting sound; each system having its own hearing threshold (Tavolga & Wodinsky 1963), and it has been suggested that fish can shift from particle velocity sensitivity to pressure sensitivity as frequency increases (Cahn *et al.* 1970, in Turl 1993). Fish that possess a coupling between the ear and swim-bladder have probably the best hearing of fish species (McCauley 1994).

Most species of fish and elasmobranchs are able to detect sounds from well below 50 Hz (some as low as 10 or 15 Hz) to upward of 500 - 1,000 Hz (Popper & Fay 1999; Popper 2003; Popper *et al.* 2003), and consequently can detect sounds within the frequency range of most widely occurring anthropogenic noises. Within the frequency range of 100 - 1,000 Hz at which most fish hear best, hearing thresholds vary considerably (50 and 110 dB re 1 μPa). They are able to discriminate between sounds, determine the direction of a sound, and detect biologically relevant sounds in the presence of noise. In addition, some clupeid fish can detect ultrasonic sounds to over 200 kHz (Popper & Fay 1999; Mann *et al.* 2001; Popper *et al.* 2004).

Potential impacts on fish species related to the operation of survey airgun arrays include pathological trauma or mortality and behavioural avoidance of seismic sound sources Indirect effects of seismic shooting on fish include reduced catches resulting from changes in feeding behaviour or vertical distribution (Skalski *et al*. 1992), but information on feeding success of fish (or larger predators) in association with seismic survey noise is lacking. Indirect impacts are discussed in more detail below.

<u>Pathological Trauma or Mortality</u>

In fish, the proximity of the swim-bladder to the inner ear is an important component in the hearing as it acts as the pressure receiver and vibrates in phase with the sound wave. Vibrations of the otoliths, however, result from both the particle velocity component of the sound as well as stimulus from the swim-bladder. The resonant frequency of the swim-bladder is important in the assessment of impacts of sounds as species with swim-bladders of a resonant frequency similar to the sound frequency would be expected to be

most susceptible to injury. Although the higher frequency energy of received seismic impulses needs to be taken into consideration, the low frequency sounds of seismic surveys would be most damaging to swim-bladders of larger fish. The lateral line is sensitive to low frequency (between 20 and 500 Hz) stimuli through the particle velocity component of sound. Consequently, there is a wide range of susceptibility among fish to seismic sounds; however those with a swim-bladder will be more susceptible to anthropogenic sounds than those without this organ.

Assessment of the pathological effects of impulsive airgun type sounds on fish species have usually involved the exposure of captive or caged fish to nearby sound sources (see McCauley, 1994 and Turnpenny and Nedwell, 1994, in CCA, 2001). The following experimental case studies provide some evidence of injury or mortality to fish species.

- Weinhold and Weaver (1972, in Turnpenny and Nedwell, 1994, in CCA, 2001) found no lethal effects of 330 and 660 $cm^3$ airguns (the estimated received level of which Turnpenny and Nedwell (1994) (in CCA, 2001) suggested to be approximately 214-216 dB re 1 µPa) to exposed caged Coho salmon (*Oncorhynchus kisutch*) smolts.

- Falk and Lawrence (1973) (in CCA, 2001) exposed caged, juvenile coregonid fish to an operating airgun (which Turnpenny and Nedwell (1994) (in CCA, 2001) estimate resulted in a received level of 226-234 dB re 1 µPa) and found certain of the fish suffered swimbladder damage.

- Kosheleva (1992) (in CCA, 2001) investigated the effects of single and arrayed airguns of between 1000 and 20,000 $cm^3$ (which Turnpenny and Nedwell (1994) (in CCA, 2001) suggested had peak sound pressure levels of between 220 and 240 dB re 1 µPa) on benthos, phytoplankton and fish and found that exposure at distance of greater than 1 m or more resulted in no pathological damage to the fish.

- Hastings (1990, in Turnpenny and Nedwell, 1994) (in CCA, 2001) found that lethal thresholds for fish began at 229 dB and transient stunning was reported at 192-198 dB received, but that captive fish usually recovered after 30 minutes. Turnpenny and Nedwell (1994) (in CCA, 2001) noted that such transient stunning could be lethal in the wild due to an increase in predation.

- McCauley (1994) (in CCA, 2001) reviewed experiments in which fish were exposed to black powder detonations and stated that the signal from detonation of black powder has similar characteristics to that of airguns. He noted that Hubbs and Reichner (1952, in McCauley, 1994) (in CCA, 2001) found that peak pressures as high as 240 dB re 1 µPa peak did not result in fish mortalities. However, no received levels are given in this text.

- McCauley *et al* (2000) (in CCA, 2001) reported preliminary results of pathological examinations of pink snapper (*Chrysophrys aurata*) exposed to airguns in experimental trials. Fish were exposed to a maximum level of sound which corresponds to an approximate rms level of 193 dB re 1 µPa. Examinations of maculae showed ablated or damaged hair cells on the saggital otoliths (1). Although the extent of such temporary damage was low, the authors note that it may be indicative of greater damage and reduced fitness after exposure. The authors noted however that the results are preliminary and that the duration of injury is at present unknown. McCauley *et al* (2003) (in CCA, 2001) found injury to fish hearing organs remained for 58 days after being subject to airgun pulses and that full hearing recovery may have taken four months.

Although the above studies provide evidence of the possibility that pathological trauma or mortality will occur if the fish is in close proximity to airguns, given the general high mobility of fish, it is generally assumed that the majority of fish species would avoid seismic noise at lower levels than where pathological injury or mortality would occur. As such, the pathological injury/ mortality impacts are deemed to be of **low** significance.

The physiological effects of seismic sounds from airgun arrays will mainly affect the younger life stages of fish such as eggs, larvae and fry, many of which form a component of the meroplankton and thus have limited ability to escape from their original areas in the event of various influences. Numerous studies have been undertaken experimentally exposing the eggs and larvae of various fish species to airgun sources (Kostyuchenko 1971; Dalen & Knutsen 1987; Holliday *et al*. 1987; Booman *et al*. 1992; Kosheleva 1992; Popper *et al*. 2005, amongst others). These studies generally identified mortalities and physiological injuries at very close range (<5 m) only. For example, increased mortality rates for fish eggs were proven out to ~5 m distance from the air guns. A mortality rate of 40-50% was recorded for yolk sac larvae (particularly for turbot) at a distance of 2-3 m (Booman *et al*. 1996), although mortality figures for yolk sac larvae of anchovies at the same distances were lower (Holliday *et al*. 1987). Yolk sac larvae of cod experienced significant eye injuries (retinal stratification) at a distance of 1 m from an air gun array (Matishov 1992), and Booman *et al*. (1996) report damage to brain cells and lateral line organs at <2 m distance from an airgun array. Increased mortality rates (10 - 20percent) at later stages (larvae, post-larvae and fry) was demonstrated for several species at distances of 1-2 m. Changes have also been observed in the buoyancy of the organisms, in their ability to avoid predators and effects that affect the general condition of larvae, their growth rate and thus their ability to survive. Temporary disorientation of juvenile fry

(1) The hearing system of fish is made up of sets of organs containing calcareous stones termed the saggital, utricle and lagena otoliths. In most boney fish the saggital otoliths are the primary hearing transducers. Each otolith has a surrounding sensory epithelium termed the macula, which is lined with hair cells. Movement of the otolith results in pressure on the macula hair cells and the nervous response.

was recorded for some species (McCauley 1994). Fish larvae with swim-bladders may be more receptive to the sounds produced by seismic airgun arrays, and the range of effects may extend further for these species than for others.

From a fish resource perspective, these effects may potentially contribute to a certain diminished net production in fish populations. However, Sætre & Ona (1996) calculated that under the "worst case" scenario, the number of larvae killed during a typical seismic survey was 0.45 percent of the total larvae population. When more realistic "expected values" were applied to each parameter of the calculation model, the estimated value for killed larvae during one run was equal to 0.03 percent of the larvae population. If the same larval population was exposed to multiple seismic runs, the effect would add up for each run. For species such as cod, herring and capelin, the natural mortality is estimated at 5-15 percent per day of the total population for eggs and larvae. This declines to 1-3 percent per day once the species reach the 0 group stage *i.e.* at approximately 6 months (Sætre & Ona 1996). Consequently, Dalen *et al*. (1996) concluded that seismic-created mortality is so low that it can be considered to have a negligible impact on recruitment to the populations.

A considerable amount of migratory fish species have been identified to move through the proposed Exploration Areas (i.e. the 'sardine run' and species listed in *Table 3.2*). As such, the likelihood of encountering feeding aggregations of large pelagic, demersal and nearshore reef species is relatively **high**. 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 potential physiological impact on demersal and nearshore reef species would, however, be **negligible** as they would only be affected in the far-field range. In light of this, the impact is therefore considered to be of **low** significance without the implementation of mitigation measures, and of **negligible** significance with mitigation measures.

Behavioural Avoidance of Seismic Survey Areas

Behavioural responses to impulsive sounds are varied and include leaving the area of the noise source (Suzuki *et al.* 1980; Dalen & Rakness 1985; Dalen & Knutsen 1987; Løkkeborg 1991; Skalski *et al.* 1992; Løkkeborg & Soldal 1993; Engås *et al.* 1996; Wardle *et al.* 2001; Engås & Løkkeborg 2002; Hassel *et al.* 2004), changes in depth distribution (Chapman & Hawkins 1969; Dalen 1973; Pearson *et al.* 1992; Slotte *et al*. 2004), spatial changes in schooling behaviour (Slotte *et al.* 2004), and startle response to short range start up or high level sounds (Pearson *et al.* 1992; Wardle *et al.* 2001). In some cases behavioural responses were observed at up to 5 km distance from the firing airgun array (Santulli *et al*. 1999; Hassel *et al*. 2004). Behavioural effects are generally short-term, however, 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 (McCauley *et al*.

2000). In some cases behaviour patterns returned to normal within minutes of commencement of surveying indicating habituation to the noise. Disturbance of fish is believed to cease at noise levels below 160 dB re 1µPa. The ecological significance of such effects is therefore expected to be **low**, except in cases where they influence reproductive activity.

The potential impact on fish behaviour could therefore be of **high intensity** (particularly in the near-field of the airgun array), over the **short term**, but limited to the survey area. Consequently it is considered to be of **low** significance without mitigation and **negligible** significance with mitigation.

Reproductive success / spawning

Fish populations can 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 will depend on the biology of the species and the extent of the dispersion or deflection. Dalen *et al*. (1996), however, recommended that in areas with concentrated spawning or spawning migration seismic shooting be avoided at a distance of ~50 km from these areas. For the current proposed seismic survey, there is potential overlap of the target area with the spawning grounds (particularly inshore of the Transkei Exploration Area) of various pelagic and demersal species along the East Coast. Various reef fish are also reported to spawn on deep-water reefs along the South Coast and undertake spawning migrations through the Exploration Areas along the East Coast to KwaZulu-Natal.

As such, the likelihood of encountering spawning aggregations of large pelagic (i.e. kingklip), demersal (i.e. anchovy and pilchard) and near shore reef species is relatively **high**. Despite this, considering the wide range over which the potentially affected species occur, the relatively **short-term** duration of the proposed survey and that the migration routes do not constitute narrow restricted paths, the impact is considered to be of **low** significance without the implementation of mitigation measures, and of **negligible** significance with mitigation measures.

Masking of Environmental Sounds and Communication

Communication and the use of environmental sounds by fish in the offshore environment off the South African East Coast are unknown. Some near shore reef species, however, are likely to produce isolated sounds or to call in choruses. Impacts arising from masking of sounds are expected to be of **low** intensity due to the duty cycle of seismic surveys in relation to the more continuous biological noise. Furthermore, as the survey would be conducted at depths in excess of 100 m, any effects on demersal fish species would be in the far field. Such impacts would occur across the survey area and for the

duration of the survey and are consequently considered of **negligible** significance both with and without mitigation.

Indirect Impacts

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 and tunas to pelagic fish 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. Considering the extensive range of the survey area, the impact is likely to be of **negligible** significance with and without mitigation.

The overall impacts of the seismic survey on fish before mitigation are judged to be of low significance before mitigation and negligible-low significance after mitigation.

**Mitigation of Impacts on Fish**

- All initiation of airgun firing be carried out as "soft-starts" of at least 20 minutes duration, allowing fish to move out of the survey area and thus avoid potential physiological injury as a result of seismic noise.
- No seismic airgun firing to be undertaken within MPAs.
- A seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be implemented, within which there will be no firing of airguns.

**Residual Impacts on Fish**

The residual impacts on fish is deemed to be of **low** significance after the implementation of "soft starts" and given the temporary nature of seismic surveys, the ability of the fish to move away from high sound levels and the large distribution range of fish species negating any possible feeding or predation impacts.

*Impacts on Turtles*

The effects of seismic noise on turtle species could include:

- Physiological injury (including disorientation), mortality from seismic noise or collision with or entanglement in towed seismic apparatus;
- Behavioural avoidance of seismic survey areas;
- Influences to reproductive success;
- Masking of environmental sounds and communication; and
- Indirect effects due to effects on prey.

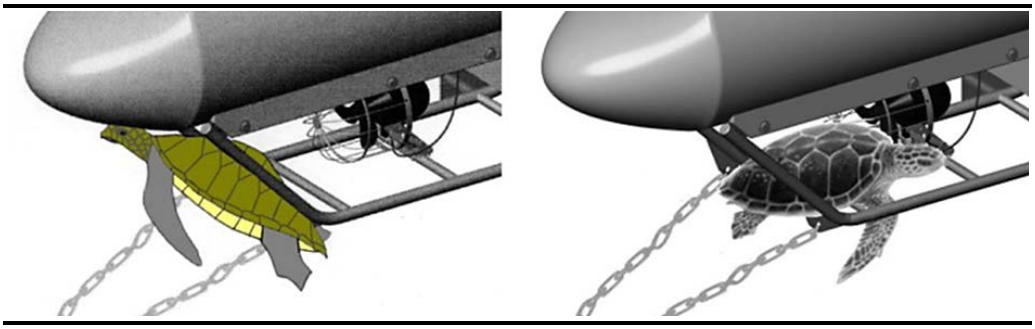
Physiological Injury or Mortality

Although no information could be sourced on physiological injury to turtle hearing as a result of seismic sounds, the overlap of their 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. This applies particularly to hatchlings and juveniles as they are unable to avoid seismic sounds whilst being transported in the Agulhas Current, and consequently are more susceptible to seismic noise. The potential impact could therefore be of **high** intensity, but remain within the **short-term**. The abundance of adult turtles and hatchlings along the East Coast is **low** as is the likelihood of encountering turtles during the proposed survey. In light of this, the potential physiological impact of seismic sounds on turtles is considered to be of **low** significance without mitigation, and **negligible** significance with mitigation.

Although collisions between turtles and vessels are not limited to seismic ships, the large amount of equipment towed astern of survey vessels does increase the potential for collision, or entrapment within seismic equipment and towed surface floats. Basking turtles are particularly slow to react to approaching objects and may not be able to move rapidly away from approaching airguns. Entrapment occurs either as a result of 'startle diving' in front of towed equipment or following foraging on barnacles and other organisms growing along seismic cables and surfacing to breathe immediately in front of the tail buoy (primarily loggerhead and olive ridley turtles). In the first case the turtle becomes stuck within the angled gap between the chains and the underside of the buoy, lying on their sides across the top of the chains and underneath the float with their ventral surface facing the oncoming water thereby causing the turtle to be held firmly in position (*Figure 6.1*, left). Furthermore, the presence of the propeller in the undercarriage of some buoy-designs prohibits turtles that have entered the undercarriage from travelling out of the trailing end of the buoy (*Figure 6.1*, right). Once stuck inside or in front of a tail buoy, the water pressure generated by the 4–6 knot towing speed, would hold the animal against/inside the buoy with little chance of escape due to the angle of its body in relation to the forward movement of the

buoy. For a trapped turtle this situation will be fatal, as it will be unable to reach the surface to breathe (Ketos Ecology 2009). To prevent entrapment, the seismic industry has implemented the use of "turtle guards" on all tailbuoys.

*Figure 6.1 Example of Turtles Trapped in Tail Buoy*



Source: Ketos Ecology, 2009

Turtles commonly become trapped in front of the undercarriage of the tail buoy in the area between the buoy and the towing chains (left), and inside the 'twin-fin' undercarriage structure (right)

The potential for collision between adult turtles and the seismic vessel, or entanglement of turtles in the towed seismic equipment and surface floats, is highly dependent on the abundance and behaviour of turtles in the survey area at the time of the survey. As the breeding areas for turtles are located in northern KwaZulu-Natal, turtles encountered during the survey are likely to be migrating vagrants and impacts through collision or entanglement would be of **low** intensity and **short-term**. The impact on turtles through collision or entanglement of seismic equipment is thus considered to be of **low** significance without mitigation and **negligible** significance with mitigation, such as the use of "turtle guards".

Behavioural avoidance of seismic survey areas

Behavioural changes in response to anthropogenic sounds have been reported for some sea turtles and include startle response (Lenhardt *et al.* 1983), an increase in swim speed and erratic behaviour indicative of avoidance (O'Hara & Wilcox 1990; McCauley *et al*. 2000). Further trials carried out on caged loggerhead and green turtles indicated that significant avoidance response occurred at received levels ranging between 172 and 176 dB re 1 µPa at 24 m, and repeated trails several days later suggest either temporary reduction in hearing capability or habituation with repeated exposure. Hearing however returned after two weeks (Moein *et al.* 1994; McCauley *et al*. 2000).

The impact of seismic sounds on turtle behaviour is of **high** intensity. It would persist only for the duration of the survey (**short-term**) and be restricted to the survey area (**local**). In light of this, and given the general extent of turtle migrations relative to seismic survey target grids, the impact of seismic noise

on turtle migrations is deemed to be of **low** significance without mitigation and **negligible** with mitigation.

Influences to reproductive success

Following their emergence on the beaches of northern KwaZulu-Natal between January and March, hatchlings maintain mostly a pelagic existence offshore in the Agulhas Current. This will transport them into the Exploration Areas during the seismic survey, which is expected to take place during the austral summer. As hatchlings are weak swimmers they are more vulnerable to collision with the towed equipment, and to direct seismic noise impacts from the airguns, which may stun them and render them more vulnerable to predation. Parts of the proposed survey area are located in deep waters of the Agulhas Current and hatchling survival may thus be affected.

The effect of seismic surveys on recruitment success will be of **high** intensity but will vary with the distance offshore and timing of the specific survey. If recruitment success is affected, this could impact population size beyond the short-term to the **medium-term**. However, 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 **negligible** with mitigation.

Masking of Environmental Sounds and Communication

Breeding adult loggerhead and leatherback turtles undertake large migrations between distant foraging areas and their nesting sites on the beaches of northern KwaZulu-Natal during the summer months October to March, with peak nesting during December and January. Although it is speculated that turtles may use acoustic cues for navigation during migrations, information on turtle communication is lacking. There is no information available in the literature on the effect of seismic noise in masking environmental cues and communication in turtles, but their expected low abundance in the survey area during the likely scheduling of the survey (November - May) would suggest that the potential significance of this impact (should it occur) would be **negligible**.

Indirect Impacts

The diets of the three common South African turtle species are remarkably diverse. As the proposed survey area is located away from any shallow water habitats known to be important for turtle feeding, destruction or adverse modification of critical habitat would thus be insignificant, and the effects of seismic surveys on the feeding behaviour of turtles is thus expected to be **negligible** both with and without mitigation.

The overall impact on turtles before mitigation is expected to be of **low** significance before mitigation and **negligible** after mitigation.

**Mitigation of Impacts on Turtles**

- Implement at least 20 minute "soft starts" at the initiation of all shooting activity to reduce noise impacts on turtles and allow time for the turtles to move from the area before pathological seismic noise levels are reached.
- An area of radius of 500 m will be scanned by an independent observer for the presence of turtles prior to the commencement of "soft starts" and these will be delayed until such time as this area is clear of turtles.
- Initiation of firing should only begin after observations have confirmed (as far as possible) that the visual area around the vessel to a distance of 500 m (safety zone) is clear of all turtle species.
- Daylight observations of the survey region should be carried out by on-board Independent Observers and incidence of turtles and their responses to seismic shooting should be recorded.
- Seismic shooting should be terminated when obvious negative changes to turtle behaviour is observed from the survey vessel, or animals are observed within the immediate vicinity (within 500 m) of operating airguns and appear to be approaching firing airgun.
- Any obvious mortality or injuries to turtles as a direct result of the survey should result in temporary termination of operations.
- Ensure that 'turtle-friendly' tail buoys are used by the survey contractor or that existing tail buoys are fitted with either exclusion or deflector 'turtle guards'.

**Residual Impacts on Turtles**

Given the mobility of turtles to avoid seismic noise, the impact of the surveys on turtle populations are expected to be of **negligible** significance.

*Impacts on Seabirds*

Among the marine avifauna occurring along the East Coast of South Africa, it is the species that feed by plunge-diving or that rest on the sea surface, which may be affected by the underwater noise of seismic surveys. Of these, only the African penguin (*Spheniscus demersus*) (SA Red Data species listed as Vulnerable) which is flightless (and consequently more susceptible to underwater seismic noise) and Cape gannet (*Morus capensis*) (SA Red Data species listed as Concerned) are considered. In African penguins the best hearing is in the 600 Hz to 4 kHz range with the upper limit of hearing at 15 kHz and the lower limit at 100 Hz (Wever *et al*. 1969). No critical ratios have, however, been measured. Principal energy of vocalisation of African

penguins was found at < 2 kHz, although some energy was measured at up to 6 kHz (Wever *et al*. 1969).

Potential impacts of seismic pulses to diving birds could include physiological injury, behavioural avoidance of seismic survey areas and indirect impacts due to effects on prey. The seabird species are all highly mobile and would be expected to flee from approaching seismic noise sources at distances well beyond those that could cause physiological injury, but initiation of a sound source at full power in the immediate vicinity of diving seabirds could result in injury or mortality where feeding behaviour override a flight response to seismic survey sounds. The potential for physiological injury or behavioural avoidance in non-diving seabird species is considered **negligible** and will not be discussed further here.

Physiological injury

The continuous nature of the intermittent seismic survey pulses suggest that African penguins and other diving birds would hear the sound sources at distances where levels would not induce mortality or injury, and consequently be able to flee an approaching sound source.

Of the plunge diving species that occur along the coastline, only the Cape Gannet regularly feeds as far offshore as 100 km, the rest foraging in near shore areas up to 40 km from the coast. The nearest nesting grounds for Cape Gannet and African penguins are at the Algoa Bay islands which are situated approximately 90 km to the north of the Algoa Exploration Area. There is therefore a **high** probability of encountering gannets in the survey area, particularly during spring and summer when pelagic shoaling species frequent the area during their spawning migrations. Although African penguins are known to forage up to 60 km offshore, they are unlikely to be affected by the seismic survey in the Algoa Bay Exploration Area as it is located beyond 90 km offshore. However, juveniles have been reported to travel up the coast regularly, such that there is a **high** probability of their entering the survey operation in the Transkei Exploration Area (which boarders the shoreline). There is thus a high likelihood of the survey encountering foraging penguins in the inshore regions of the licence area, and Cape gannets are likely to be encountered further offshore, particularly if the survey schedule overlaps with the annual 'sardine run' between June and August.

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

Behavioural avoidance

Behavioural avoidance by diving seabirds would be limited to the vicinity of the operating airgun within the survey area (**local**) over the duration of the survey period (**short term**). The impact is likely to be of **medium** to **high** intensity. The potential impact on the behavioural avoidance of feeding areas by diving seabirds is considered to be of **low** significance without mitigation, and **negligible** significance with mitigation.

Indirect impacts due to effects on prey

As with other vertebrates, the assessment of indirect effects of seismic surveys on diving seabirds 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 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. The broad ranges of potential fish prey species (in relation to potential avoidance patterns of seismic surveys of such prey species) and extensive ranges over which most seabirds feed suggest that indirect impacts would be **negligible** with and without mitigation.

As there is a relatively high probability of encountering gannets and penguins in closer inshore areas (due to the location of important bird breeding colonies relatively close to the exploration area) the overall impacts of the seismic surveys on seabirds are deemed to be of **low** significance due to their high mobility and large feeding ranges.

**Mitigation of Impacts on Seabirds**

- Initiation of airgun firing will be carried out as "soft-starts" of at least 20 minutes duration.
- An area with a radial length of 500 m shall be scanned by an independent observer for the presence of diving seabirds prior to the commencement of "soft starts" and these will be delayed until such time as this area is clear of seabirds.
- Seabird incidence and behaviour should be recorded by an on-board Independent Observer. Any obvious mortality or injuries to seabirds as a direct result of the survey should result in temporary termination of operations.
- Any attraction of predatory seabirds (by mass disorientation or stunning of fish as a result of seismic survey activities) and incidents of feeding behaviour among the hydrophone streamers should be recorded by an on-board Independent Observer.
- The surveys should be scheduled outside of the 'sardine run' period (i.e. June and July).

**Residual Impact on Seabirds**

The overall residual impact on seabirds is likely to be **negligible**, given the transitory nature and short duration of the seismic surveys and the large feeding range of the seabird species that are able to hear the seismic noise and move away from the source.

*Impacts on Seals*

The Cape fur seal (*Arctocephalus pusillus pusillus)* is the only seal species living along the South African coast. It forages over the continental shelf to depths of over 200 m and would consequently be expected to occur within the proposed Exploration Areas. It is widely distributed, particularly along the South and Western Coasts of South Africa. In terms of the Exploration Areas, there is only one significant seal colony situated at Black Rocks (Bird Island group) in Algoa Bay, to the south of the proposed Algoa Exploration Area.

Underwater behavioural audiograms have been obtained for two species of Otariidae (sea lions and fur seals), but no audiograms have been measured for Cape fur seals. Extrapolation of these audiograms to below 100 Hz would result in hearing thresholds of approximately 140-150 dB re 1 µPa for the California sea lion and well above 150 dB re 1 µPa for the Northern fur seal. The range of greatest sensitivity in fur seals lies between the frequencies of 2-32 kHz (McCauley 1994). Underwater critical ratios have been measured for two northern fur seals and averaged ranged from 19 dB at 4 kHz to 27 dB at 32 kHz. The audiograms available for otariid pinnipeds suggest they are less sensitive to low frequency sounds (<1 kHz) than to higher frequency sounds (>1 kHz). The range of low frequency sounds (30-100 Hz) typical of seismic airgun arrays thus falls below the range of greatest hearing sensitivity in fur seals. This generalisation should, however, be treated with caution as no critical ratios have been measured for Cape fur seals.

Seals produce underwater sounds over a wide frequency range, including low frequency components. Although no measurement of the underwater sounds have been made for the Cape fur seal, such measurements have been made for a con-generic species *Arctocephalus philippii*, which produced narrow-band underwater calls at 150 Hz. Aerial calls of seals range up to 6 Hz, with the dominant energy in the 2-4 kHz band. However, these calls have strong tonal components below 1 kHz, suggesting some low frequency hearing capability and therefore some susceptibility to disturbance from the higher frequency components of seismic airgun sources (Goold & Fish 1998; Madsen *et al*. 2006).

The potential impact of seismic survey noise on seals could include physiological injury to individuals, behavioural avoidance of individuals (and subsequent displacement from key habitat), masking of important

environmental or biological sounds and indirect effects due to effects on predators or prey.

Physiological injury or mortality

The physiological effects of loud low frequency sounds on seals are not well documented, but include cochlear lesions following rapid rise time explosive blasts (Bohne *et al*. 1985; 1986), temporary threshold shifts (TTS) following exposure to octave-band noise (frequencies ranged from 100 Hz to 2000 Hz, octave-band exposure levels were approximately 60–75 dB, while noise-exposure periods lasted a total of 20–22 min) (Kastak *et al*. 1999), with recovery to baseline threshold levels within 24 h of noise exposure.

Using measured discomfort and injury thresholds for humans, Greenlaw (1987) modelled the pain threshold for seals and sea lions and speculated that this pain threshold was in the region of 185 – 200 dB re 1 µPa. The impact of physiological injury to seals from seismic noise is deemed 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. However, noise of moderate intensity and duration may be sufficient to induce TTS under water in pinniped species (Kastak *et al*. 1999). Reports of seals swimming within close proximity of firing airguns should thus be interpreted with caution in terms of the impacts on individuals as such individuals may well be experiencing hearing threshold shifts.

The potential for physiological injury to seals from seismic noise is expected to be low as being highly mobile, fur seals would avoid severe sound sources at levels well below those at which discomfort occurs. Past studies suggest that noise of moderate intensity and duration is sufficient to induce TTS in seals, as individuals did not appear to avoid the survey area. Their tendency to swim at or near the surface will also expose them to reduced sound levels when in close proximity to an operating airgun array. Seal colonies in the vicinity of the proposed survey area are located at Seal Island in Mossel Bay, on the northern shore of the Robberg Peninsula in Plettenberg Bay and at Black Rocks (Bird Island group) in Algoa Bay. As seals are known to forage up to 120 nautical miles offshore, the proposed survey area therefore potentially falls within the foraging range of seals from the nearby colonies, particularly in the Algoa Bay area. It is therefore **probable** that seals will be encountered within the proposed survey area; however on a sporadic basis. 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 survey area (**local**), although injury could extend beyond the survey duration. The duration of the impact would extend for the period of the survey (**short term**). The significance of the impact without mitigation is **negligible** with and without mitigation.

Behavioural avoidance

Information on the behavioural response of fur seals to seismic exploration noise is lacking (Richardson *et al*. 1995; Gordon *et al*. 2004). Reports of studies conducted with Harbour and Grey seals include initial startle reaction to airgun arrays, and range from partial avoidance of the area close to the vessel (within 150 m) (Harris *et al*. 2001) to fright response (dramatic reduction in heart rate), followed by a clear change in behaviour, with shorter erratic dives, rapid movement away from the noise source and a complete disruption of foraging behaviour (Gordon *et al*. 2004). In most cases, however, individuals quickly reverted back to normal behaviour once the seismic shooting ceased and did not appear to avoid the survey area. Seals seem to show adaptive responses by moving away from airguns and reducing the risk of sustaining hearing damage. Potential for long-term habitat exclusion and foraging disruption over longer periods of exposure (i.e. during full-scale surveys conducted over extended periods) is however a concern.

Although partial avoidance (to less than 250 m) of operating airguns has been recorded for some seals species, Cape fur seals appear to be relatively tolerant to loud noise pulses and, despite an initial startle reaction, individuals quickly reverted back to normal behaviour. The potential impact of seal foraging behaviour changing in response to seismic surveys is thus considered to be of **low** to **medium** intensity and limited to the survey area (local) and duration (**short term**). The significance of behavioural avoidance impacts is consequently deemed **negligible**, both with and without mitigation.

Masking of environmental sounds 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 firing every 10 to 15 seconds). The impacts of masking are considered **negligible**, both with and without mitigation.

Indirect effects due to the effects of seismic sounds on prey species

As with other vertebrates, the assessment of indirect effects of seismic surveys on Cape fur seals 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 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 would be **negligible**, both with and without mitigation.

The overall impact on seals is deemed to be **negligible** due to their high mobility and minimal behavioural impacts.

**Mitigation of Impacts on Seals**

- All initiation of airgun firing will be carried out as "soft-starts" of at least 20 minutes duration.
- An area with a radial length of 500 m will be scanned by an independent observer for the presence of seals prior to the commencement of "soft starts" and these will be delayed until such time as this area is clear of seals. If after a period of 30 minutes seals are still within 500 m of the airguns, the normal "soft start" procedure should be allowed to commence for at least 20-minutes duration.
- Daylight observations of the survey region should be carried out by on-board Marine Mammal Observers (MMOs) and incidence of seals and their responses to seismic shooting should be recorded.
- Seismic shooting should be terminated when obvious negative changes to seal behaviour are observed from the survey vessel.
- Any obvious mortality or injuries to seals as a direct result of the survey should be recorded.

**Residual Impact on Seals**

The overall impact on seals is deemed to be **negligible** due to their high mobility and minimal behavioural impacts.

*Impacts on Cetaceans (Whales and Dolphins)*

A wide diversity of cetaceans (whales and dolphins) occurs off the East Coast of South Africa. The majority of migratory cetaceans in South African waters are baleen whales (mysticetes), although toothed whales (odontocetes) may be resident or migratory. Potential impacts of seismic pulses to 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 prey.

The factors that affect the response of marine mammals to sounds in their environment include the sound level and its prevailing acoustic characteristics, the ecological features of the environment in which the animal encounters the sound and the physical and behavioural state of the animal. When discussing the potential effects of seismic surveys on marine mammals we should bear in mind the lack of data, and resultant uncertainty, concerning the auditory capabilities and thresholds of impacts on the different species encountered and the individual variability in hearing thresholds and behavioural responses which are likely to influence the degree of impact (Luke *et al*. 2009; Gedamke *et al*. 2011). This uncertainty and variability can

have a large impact on how risk to marine mammals is assessed. Assessing the impact of seismic activity on populations in the Agulhas system is further hampered by a poor understanding of the abundance and distribution of many of the species found here.

Marked differences occur in the hearing of baleen whales (mysticete cetaceans) and toothed whales and dolphins (odontocete cetaceans). The vocalisation and estimated hearing range of baleen whales (centred at below 1 kHz) overlap the highest peaks of the power spectrum of airgun sounds and consequently these animals may be more affected by disturbance from seismic surveys (Nowacek *et al*. 2007). In contrast, the hearing of toothed whales and dolphins is centred at frequencies of between 10 and 100 kHz, suggesting that these may react to seismic shots at long ranges, but that hearing damage from seismic shots is only likely to occur at close range. Mysticete and odontocete cetaceans are thus assessed separately below.

Physiological injury

There is little information available on the levels of noise that would potentially result in physiological injury to cetaceans, and no permanent threshold shifts have been recorded. 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. Deep-diving cetacean species (e.g. sperm whale) 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.

The majority of baleen whales migrate to the southern African subcontinent to breed during winter months. Humpback whales are reported to reach the coast in the vicinity of Knysna on their northern migrations around April, continuing through to September/October when the southern migration begins and continues through to December. Southern right whales arrive in coastal waters on the East Coast in June, building up to a maximum in September/October and departing again in December. The proposed Exploration Areas thus lies both within the migration paths of humpback whales, and adjacent to nearshore areas frequented by southern right whales. As the survey is 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. However, the survey is 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 impact of potential physiological injury to both mysticete and odontocete cetaceans 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 survey area. The impact is therefore considered to be of **medium** significance without mitigation for resident odontocetes, and of **medium** significance without mitigation for mysticetes (mainly Humpbacks in November/December). Significance would reduce to **low** with mitigation.

Behavioural avoidance

Avoidance of seismic survey activity by cetaceans, particularly mysticete species, begins at distances where levels of approximately 150 to 180 dB are received. More subtle alterations in behaviour may occur at received levels of 120 dB. Although behavioural avoidance of seismic noise in the proposed survey area 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 baleen whale species.

The timing of the survey relative to seasonal breeding cycles (such as those observed in migrating baleen whales) may influence the degree of stress induced by noise exposure (Tyack 2008). Displacement from 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. It is likely that the proposed survey area overlaps with migration routes of both humpback and southern right whales to and from their breeding grounds.

The humpback whale has its winter breeding concentrations on the east coast of Africa, from northern KwaZulu-Natal northwards and therefore over 400 km to the north-east of the northern boundary of the proposed survey areas. Southern right whales, however, currently have their most significant winter concentrations on the South African South Coast between Port Elizabeth and Cape Town. The nearshore areas of the De Hoop MPA and St. Sebastian Bay at Cape Infanta ranks as probably the most important nursery area for Southern Right whales in the world, containing 70-80% of the cow-calf pairs on the South African coast. The proposed survey area in the Algoa Block is located beyond the 200 m isobath and therefore does not overlap with such known areas. The southern boundary of the Transkei Block is located ~150 km to the northeast and thus similarly does not overlap with important nursery area for southern right whales. However 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.

The potential impact of behavioural avoidance of seismic survey areas by mysticete cetaceans is considered to be of high intensity, across the survey area and for the duration of the survey. Considering the distribution ranges of most species of cetaceans, the impact of seismic surveying is considered of

**low** (southern rights) and **medium** (humpbacks in November/December) significance before mitigation. Limiting seismic surveys to outside of the winter/spring (June to December) migration would reduce the intensity of potential impacts to low resulting in **negligible** significance with mitigation. As the survey is likely to commence before the end of the return migration of humpbacks (November/December), additional mitigation measures (PAM) will need to be implemented, and although the intensity of potential impacts would remain high, significance with mitigation would be **low**.

Information available on behavioural responses of toothed whales and dolphins to seismic surveys is more limited than that for baleen whales. No seasonal patterns of abundance are known for odontocetes occupying the proposed study area and information on breeding and calving areas and seasons is also lacking. Furthermore, as there is less evidence of avoidance of seismic surveys by toothed whales (including dolphins), a precautionary approach to avoiding impacts is thus recommended. Consequently the impact of seismic survey noise on the behaviour of toothed whales is considered to be of medium to high intensity over the survey area and duration. A number of toothed whale species have a more pelagic distribution and are thus likely to be encountered further offshore. The overall significance will therefore vary between species, and consequently ranges between **low** and **negligible** before mitigation and **negligible** with mitigation.

Masking of environmental sounds and communication

Baleen whales appear to vocalise almost exclusively within the frequency range of the maximum energy of seismic survey noise, while toothed whales vocalise at frequencies higher than these. As the by-product noise in the mid-frequency range can travel far, masking of communication sounds produced by whistling dolphins and blackfish (1) 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. However, masking of communication signals is likely to be limited by the low duty cycle of seismic pulses. Consequently, the intensity of impact on baleen whales is likely to be low over the survey area and duration, but high in the case of toothed whales. Whereas for mysticetes the significance is rated as **negligible**, both with and without mitigation, for odontocetes it is rated as **low** without mitigation and **negligible** with mitigation.

Indirect impacts due to effects on prey

As with other vertebrates, the assessment of indirect effects of seismic surveys on resident odontocete cetaceans is limited by the complexity of trophic

(1) The term blackfish refers to the delphinids: Melon-headed whale, Killer whale, Pygmy Killer Whale, False Killer Whale, Long-finned Pilot Whale, Short-finned Pilot Whale.

pathways in the marine environment. However, it is likely that both fish and cephalopod prey of toothed whales and dolphins may be affected over limited areas, although the impacts are difficult to determine. The 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 of **negligible** significance with and without mitigation. Baleen whales do not feed while in the proposed survey area so the significance of indirect effects on their food source is **negligible**.

Other potential impacts

Given the slow speed (about 4 - 6 knots) of the vessel while towing the seismic array, ship strikes are unlikely. However, entanglement in gear is possible.

The overall impact on cetaceans during the seismic survey is deemed to be of **medium** significance prior to mitigation due to the incidence of cetaceous species within the exploration area, and their ability to move away from the sound source.

**Mitigation of Impacts on Cetaceans**

- The regulations for Boat-based Whale Watching and Protection of Turtles (R 725) as part of the Marine Living Resources Act (Act No. 18 of 1998) stipulate that an aircraft or survey vessel must maintain a minimum distance of 300 m from any whale. As this may be both impractical and impossible, an exemption permit must be applied for through the Department of Environmental Affairs and Tourism.
- As far as possible, avoid planning seismic surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November), and ensure that migration paths are not blocked by seismic operations. In addition, avoid surveying during December when humpback whales may still be moving through the area on their return migrations. If surveying during this time cannot be avoided all other mitigation measures must be stringently enforced, and PAM technology, which detects cetaceans through their vocalisations, must be implemented 24-hours a day.
- As no seasonal patterns of abundance are known for odontocetes occupying the study area, a precautionary approach to avoiding impacts is recommended.
- Survey vessels should accommodate dedicated independent MMOs with experience in seabird, turtle and marine mammal identification and observation techniques, to carry out daylight observations of the survey region and record incidence of marine mammals, and their responses to seismic shooting. Data collected should include 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). Both the identification and the behaviour of the animals must be recorded accurately along with current seismic noise levels.

- All initiations of seismic surveys must be carried out as "soft-starts" for a minimum of 20 minutes (JNCC 2010). This requires that the sound source be ramped from low to full power, thus allowing a flight response to outside the zone of injury or avoidance. The rational for the 20 minute "soft-start" period is based on the flight speeds of cetacean species.
- Initiation of firing is only to begin after observations by MMOs have deemed the visual area around the vessel to a distance of 500 m to be clear of all large cetacean species for at least 30 minutes prior to firing, so that deep- or long-diving species can be detected. In the case of small cetacean (particularly dolphins), which are common in inshore waters and 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 airguns, in particular the Indo-Pacific humpback dolphin (*Sousa chinensis*) or the Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus),* listed in the South African Red Data Book as 'vulnerable' and 'endangered' respectively. If after a period of 30 minutes small cetaceans are still within 500 m of the airguns, 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 airguns 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 "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. Breaks shorter than 20 minutes should be followed by a "soft-start" of similar duration.
- Seismic shooting should be terminated when obvious negative changes to cetacean behaviour is observed, or animals are observed within the immediate vicinity (within 500 m) of operating airguns and appear to be approaching firing airgun.
- 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.
- All data recorded by MMOs should at minimum form part of a survey close–out report. Furthermore, daily or weekly reports should be forwarded to the necessary authorities to ensure compliance with the mitigation measures.
- Seabird, turtle and marine mammal incidence data and seismic source output data arising from surveys should be made available on request to the Marine Mammal Institute, Department of Agriculture, Fisheries and Forestry, and the Petroleum Agency of South Africa for analyses of survey impacts in local waters.
- Should the survey schedules overlap with the start of the sensitive period in terms of large mammals migrating through the area, ensure that PAM

technology is implemented to confirm that no cetaceans are present in the vicinity of the vessel. PAM is also to be used when surveying at night or during adverse weather conditions and thick fog. During the commencement of night-time operations, visual watches should be maintained using night-vision/infra-red binoculars.

- The use of PAM is encouraged by most international guidelines as a mitigation tool to detect marine mammals through their vocalisations, particularly if species of particular conservation importance are likely to be encountered in the proposed survey area, or where a given species or group is difficult to detect by visual observation alone. Such monitoring can provide distance and bearing of the animals from the survey vessel. Although PAM would only identify animals that are calling or vocal, it has the advantage of 24 hour per day availability as opposed to visual monitoring, which can only be confidently carried out during daylight hours, or under adequate visibility conditions. Considering that most of the offshore migrating baleen whale species likely to be encountered are listed as "Endangered", every effort should be made to ensure that the vessel is fitted with PAM technology.
- The use of the lowest practicable airgun volume should be defined and enforced, and airgun use should be prohibited outside of the licence area.
- No seismic survey-related activities are to take place within declared Marine Protected Areas.
- A seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be implemented, within which there will be no firing of airguns.

**Residual Impact on Cetaceans (Whales and Dolphins)**

The overall impact on cetaceans is deemed to be **low** after the implementation of mitigation measures due to the high levels of mobility, the short duration of the seismic surveys and the avoidance of the winter migration times.

*Marine Transport Routes*

Seismic surveys require accurate navigation of the sound source and receiver streamers over pre-determined survey transects. This and the fact that the array and the hydrophone streamers need to be towed in a set configuration and at a set speed behind the seismic vessel, means that the survey operation has little manoeuvrability while operating. Consequently, other vessels may be required to alter course to avoid the towed array and hydrophone streamers and to keep clear of the exclusion zone.

The displacement of transport shipping will be limited to within the extreme near vicinity of the seismic vessel and array and will be of very **temporary** extent (hours). Chase vessels will be present in front and behind the seismic vessel to ensure that there is a clear path. The impact of such displacement is

not significantly greater than displacement associated with any other vessel restricted in her ability to manoeuvre and is deemed to be of **negligible** significance after mitigation.

**Mitigation of Impacts on Marine Transport Routes**

- A notice of the seismic operations will be provided to mariners of through the SA Navy Hydrographic Office and port captains of the Port of Port Elizabeth and the Port of Ngqura.

**Residual Impacts on Marine Transport Routes**

The impact on marine transport routes is considered to be **negligible** due to the short duration of the survey.

*Mariculture Activities*

Four mariculture farms are located within the proposed Transkei Exploration Area (near to East London), and one mariculture farm (oyster) is located just to the west of the project area, near to the town of Port Alfred. These farms include three fin fish farms and an abalone farm. These farms are mainly located onshore with some close inshore activities and are therefore unlikely to be impacted by the proposed activities.

Although negligible impacts are expected in relation the oyster farming operations and the operation of the seismic airguns (particularly as these are land based or very near shore), impacts associated with seismic operations and fin fish farms are assessed to be comparative to those described in the '*Impact on Fish*' Section above. This would include the potential for pathological trauma, mortality or behavioural responses of the fish to the noise generated by the airguns. Furthermore, indirect effects, such as changes to feeding success of the fish, could ensue; however information on such impacts is lacking.

Pathological trauma or mortality may occur if the fin fish farm is located in close proximity to the operating airguns, as the fish will not be mobile enough to avoid seismic noise levels that may cause such effects. The extent of the impact would be limited to those farms in close proximity to the seismic survey pathways (**local**) over the duration of the survey period (**short term**). As such, and owing to the fact that the existing fin fish farms within the proposed Transkei Exploration Area are either land based or located within the near shore area, the intensity of the impact is considered to be **low,** as the fish would only be affected in the far-field range in the worst case scenario. In

light of this, the impact is therefore considered to be of **low** significance without the implementation of mitigation measures, and of **negligible** significance with mitigation measures.

**Mitigation of Impacts on Fin Fish Mariculture**

- Confirm exact locations of mariculture activities prior to undertaking seismic surveys. If necessary, as determined by the applicant, establish a seismic buffer around fin fish mariculture operations to reduce potential impacts to these facilities.

**Residual Impacts on Fish**

The residual impacts on fin fish mariculture activities is deemed to be of **negligible** significance after the implementation of mitigation as fish would only be affected in the far-field range, in the worst case scenario.

*Commercial, Recreational and Subsistent Fishing*

Seismic surveys could potentially impact the fishing industries through:

(i) temporary cessation or displacement of fishing activities within the proposed seismic survey area;
(ii) alteration in the rates and/or distribution of fish catches; or
(iii) interaction with fishing gear.

The impact proposed seismic activities could have on commercial, recreational and subsistent fishing sectors that operate within and around the proposed exploration area is discussed in more detail below.

Temporary Cessation or Displacement of Fishing Activities

**Small Pelagic Purse-Seine Fishery**

The Small Pelagic Purse-Seine Fishery operates predominantly inshore on the West Coast with some fishing activity occurring in the inshore bay areas of the South Coast. No operations are undertaken in and/or around the vicinity of the proposed Exploration Areas. Given the above mentioned geographic distribution, the proposed Project is expected to have no impact on the small pelagic fishery. Furthermore, the degree of confidence for this assessment is considered to be high. In light of this, no further assessment is considered necessary.

It should however be noted, that if the seismic vessel moves out and inshore of the proposed Algoa exploration area, the likelihood of the towed array encountering small pelagic gear will increase.

**Trawling**

A small proportion of the trawling grounds overlap with the north-western boundary of the Algoa Exploration Area. This relates to approximately 857 km² of trawling grounds, which coincide with this exploration area. This is equivalent to approximately 0.6 % of the total trawl ground available to the fishery. Over the period 2006 to 2011, 0.08 % of the total effort of the demersal trawl fishery was conducted within this area at an average of 27 trawls per year.

The displacement of fishing effort or activities will be limited to areas in close proximity to the seismic vessel, during the operational phase of the survey. There is therefore potential that trawlers will be directly affected by seismic vessels for a **short-term** period, when both the trawling and seismic vessels are in the same area. During these periods trawlers would need to shift their effort to adjacent grounds. Because trawl grounds are located in the Algoa Exploration Area, activity that reduces operational trawling time, especially when weather conditions and fish availability are favoured, will impact **negatively** on trawl operations. Given the low percentage of total trawl grounds that fall within the proposed Exploration Areas, the intensity of the impact is assessed to be **low**. In light of this, the impact significance rating is assessed to be **negligible** to **low**.

**Demersal Trawl Fishery**

The demersal trawl fishery is South Africa's most important fishery and, for the last decade, it has accounted for more than half of the income generated from commercial fisheries. It is formally separated into an offshore sector, which targets deep-water hake (*M. paradoxus)* and an inshore sector targeting shallow-water hake (*M. capensis*) and Agulhas sole (*Austroglossus pectoralis*).

It is likely that both freezer and wet fish trawler vessels would be encountered within the proposed Algoa Exploration Area. Although these vessels are restricted in manoeuvrability when gear is deployed the gear can be recovered within a period of 30-minutes or the vessel can take avoiding action at its trawl speed. Therefore, direct communication from the survey vessel would be required in order to keep trawl vessels clear of the survey vessel.

The impact of the proposed survey operations on the demersal trawl sector is considered to be of **local** extent and **short-term** duration. The status of the impact is assessed to be **negative**, of **low** intensity and of overall **negligible** significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is **high**.

**Mid Water Trawling**

The mid-water trawl fishery operates on the eastern extent of the South Coast (up to 28°E) in water depths greater than 100 m and therefore coincides with the proposed Algoa Exploration Area. This relates to approximately 4.4% of the mid-water trawl fishing grounds that overlap with the Algoa exploration area. This constitutes about 0.3% (or 430 kg) of the total cumulative catch for the years 2000 - 2011.

The impact of the proposed survey operations on the mid-water trawl fishery is considered to be of **local** extent and **short-term** duration. The status of the impact is assessed to be **negative**, of **low** intensity and of overall **negligible** significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is **high**.

**Longlining**

Longlines would be affected by the proposed seismic surveys because of their length and potential drift patterns. All longline gear would need to be removed from the water or fishing efforts directed elsewhere during the survey period to avoid any gear entanglements and disruptions to both activities. Clear communication will need to be facilitated between the longline and survey vessels to ensure that this occurs.

The impact seismic activities may have on both long-line fishing sectors, found within the proposed Exploration Areas (i.e. hake-directed and shark-directed long-line fisheries), are discussed individually below.

**Hake-Directed Long-line Fishery**

Demersal hake long-line fishing activities would be expected to occur within the western portion of proposed Algoa Exploration Area. In this regard, long-line grounds coincide with approximately 4,564 km² of this area, which is estimated to be 2 percent of the total grounds fished by the hake demersal long-line fishery.

The impact of the proposed survey operations on the demersal hake-directed long-line sector is considered to be of **local** extent and **short-term** duration. The status of the impact is assessed to be **negative**, of **low** intensity and of overall **negligible** significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is **high**. Given the very low total catch for this sector within the proposed Exploration Areas, the significance of the impact on the hake-directed long-line fisheries is expected to be **negligible**, as effort could be directed elsewhere.

**Shark-Directed Long-Line Fishery**

The demersal shark-directed longline fishing grounds do not coincide with the proposed Exploration Areas. As such, **no impact** is expected on the shark directed longline industry and the degree of confidence of the assessment for this fishery is high. As such, no further assessment of this sector is considered necessary.

It should be noted that if the seismic vessel moves out and inshore of the Algoa Exploration Area, the likelihood of the towed array encountering demersal longline gear increases.

**Large Pelagic Long-Line Fishery**

Pelagic long-line effort extends along and offshore of the 200 m isobath. A high proportion of the pelagic longline grounds occur within the proposed Exploration Areas (in both the Transkei and Algoa Exploration Areas). Within the South African and foreign-flagged fleets combined approximately 7 % of the total national effort is conducted within this area (approximately 130 800 hooks per year), and 6 % of the total national catch is taken by this fishery (approximately 85 tons per year).

The impact of the proposed survey operations on the large pelagic long-line sector is considered to be of **regional** extent and **short-term** duration. The status of the impact is assessed to be **negative**, of **medium** intensity and of overall **low** significance. It is highly probable that the impact would occur and the degree of confidence of the assessment for this fishery is **high**.

**South Coast Rock Lobster**

The South Coast Rock Lobster (*Palinurus gilchristi*) occurs predominantly in one area along the East Coast (within the western portion of the Transkei exploration area), namely within 50 km of the shoreline between Port Elizabeth and East London. This area coincides with approximately 5% (2600 $km^2$) of the total South Coast rock lobster fishing grounds on the Agulhas Bank. Within the proposed exploration area approximately 21,400 traps were set between 2001 and 2011, which is 3% of the total effort conducted within South African waters by the South Coast rock lobster fishery. The catch of rock lobster taken from the area amounted to 3 % of the total catch taken by the fishery between the years 2001 - 2011.

Once lines and traps are set, they are often left unattended for a few days, and can therefore easily be disturbed and damaged by towed equipment or surface navigation associated with seismic surveys. The setting and hauling of the fishing gear is a slow, which limits the manoeuvrability of lobster vessels and restricts passage of other vessels. These lobster vessels will need to adhere to the exclusion zone enforced around the seismic vessel and will therefore be restricted in placing gear within the exploration area during the

survey, resulting in a potential for decreased catch if they are unable to fish elsewhere.

The impact of the proposed survey operations on the South Coast rock lobster fishery is considered to be of **local** extent and **short-term** duration. The status of the impact is assessed to be **negative**, of **low** intensity and of overall **negligible** significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is **high**.

**Squid Jiggery**

Although the eastern extent of the South Coast is generally an important area for squid jigging, fishing is seasonal (October – March, with a seasonal closure of November) and the areas of higher fishing effort are located close to the coast at Jeffreys Bay, Cape St Francis as well as a small areas very close to Port Elizabeth harbour.

This relates to approximately 6 % (2,565 km²) of the squid jig fishing grounds coinciding with portions of the Transkei and Algoa Exploration Areas. However, squid fisheries are not expected to interact with the seismic surveys. Furthermore, these fishing activities are not restricted to the survey area and can move to other areas to avoid the seismic activities.

As a result, the impact on squid jigging is deemed to be of **negligible** significance. No further assessment is considered necessary.

**Traditional Linefishing**

Traditional linefishing activity along the East Coast involves commercial, subsistence and recreational fishers using hand lines or rod-and-reel. This fishery is also made up of commercial and recreational shore and boat-based anglers (Brouwer *et al*, 1997 (in CCA, 2001), spearfishers (Mann *et al*, 1997) (in CCA, 2001), skin divers collecting subtidal invertebrates and exploiters of intertidal organisms. In addition to this, the East Coast has a considerable amount of subsistent fishers who sustain or supplement their livelihoods through harvesting fish and other marine resources that are available to them (refer to *Section 3.6.4*).

Along the East Coast, most of the linefish and hake hand-line activities are expected to occur predominantly in the proposed Transkei Exploration Area, particularly in the inshore regions (< 100 m), where the survey vessel is likely to transit during inshore line changes. Similarly, subsistent fishers will predominantly utilise the rocky shoreline and near shore areas of the region. In addition to this, recreational and/or commercial fishing efforts may coincide with the northern boundary of the proposed Algoa Exploration Area.

Given the mobility of the commercial, recreational and subsistence fishers and the short duration of the seismic surveys, the impacts on cessation or displacement are likely to be **low**, prior to mitigation.

Alteration of the rate and/ or distribution of catches

A further effect of seismic surveys on the fishing industry would be temporary avoidance of seismic survey areas by some fish species (See *Section 6.5.2*). Such avoidance may lead to reduced catches over the extreme short term in some pelagic, midwater or line fisheries in the seismic survey area, although increased catches could theoretically be experienced outside of the survey area. Both increased and decreased demersal catches have been associated with seismic surveys. It is expected that the **short term** nature of the impacts on fish catch size and distribution would mean that the extent of any changes to annual catches would be **negligible**.

The significance of the impact on alterations to fishing catch rates and catch distribution is expected to be **negligible**.

Interaction with Fishing Gear

Two of the gear types used within the proposed survey area are potentially left unattended for a long period of time (days), these include long-lines and lobster traps. In the event that long-lines or traps are found in the path of a towed seismic array it is highly likely that steps would have to be taken to avoid the fishing gear and seismic equipment becoming entangled and the associated cost implications of damage to both the fishing and the oil and gas industries. Loss of gear and reduced catches are costly to the fishing industry. In the same way, entanglement of seismic gear with a towed long-line, or by fishing vessels or trawlers passing through the gear, would have significant financial implications for the seismic survey operator. Trawlers operate extensively in the region and are too considered as vessels with restricted manoeuvrability when towing their trawl gear.

The impact of seismic surveys on fishing gear could be of **medium** significance prior to mitigation and of **low** significance after mitigation.

The mitigation measures outlined below, if implemented correctly, will serve to reduce or contain the impact on the various fishing activities in the region.

**Mitigation of Impacts on Fishing**

- Prior to the commencement of the survey, the fishing industry, DAFF (Branch: Fisheries) and other IAPs should be consulted and informed of the pending activity and the likely implications for the various fishing sectors in the area as well as research surveys planned to coincide with the proposed seismic operations. IAPs should include; South African Deepsea

Trawling Industry Association (SADSTIA), South East Coast Inshore Fishery Association (SECIFA), Small Hake Quota Holders Association, South African Tuna Longline Association, Hake Longline Association, South Coast Rock Lobster Association, Shark Longline Association, South African Marine Linefish Management Association (SAMLMA) and Blue Continent Products.

- Appointment of a fisheries liaison officer (FLO) to communicate with and meet with the various fisheries stakeholders and to inform all fishery stakeholders of the seismic plan and associated timeframes. The FLO should liaise with all affected fishing vessels, particularly all lobster fishing vessels as well as those involved in midwater trawl activities in the region to plan the placing of fishing gear, if possible, or provide additional notice of the areas of exclusion.
- Ensure that the survey area is free of fishing gear that could be physically contacted prior to the seismic vessel undertaking its operation in that area. This should be arranged through an FLO and his/her land-based communication network.
- The operator must provide timeous information on the proposed seismic plan to the public in order to reduce impacts on recreational fishers and marine users.
- A 'sweeper vessel' will be used at the beginning of the survey to help set up communications with the fishers in the area and to clear the area of potentially problematic fishing gear (e.g. rock lobster traps) prior to the seismic vessel entering the specific survey location.
- A chase boat will be used to maintain the exclusion zone and ensure that no vessels or fishing gear remain in the path of the seismic vessel.
- A notice of the seismic operations will be provided to mariners of through the SA Navy Hydrographic Office as well as to the port captains at the Ports of Port Elizabeth and Ngqura.
- A daily electronic reporting routine should be set up to keep interested and affected parties informed of survey activity, fisheries interactions and environmental issues.

**Residual Impacts on Fishing**

- The overall impacts on fishing activities are of low significance after mitigation due to the mobility of the fishing vessels, the short duration of the seismic survey, the provision of timeous information on the survey plan and schedule to the stakeholders and the use of a 'sweeper vessel' to minimise the loss of gear.

*Impacts on Marine Mining Industries*

As seismic operations require that the tow-vessels hold a fixed course on predetermined transects, other vessels may be required to alter course to

avoid the operation and the towed array and hydrophone streamers. Although possible conflicts of interests exist where mining and seismic surveys are planned in co-incident areas, there are no mining activities within the Exploration Area and therefore no impacts on marine mining activities.

*Communication Infrastructure*

Although the SAT3 cable (the only undersea cable which currently runs along the South and East Coast) is located within the proposed Algoa Exploration Area, no vessels will anchor within 1 nm of the cable. Furthermore, the towed airguns will only be a maximum of 25 metres below the water surface. As such, no effects of seismic vessel movements during the operational phase on submarine fibre optic cables, linkage boxes or repeaters are expected.

### *6.5.3 Decommissioning and Post-Closure Phases*

This phase includes the gathering, dismantling and loading of the seismic lines and geophones, demobilisation of the seismic vessel and any chase vessels, travel from the seismic acquisition area back to the port and disposal of any generated waste during the seismic activities.

*Geology, Sediment and Physical Oceanography*

No impact will occur as staff and vessel mobilisation do not have physical impacts on the geology and sediments of the seabed or coastline or on the physical oceanography. The seismic activities, including the deployment of the geophone streamers occur no deeper than 25 m from the surface of the sea and therefore has no impact on the geology, sediment or physical oceanography.

*Physical Nature of Surrounding Areas*

No impact is envisaged, as the staff, vessel and streamer demobilisation do not have any effect on the physical nature of the receiving environment.

*Air Quality*

Emissions to the atmosphere during the decommissioning phase will result mainly from movement of the seismic vessel off site. This **negligible** impact on air quality would be minimal and no greater than that from another vessel of similar size.

*Water Quality*

All survey vessels must comply with international agreed standards regulated under MARPOL 73/78 and relevant South African legislation for the disposal of waste.

*Fauna and Flora*

No impact on flora or fauna is envisaged as the vessel would be steered as an ordinary vessel to the survey area.

*Marine Transport Route*

Movement of the seismic vessel onto site is expected to have a negligible impact on transport routes after mitigation. The seismic equipment and geophone array will be dismantled at the survey area before returning to port. The operator will provide details of the seismic survey plan to mariners and fishing operators in advance of the initiation of seismic activities.

*Mariculture Activities*

There will be no impact on mariculture activities. The demobilisation of the vessel would result in no particular increase in marine traffic levels in the area, no significant changes to the physical nature of the area which may impact mariculture activities.

*Commercial and Recreational Fishing*

Movement of the seismic vessel from site back to port, is expected to only have a **negligible** impact on fishing activities after mitigation. The seismic equipment and geophone array will be dismantled at the survey area before returning to port and immediately after the seismic surveys. The operator will provide details of the seismic survey plan to fishing operators within and around the proposed Exploration Area and to other mariners by notice through the SAN Hydrographic office and to the public via advertisement in advance to allow commercial and recreational fishers to plan their fishing activities in the area.

*Impacts on Marine Mining Industries*

There will be no impact on mining activities as no mining activities are being undertaken within the survey area.

*Communication Infrastructure*

No effects on submarine fibre optic cables, linkage boxes or repeaters are expected.

## 6.6 SUMMARY

As discussed above the impacts associated with airborne geophysics, multi-beam bathymetry and the seabed sampling programme are likely to be low and relate largely to the noise from vessels and aircraft, potential for collision

with marine mammals and impacts to the seabed associated with the seabed sampling.

A summary of the environmental impacts relating to seismic surveys discussed within this chapter are included in *Table 6.3*. As is evident from the table, there are four operational impacts where the residual (post mitigation) impact is deemed to be of **low** significance. The potential impacts on cetaceans is deemed to be of **low** to **medium** significance (prior to mitigation) and of **negligible** to **low** significance after the implementation of mitigation measures such as 'soft-starts' and not initiating shooting until confirmation that there are no cetaceans within 500 m of the seismic vessel. The impacts on fish, turtles and seabirds are deemed to be of **low** significance (prior to mitigation) and **negligible** after mitigation. Similarly, the impact on mariculture activities located within the proposed Exploration Areas was assessed to be of **low** significance (prior to mitigation) and **negligible** after mitigation. The remainder of the impacts assessed are deemed to be of **negligible** significance (post mitigation). These impacts reflect a composite assessment of the impacts on the various species affected.

The impacts on commercial, recreational and subsistence fishing are deemed to be of **low** to **medium** significance (prior to mitigation) due to the potential reduction in catch as a result of disturbance of fishing gear, the implementation of the exclusion zone and potential movement of fish from the usual fishing habitat and grounds. After the implementation of mitigation measures such as liaison and notification of fishing operators, this impact should be reduced to being of **negligible** to **low** significance.

***Table 6.3*** ***Summary of the Significance of Identified Impacts of the Proposed Seismic Surveys within the proposed Exploration Areas***

| *PHASE* | **Establishment Phase** | | **Operational Phase** | | **Decommissioning Phase** | |
|---|---|---|---|---|---|---|
| *SIGNIFICANCE* | **Without mitigation** | **With mitigation** | **Without mitigation** | **With mitigation** | **Without mitigation** | **With mitigation** |
| Geology, Sediment and Oceanography | - | - | - | - | - | - |
| Physical Surroundings | - | - | - | - | - | - |
| Air Quality | N | N | N | N | N | N |
| Water Quality | N | N | N | N | N | N |
| Phytoplankton and Zooplankton | - | - | N | N | - | - |
| Invertebrates | - | - | N | N | - | - |
| Cephalopods (including Squid) | - | - | N | N | - | - |
| Fish | - | - | L | N | - | - |

| *PHASE* | Establishment Phase | | Operational Phase | | Decommissioning Phase | |
|---|---|---|---|---|---|---|
| Seabirds | - | - | L | N | - | - |
| Turtles | - | - | L | N | - | - |
| Seals | - | - | N | N | - | - |
| Cetaceans | - | - | L to M | N to L | - | - |

- = No Impact N=Negligible, L=Low Impact, M=Medium Impact, H=High Impact.
Normal font text = without mitigation
Definition of impact significance:
Low: The impact will not have an influence on a decision regarding whether or not the activity should go ahead
Medium: The impact should have an influence on the decision unless it is mitigated
High: The impact would influence the decision regardless of any possible mitigation

In addition, the assessment of the potential impacts of the seismic survey has provided an indication of the interactions of certain species and activities at different times of the year. The potential impacts of the seismic survey for these species vary throughout the year, as a result of breeding times and migration patterns. The sensitive time periods for the various faunal species and other factors are represented in *Table 6.4*.

***Table 6.4 Summary of Scheduling Interactions based on Breeding, Migration, Fishing Seasons and Weather Conditions***

| Species/ Activity | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Juvenile turtles in Agulhas current | | ■ | ■ | ■ | | | | | | | | |
| Fin whale | | | | | ■ | ■ | ■ | | | ■ | ■ | |
| Blue whale | | | | | ■ | ■ | ■ | | | | | |
| Southern right whale | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | |
| Sei whale | | | | | ■ | ■ | | ■ | ■ | ■ | | |
| Humpback whale | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Various resident cetaceans* | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Sardine Run | | | | | | ■ | ■ | | | | | |
| Unconducive weather conditions | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | |

* These include Cuvier's beaked whale, pygmy sperm whales, killer whale, false killer whales, pygmy killer whales, Risso's dolphins, sperm whales and shortbeaked common dolphin which are found throughout the offshore waters of the South Coast.

At present the seismic survey schedule has not been confirmed, however it is likely they will be undertaken during the summer months (December/January – May) when weather conditions are conducive. As such the seismic survey is likely to interact with various cetacean species, the humpback whale and juvenile turtles. The mitigation measures to minimise these impacts include "soft starts", confirmation of no cetaceans (and turtles, as far as possible) before initiation of the soft-starts and good communication with fishing operators to enable early planning around the seismic activities.

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# 7 *CONCLUSION*

This Environmental Management Programme (EMPr) has been prepared to support *Impact Africa Limited's (Impact Africa)* application for an Exploration Right to carryout exploration activities. The exploration activities would be carried out in the Transkei and Algoa Exploration Areas off the East Coast of South Africa (refer to *Figure 1.1*). The proposed Exploration Areas are made up of a tranche of whole and part blocks covering an area of approximately 45,838 km² which generally stretches from the shoreline to an outer range of between 100 km and 135 km offshore.

Impact Africa's proposed three year work programme would consist of the following:

- Airborne geophysics (gravity and magnetics) y survey using fixed wing aircraft to identification of prospective areas of structural and trap development and to address depth to basement/magnetic sources.

- Acquisition and or licensing, processing and interpretation of 2D or 3D seismic data.

- Measurement of surface heat flow to determine thermal regime and calibrate thermal models.

- Determination of seabottom bathymetry using a multibeam echosounder to look for hydrocarbon seepages and constrain boundary conditions

- Sampling and analysis of the seabed and water column to identify seabed and near surface features indicative of natural hydrocarbon seepage.

The purpose of undertaking such exploration activities is to investigate the subsea geological structures to determine the presence of hydrocarbons (i.e. oil and gas). No additional work is anticipated during the three year exploration right period.

This EMPr was developed from the PASA-approved generic EMPr. In addition a fisheries specialist and a marine fauna specialist were appointed to undertake desktop fisheries and marine faunal studies respectively to provide additional information on these issues. A marine heritage specialist was also appointed to provide input into this aspect of the study.

A consultation process was undertaken, and issues that were raised related to the impacts on particular marine species and the Marine Protected Areas (MPAs), as well as fishing and mariculture activities. A number of mitigation measures are recommended within the impact assessment to avoid or reduce

the impacts and are summarised in the Implementation Plan contained in *Part B* of the EMPr.

Of the proposed exploration activities, the potential impacts associated with airborne geophysics, multi-beam bathymetry and the seabed sampling programme are briefly discussed in *Chapter 6*, as these activities are expected to have negligible to low associated impacts. The impacts of seismic surveys are assessed in more detail.

The impact assessment identified two impacts relating to seismic surveys where the residual (post mitigation) impact is deemed to be of **low** to **medium** significance:

- The potential impacts on cetaceans is deemed to be of **low** to **medium** significance (prior to mitigation) and of **negligible** to **low** significance after the implementation of mitigation measures such as 'soft-starts' and not initiating shooting until confirmation that there are no cetaceans within 500 m of the seismic vessel, as well as the avoidance of certain important migration time periods.

- The impacts on commercial, recreational and subsistence fishing activities are also deemed to be of **low** to **medium** significance (prior to mitigation) due to the potential reduction in catch as a result of disturbance of fishing gear, the implementation of the exclusion zone and potential movement of fish from the usual fishing habitat and grounds. After the implementation of mitigation measures such as liaison and notification of fishing operators, this impact should be reduced to being of **negligible** to **low** significance.

The impacts on fish, turtles and seabirds are deemed to be of **low** significance (prior to mitigation) and **negligible** after mitigation. Similarly, the impact on mariculture activities (located within the proposed exploration areas) was assessed to be of **low** significance (prior to mitigation) and **negligible** after mitigation. The remainder of the impacts assessed are deemed to be of **negligible** significance (post mitigation).

In terms of socio-economic impacts the impacts associated with tourism and recreation are deemed to be **low** (before and after mitigation), and the impact to diving and underwater cultural activities is deemed to be **medium** (prior to mitigation) and **low** after the implementation of mitigation measures. The impact on sites of historic, archaeological and cultural interest (including shipwrecks) is deemed **insignificant** after the implementation of mitigation measures.

Mitigation measures identified within the impact assessment are summarised into an Implementation Plan which describes the framework for implementation of environmental and social controls during all phases of the

exploration activities. In order to facilitate the implementation of controls, the Implementation Plan specifies the appointment of a Fisheries Liaison Officer (FLO) and a Marine Mammal Observer (MMO) during certain activities. Key mitigation measures for seismic activities also include the use of 'soft start' procedures (only initiated once key marine fauna species are confirmed – as far as possible - to not be within 500 m of the exploration vessel), MMOs to perform visual observations to monitor impacts on cetaceans, diving birds and turtles and specifically ensure that the seismic vessel does not fire within 500 m of these species. An MMO will also be required on board during the undertaking of the bathymetric survey in order to ensure the minimisation of impacts to marine fauna. The use of Passive Acoustic Monitoring (PAM) is recommended, specifically during night time when visual observations are not possible. Monitoring, auditing and reporting requirements are defined within the Implementation Plan to monitor Impact Africa's compliance with the EMPr. Further, a seismic buffer zone of 10 km from the coast and 2km around the MPAs will be implemented, within which there will be no firing of airguns. No exploration activities will occur within the MPAs (i.e. Amathole, Dwesa-Cwebe, Hluleka and Pondoland MPAs).

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Appendix A

# Background Information Document

# Background Information Document and Invitation to Comment

**PROPOSED OIL AND GAS EXPLORATION ACTIVITIES IN THE TRANSKEI/ALGOA EXPLORATION AREA, OFF THE EASTERN CAPE COAST OF SOUTH AFRICA**

## Aim of this Document

The aim of this Background Information Document (BID) is to provide stakeholders with information about the proposed oil and gas exploration activities for the Transkei/ Algoa Exploration Area, off the Eastern Cape coast of South Africa.

You are invited to raise issues and concerns that you may have about the project. Potential positive and negative environmental and social impacts will be investigated during the compilation of the Environmental Management Programme (EMPr).

The EMPr, along with **your comments,** will then be submitted to the Petroleum Agency of South Africa (PASA), who will decide whether or not to issue an Exploration Right.

Please direct comments to:
**Claire Alborough of ERM.**
**Tel:** 021 681 5400 **Fax:** 021 686 0736
**Email:** claire.alborough@erm.com
**Postal address:** Postnet Suite 90,
Private Bag X12, Tokai, 7966

**Please register or comment on or before 12 April 2013.**

## Background Information

Impact Africa Limited (Impact Africa) has lodged an application with the Petroleum Agency of South Africa (PASA) for an Exploration Right in terms of Section 79 of the Mineral and Petroleum Resources Development Act (MPRDA) in order to explore for oil and gas in the Transkei/Algoa Exploration Area off the East Coast of South Africa. PASA accepted Impact Africa's application on 1st March 2013. In terms of the MPRDA, a requirement for obtaining an Exploration Right is that an Environmental Management Programme (EMPr) must be compiled and submitted to PASA for consideration and for approval by the Minister of Mineral Resources. Environmental Resources Management Southern Africa (Pty) Ltd (ERM) has been appointed to conduct the process to prepare the EMPr in accordance with the requirements of the MPRDA and the Regulations thereto.

The Transkei/ Algoa Exploration Area is located above a narrow shelf area situated off the Eastern Cape Coast of South Africa (see Figure 1). Together the two exploration areas cover an area of approximately 45,838 km² with water depths ranging from the shoreline to approximately 4000 m. The purpose of the exploration activities is to investigate the subsea geological structures to determine the presence of hydrocarbons (oil and gas).

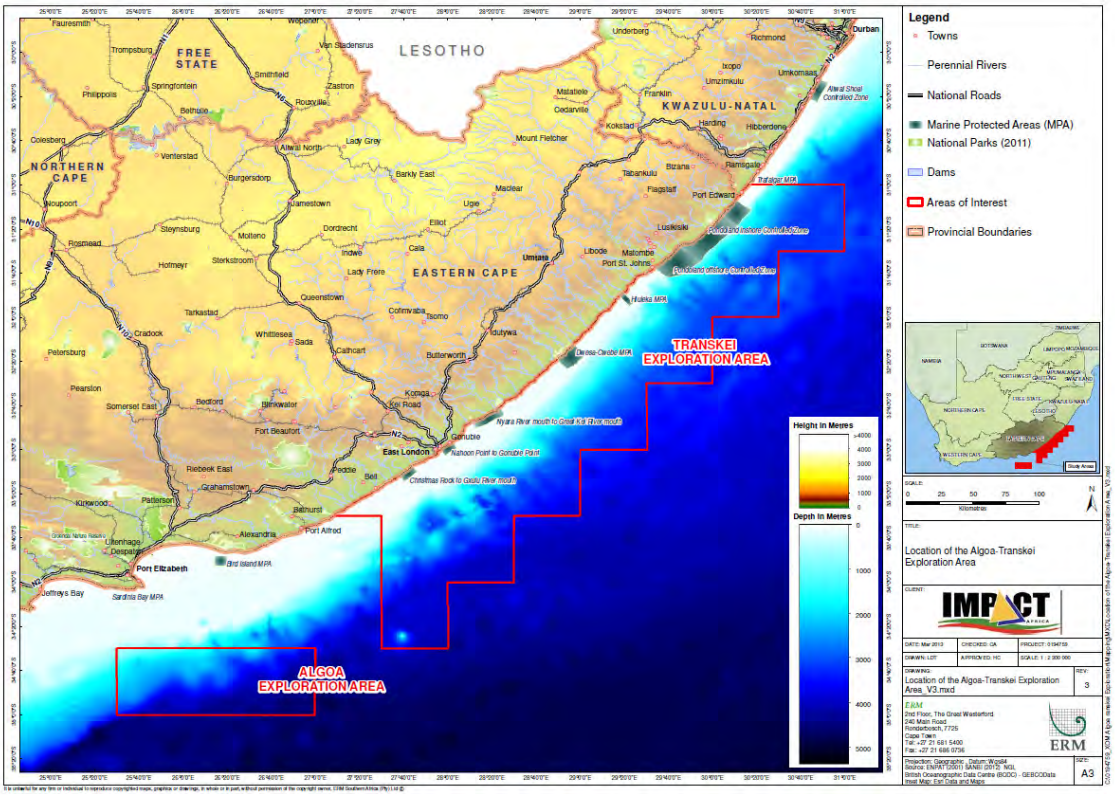



*Figure 1. Location of the Exploration Area*

## Key Issues Identified

The EMPr will identify the key issues associated with the proposed activities and determine the controls that will be implemented to avoid or reduce environmental and social impacts. A preliminary assessment has indicated the following key issues:

- Noise effects on marine fauna from multi-beam bathymetry survey, seabed sampling programme and seismic survey;
- Effects of activities on the fishing industry, including effects on fish behaviour, fish catches and cessation or displacement of fishing activities, as a result of noise effects and presence of survey vessels;
- Impact on tourism and recreation as a result of noise effects and presence of survey vessels;
- Interference with marine recreational facilities and transport routes; and
- Waste discharge to sea and emissions to the atmosphere.

These issues, as well as others identified through the process of developing the EMPr will be assessed. To better understand the existing environmental and social setting, a fisheries specialist study and a marine faunal specialist study will be undertaken. To the extent possible, the proposed seismic surveys would be scheduled to avoid critical periods for marine mammals or protected species such as mating or calving periods. A safety buffer zone will be implemented around sensitive marine features such as Marine Protected Areas. Furthermore, no exploration activities will be undertaken within such protected areas.

## Project Description

Impact Africa Limited is proposing a three-year exploration programme. The proposed exploration programme will be conducted in a phased approach. It should, however, be noted that some of the phases might occur in parallel or the final order of activities may change. The proposed exploration programme would commence with airborne geophysics acquisition in 2014. Thereafter a 2D and / or 3D seismic surveys would be acquired, followed by processing and interpretation. An integrated seabed sampling programme would be undertaken in order to identify seabed features that are indicative of natural hydrocarbon seepage and to sample sediments and associated hydrocarbons at and just below the seabed. The proposed exploration programme would consist of the activities described below.

**Airborne Geophysics Programme:** Impact Africa proposes to acquire airborne gravity and magnetic data covering all or parts of the Transkei Algoa Exploration Area with a minimum of 7,500 km², which in that case would take in the order of 60 days. If data were to be acquired over the entire Transkei Algoa Exploration Area of 45,838 km² then this would take in the order of 180 days to complete. Acquisition of these data sets and integration of the airborne geophysical data with well data, and other geologic and geophysical data sets, would provide support for future seismic acquisition planning programmes, as well as support integrated seismic interpretation efforts, exploration concepts and exploration strategies.

**Seismic Survey Programme:** 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 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 (see Figure 2). Analyses of the returned signals allow for interpretation of subsea geological formations.

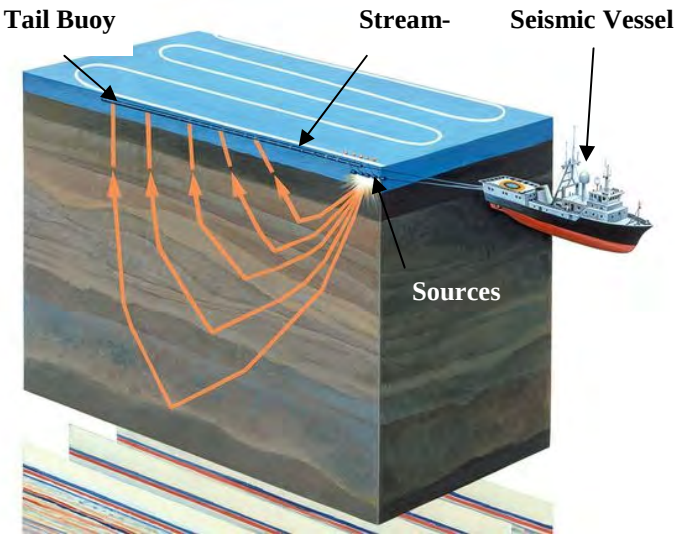



*Figure 2. Principles of Seismic Data Acquisition*

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

For this investigation Impact Africa is proposing to undertake acquisition of a 2D seismic survey. However, if it is determined by subsequent analysis of existing data, that acquisition of a seismic dataset utilising 3D seismic techniques might be a more advantageous approach for data collection, then a 3D seismic survey might be substituted for the 2D survey or may be done in addition to the 2D seismic survey.

The proposed 2D seismic survey would be in the order of 5,000 km in total length. Most lines will be widely spaced over the Transkei Algoa Exploration Area with some areas where the lines will be closer together.
Although survey commencement would ultimately depend on a permit award date, availability of seismic contractors and other factors, it is anticipated that the survey would be undertaken during the summer of 2014/2015 and would take approximately 150 days to complete.

Specific details of the seismic survey would be developed based on the results of other studies and following selection of a seismic survey contractor and survey vessel. The specific details of the survey will be submitted to PASA through an Environmental Notification.




*Figure 3. Seismic Vessel Conduction a Seismic Survey*

**Seismic Vessel and Equipment:** The seismic survey vessel will travel along transects of a prescribed course or grid that is carefully chosen to cross known or suspected geological structures. The vessel travels at a speed of four to six knots (i.e. 2 to 3 metres per second).

The seismic survey will involve a towed airgun array, which provides the seismic source energy for the profiling process, and a seismic wave detector system, usually known as a hydrophone streamer (see Figure 3). The sound source or airgun array (one for 2D and two for 3D) will 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 will be towed at a depth of between 6 m and 30 m and will 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 are illustrated in Figure 4.

The airgun will be fired at approximately 10 to 20 second intervals at an operating pressure of between 2,000 to 2,500 psi and a volume of 3,000 to 5,000 cubic inches. Similar airgun source arrays are around 220 dB re 1 mPa2-m.
However, based on analogue sound sources, sound levels for the seismic survey can notionally be expected to attenuate below 160 dB less than 1,325 m from the source array.

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.

**Seismic Survey Exclusion Zone:** Under the International Maritime Organization (IMO) Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), a seismic survey vessel that is engaged in surveying is defined as a 'vessel restricted in its ability to manoeuvre' which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. Vessels engaged in fishing shall, so far as possible, keep out of the way of the seismic survey operation.

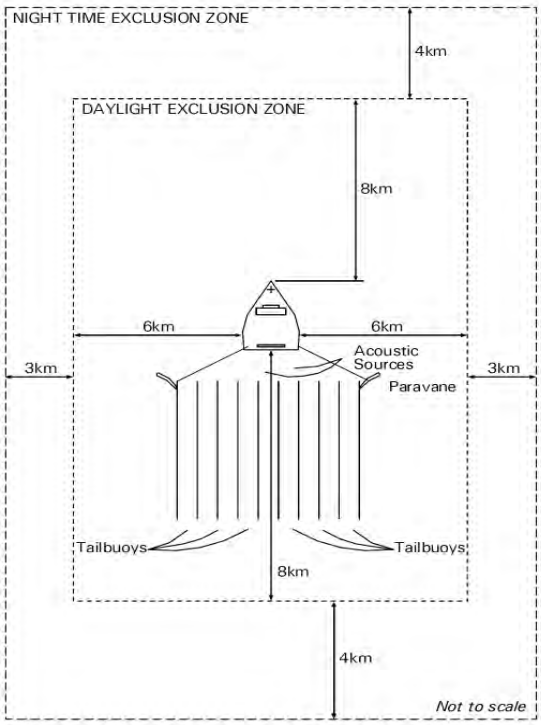



*Figure 4. Configuration of a typical 3D survey vessel with Safe Operational Limits for 2D and 3D Surveys.*

Under the South Africa Marine Traffic Act, 1981 (No. 2 of 1981), a seismic survey vessel and its array of airguns and hydrophones fall under the definition of an "offshore installation" and as such it is protected by a 500 m safety buffer zone. It is an offence for an unauthorised vessel to enter the safety zone. In addition to the statutory limit, the seismic vessel will also request an additional safety buffer zone during operations of typically 8 km fore and aft of the vessel and 6 km abeam during daylight; and 12 km fore and aft and 9 km abeam during the night.

**Surface Heat Flow Measurements, Seabed and Water Column Sampling Programme:** The heat flow measurements will be conducted using heat flow probes, which will measure both the temperature and thermal conductivity of sediments in situ up to 12 m below the seabed. The measurement device will be dropped from a vessel into the seabed, allowed to equilibrate and then recovered to the surface.

No samples or other materials will be recovered with the heat flow probe. Acquisition of these data will be used to determine the thermal regime and calibrate thermal models to understand hydrocarbon system potential. It is anticipated that a minimum of 50 measurements may be collected across the Transkei Algoa Exploration Area, which would take 60 days to complete.

Water column samples may be taken for analysis such as hydrocarbon, heavy and trace metal analysis. Additionally a Conductivity, Temperature, Depth (CTD) profiler may be deployed to measure additional parameters such as salinity, temperature, dissolved oxygen and turbidity. For each station it is expected that three water depths will be sampled; near surface (~1 m below surface), mid-water, and near bottom.

**Multibeam Echo Sounder and Sub-Bottom Profile Programme:** The multi-beam bathymetry survey would be undertaken over the majority of the Transkei Algoa Exploration Area. This system produces a digital terrain model of the seafloor.
The survey vessel will be equipped with a multi-beam echo sounder to obtain swath bathymetry and a sub-bottom profiler to image the seabed and the near surface geology in the immediate vicinity of each core and test location (see Sediment Coring Programme below). The multi-beam system provides depth sounding information on either side of the vessel's track across a swath width of approximately two times the water depth. The multi-beam echo sounder emits a fan of acoustic beams from a transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1µPa at 1m. The sub-bottom profiler emits an acoustic pulse from a transducer at frequencies ranging from 3 kHz to 40 kHz and typically produces sound levels in the order of 206 db re 1µPa at 1m. It is anticipated that data acquisition would take approximately 150 days to complete at a vessel speed around 5 knots.

**Sediment Coring Programme:** The Sediment Coring Programme would include piston coring in order to sample for natural hydrocarbon seepage. A piston corer would be used to collect seabed geochemical samples. The piston corer is lowered over the side of the survey vessel and allowed to free fall from about 3 m above the seabed to allow good penetration. Recovered core samples will be visually described and three sets of sub-samples will be retained for further analysis in an onshore laboratory. Any material having geologic or environmental interest will be preserved for further study. The remaining sediment will be returned to the seabed. It is anticipated that in the order of 50 core samples would be collected across the Exploration Right area, which would take in the order of 120 days to complete. A larger number of samples could be taken depending of seepage or expulsion features identified but also depending of the observed geologic complexity. Each individual core would have a disturbance area and volume of 0.01 $m^2$ and 0.07 $m^3$, respectively, resulting for 50 core samples in a total disturbance area and volume of approximately 0.39 $m^2$ and 3.53 $m^3$, respectively.

## Proposed EMPr Process

The following steps will be undertaken to ensure compliance with the MPRDA and Regulation thereto:

- A BID (this document) will be compiled and distributed for registration and comment period from 22 March 2012 to 12 April 2013;
- The proposed project and I&AP registration/comment period will be advertised in four newspapers, namely The Times, The Daily Dispatch, The Herald and Die Burger (Eastern Cape);
- An I&AP database will be compiled based on responses to the BID and advert, as well as other databases of previous studies in the area;
- Specialist studies will be commissioned and undertaken to address those issues requiring further investigation;
- An EMPr will be compiled integrating all specialist studies and other relevant information;
- The EMPr will be released toward mid-May for a 30-day review and comment period;
- All comments received will be collated and responded to in the Comments Report, which will be appended to the EMPr; and
- The EMPr will be submitted to PASA for consideration on or before 28 June 2013.

# *STAKEHOLDER COMMENT SHEET*

You are invited to participate in the EMPr process and raise any issues and concerns you may have about the proposed Project. Your comments are a key part of the assessment process and it is important that ERM and Impact Africa understand your concerns so that they can be responded to and addressed as part of the EMPr .

To be kept informed throughout the process you must register as an Interested and Affected Party. To register please send an email to or forward this form to the address (or fax number) given below. If you wish to make any comments at this stage please feel free to use this form or alternatively, please do not hesitate to send a separate email, fax or letter to Claire Alborough of ERM.

Please ensure you are registered via email, post or fax by **12 April 2013** so that we can take your comments into consideration in the revised EMPr.

Please quote the following reference number on all correspondence: 0194759

| Please fill in your details | |
|---|---|
| Name: | Organisation: |
| Telephone: | Position: |
| Cell phone: | Email: |
| Address: | |

**ENVIRONMENTAL RESOURCES MANAGEMENT, ERM**

T. 021 681 5400
F. 021 686 0736
E. claire.alborough@erm.com
P. Postnet Suite 90, Private Bag X12, Tokai, 7966

**Contact: Claire Alborough**

Are there any Interested and Affected Parties whom you believe should be consulted during the course of the EMPr? If yes, please send ERM the name, organisation (if applicable), postal address, telephone and fax numbers of the person(s) concerned so that they can be included on the list of stakeholders.

**It would be useful if you could respond to the question below, but please feel free to provide any comments you would like to raise. Please continue on additional paper if required.**

Do you/ your organisation have any concerns with regards to these proposed activities? If yes, please clearly list your issues, concerns, views and/or questions you may have regarding this project.

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***Thank you for your participation***

Appendix B-1

# Advertisements

11060 Sale in Execution

**NOTICE OF SALE IN EXECUTION**

IN THE HIGH COURT OF SOUTH AFRICA (SOUTH GAUTENG HIGH COURT, JOHANNESBURG)
Case Number: 3109/2012
In the matter between:
NEDBANK LIMITED
Plaintiff
and
MAHLANGU, SIBUSISO
Defendant

In execution of a judgment of the High Court of South Africa (South Gauteng High Court Johannesburg) in the abovementioned suit, a sale without a reserve price, the price subject to the Plaintiff's approval, will be held by the Sheriff, Roodepoort at 182 Progress Road, Lindhaven, Roodepoort on the 12th day of April 2013 at 10h00 of the undermentioned property of the Defendant on the conditions to be read out by the Auctioneer at the time of the sale , which conditions will lie for inspection, prior to sale, at the offices of the Sheriff,
Roodepoort at 182 Progress Road, Lindhaven,
Roodepoort
Certain: Erf 837 Roodekrans Extension 2 Township
Registration Division I.Q
The Province of Gauteng and also known as 2 Bluebell Street, Roodekrans
Measuring: 1 208m² (ONE THOUSAND TWO HUNDRED AND EIGHT ) square metres
Improvements: (none of which are guaranteed) consisting of the following
Main building: 3 bedrooms, 2 bathrooms, lounge, family Room, kitchen, Scullery
Outbuildings: Servants Quarters, 2 Garages, Carport, swimming pool
Constructed: tiled roof & brick wall
Terms: 10% (ten percent) of the purchase price in cash in the day of the sale; balance payable against registration of transfer to be secured by a bank or other acceptable guarantee to be furnished within 14 (fourteen) days from the date of sale.
Auctioneer's charges, payable on the day of sale, to be calculated as follows; 6% (six percent) on the proceeds of the sale up to a price of R30 000.00 (thirty thousand rand) and thereafter 3.5% (three point five percent) up to a maximum fee of R8 750.00 (Eight Thousand Seven Hundred and Fifty Rand) , plus VAT. Minimum charge R440.00 (Four hundred and Forty Rand), plus VAT.
Dated at Johannesburg on this the 8th day of February 2013.

**HEYNS & PARTNERS INCOPORATED**
Attorneys for the Plaintiff
Per:
W ROBERTSON
1st Floor, Bradford Corner
2 Bradford Road
BEDFORD GARDENS
Tel:011 615 8591
(Ref: W Robertson/S52054)

**01U13B**

11060 Sale in Execution

**NOTICE OF SALE IN EXECUTION**

IN THE HIGH COURT OF SOUTH AFRICA (SOUTH GAUTENG HIGH COURT, JOHANNESBURG)
Case Number: 51193/2007
In the matter between:
NEDBANK LIMITED
Plaintiff
and
COETZEE, STEFANUS JOHANNES
Defendant

In execution of a judgment of the High Court of South Africa (South Gauteng High Court Johannesburg) in the abovementioned suit, a sale without a reserve price, the price subject to the Plaintiff's approval, will be held by the Sheriff, Johannesburg West at 69 Juta Street, Braamfontein on the 11th day of April 2013 at 12h00 of the undermentioned property of the Defendant on the conditions to be read out by the Auctioneer at the time of the sale, which conditions will lie for inspection, prior to sale, at the offices of the Sheriff, Johannesburg West, 31 Henley Road, Auckland Park.
Certain: REMAING EXTENT OF ERF 1501 NEWLANDS TOWNSHIP
REGISTRATION DIVISION I.Q
THE PROVINCE OF GAUTENG
MEASURING: 223m² (TWO HUNDRED AND TWENTY THREE) SQUARE METRES
HELD BY DEED OF TRANSFER NO:T16913/2007
Situated: 12 DU PREEZ ROAD, NEWLANDS
Improvements: (none of which are guaranteed) consisting of the following
Main building: 3 bedrooms, bathroom, lounge, Kitchen, Dining room
Outbuildings:
Garage
Constructed: tiled roof & brick wall
Terms: 10% (ten percent) of the purchase price in cash in the day of the sale; balance payable against registration of transfer to be secured by a bank or other acceptable guarantee to be furnished within 14 (fourteen) days from the date of sale.
Auctioneer's charges, payable on the day of sale, to be calculated as follows; 6% (six percent) on the proceeds of the sale up to a price of R30 000.00 (thirty thousand rand) and thereafter 3.5% (three point five percent) up to a maximum fee of R9 655.00 (Nine thousand Six Hundred and fifty Five Rand) , plus VAT. Minimum charge R485.00 (Four hundred and Eighty Five Rand), plus VAT.
Dated at Johannesburg on this the 20th day of February 2013.

**HEYNS & PARTNERS INCOPORATED**
Attorneys for the Plaintiff
Per:
W ROBERTSON
1st Floor, Bradford Corner
2 Bradford Road
BEDFORD GARDENS
Tel:011 615 8591
(Ref: W Robertson/MJ/S52618)

**01U1CS**

11060 Sale in Execution

**NOTICE OF SALE IN EXECUTION**

IN THE HIGH COURT OF SOUTH AFRICA
SOUTH GAUTENG HIGH COURT JOHANNESBURG
CASE NO. 2012/1478
In the matter between:
NEDBANK LIMITED
Plaintiff
and
RASOOL, MIAM GHULAM
1st Defendant
RASOOL, BALQEES AKHTAR
2nd Defendant

In execution of a judgment of the South Gauteng High Court, Johannesburg in the abovementioned suit, a Sale without a reserve price, the price subject to the Plaintiff's approval, will be held by the Sheriff, Halfway House at 614 James Crescent, Halfway House on the 9th day of APRIL 2013 at 11h00 of the undermentioned property of the Defendant on the conditions to be read out by the Auctioneer at the time of the sale, which conditions will lie for inspection, prior to the sale, at the offices of the Sheriff, 614 James Crescent, Halfway House (short description of property, situation and street number)
Certain:Erf 816 Wendywood Extension 2 Township,
Registration Division I.R.
The Province of Gauteng and also known as 9 Acacia Street, Wendywood Ext. 2 (Held under Deed of Transfer No. T51195/2007)
Measuring: 1000m² (One Thousand) square metres
Improvements: (none of which are guaranteed) consisting of the following:
Main Building:
3 Bedrooms, 2 Bathrooms, Lounge, Dining room, Kitchen, Entrance hall
Outbuilding:
Double garage
Constructed:
Brick under tiles
Terms : 10% (Ten percent) of the purchase price in cash on the day of the sale; the balance payable against registration of transfer to be secured by a bank or other acceptable guarantee to be furnished within 14 (fourteen) days from the date of sale.
Auctioneer's charges, payable on the day of sale, to be calculated as follows: 6% (Six percent) on the proceeds of the sale up to a price of R30000.00 (Thirty Thousand Rand) and thereafter 3.5% (Three point Five percent) up to a maximum fee of R9655.00 (Nine Thousand Six Hundred and Fifty Five Rand), plus VAT. Minimum charge R485.00 (Four Hundred and Eighty Five Rand), plus VAT.
DATED at JOHANNESBURG on this the 25th day of FEBRUARY 2013.
ROSSOUWS LESIE INC.
8 Sherborne Road
Parktown, Johannesburg
PO Box 1588,
JOHANNESBURG
Tel: (011) 726-9000 /
Fax: (011) 726-3855
Ref: MAT7595/JJ Rossouw/R Beetge

**01U1YT**

11060 Sale in Execution

**NOTICE OF SALE IN EXECUTION**

IN THE HIGH COURT OF SOUTH AFRICA (SOUTH GAUTENG HIGH COURT, JOHANNESBURG)
Case Number: 31382/2011
In the matter between:
NEDBANK LIMITED
Plaintiff
and
KHESWA, LUCKY GORDON
Defendant

In execution of a judgment of the High Court of South Africa (South Gauteng High Court Johannesburg) in the abovementioned suit, a sale without a reserve price, the price subject to the Plaintiff's approval, will be held by the Sheriff, Roodepoort at 182 Progress Road, Lindhaven, Roodepoort on the 12th day of April 2013 at 10h00 of the undermentioned property of the Defendant on the conditions to be read out by the Auctioneer at the time of the sale , which conditions will lie for inspection, prior to sale, at the offices of the Sheriff,Roodepoort at 182 Progress Road, Lindhaven, Roodepoort
Certain:
Portion 4 of Erf 271 Florida Township
Registration Division I.Q
The Province of Gauteng and also known as 1D Alexandra Street, Florida
Measuring: 314m² (THREE HUNDRED AND FOURTEEN ) square metres
Improvements: (none of which are guaranteed) consisting of the following
Main building: 2 bedrooms, bathroom, lounge, kitchen,
Outbuildings: None
Constructed: tiled roof & brick wall
Terms: 10% (ten percent) of the purchase price in cash in the day of the sale; balance payable against registration of transfer to be secured by a bank or other acceptable guarantee to be furnished within 14 (fourteen) days from the date of sale.
Auctioneer's charges, payable on the day of sale, to be calculated as follows; 6% (six percent) on the proceeds of the sale up to a price of R30 000.00 (thirty thousand rand) and thereafter 3.5% (three point five percent) up to a maximum fee of R9 655.00, plus VAT. Minimum charge R485.00, plus VAT.
Dated at Johannesburg on this the 29th day of February 2013.

**HEYNS & PARTNERS INCOPORATED**
Attorneys for the Plaintiff
Per:
W ROBERTSON
1st Floor, Bradford Corner
2 Bradford Road
BEDFORD GARDENS
Tel:011 615 8591
(Ref: W Robertson/S51810)

**01U13E**

11060 Sale in Execution

**NOTICE OF SALE IN EXECUTION**

IN THE HIGH COURT OF SOUTH AFRICA (NORTH GAUTENG HIGH COURT, PRETORIA)
Case Number: 52422/2012
In the matter between:
NEDBANK LIMITED
Plaintiff
and
ROODT, JOHANNES HENDRICK LUBBE
Defendant

In execution of a judgment of the High Court of South Africa (North Gauteng High Court Pretoria) in the abovementioned suit, a sale without a reserve price, the price subject to the Plaintiff's approval, will be held by the Sheriff, Springs at 99 Eight Street, Springs on the 10th day of April 2013 at 11h00 of the undermentioned property of the Defendants on the conditions to be read out by the Auctioneer at the time of the sale, which conditions will lie for inspection, prior to sale, at the offices of the Sheriff, 99 Eight Street, Springs.
Certain:
Erf 1127 Geduld Extension Township
Registration Division I.R
The Province of Gauteng
Measuring: 495m² (Four Hundred and Ninety Five Square Metres)
Also known as: 18 Retief Street, Geduld Extension Township, Springs
Held by Deed of Transfer No T17765/1993
Improvements: (none of which are guaranteed) consisting of the following
Main building: 3 bedrooms, bathroom, lounge, kitchen, family Room
Outbuildings: Garages
Constructed: tiled roof & brick wall
Terms: 10% (ten percent) of the purchase price in cash in the day of the sale; balance payable against registration of transfer to be secured by a bank or other acceptable guarantee to be furnished within 14 (fourteen) days from the date of sale.
Auctioneer's charges, payable on the day of sale, to be calculated as follows; 6% (six percent) on the proceeds of the sale up to a price of R30 000.00 (thirty thousand rand) and thereafter 3.5% (three point five percent) up to a maximum fee of R9 655.00 (Nine Thousand Six Hundred and Fifty Five Rand), plus VAT. Minimum charge R485.00 (Four hundred and Eighty Five Rand), plus VAT.
Dated at Johannesburg on this the 28th day of February 2013.

**HEYNS & PARTNERS INCOPORATED**
Attorneys for the Plaintiff
Per:
W ROBERTSON
1st Floor, Bradford Corner
2 Bradford Road
BEDFORD GARDENS
Tel:011 615 8591
(Ref: W Robertson/MJ/S50355)

**01U1CT**

11060 Sale in Execution

**NOTICE OF SALE IN EXECUTION**

IN THE HIGH COURT OF SOUTH AFRICA (NORTH GAUTENG HIGH COURT, PRETORIA)
CASE NUMBER: 23910/2012
In the matter between:
THE STANDARD BANK OF S.A LIMTED
Plaintiff
And
MAGESHVERAN MOODLEY
ID-811026 5099 08 4
1st Defendant
MELISSA CAROLINE MOODLEY
ID-801126 0174 08 0
2nd Defendant

In execution of a judgement of the High Court of South Africa (North Gauteng High Court, Pretoria) in the abovementioned suit, a sale without reserve will be held by the Sheriff, Roodepoort, at the offices of the sheriff, 182 Progress Way, Lindhaven, Roodepoort on Friday, 12 April 2013 at 10h00 of the undermentioned property of the Defendants subject to the Conditions of the sale which are available for inspection at the offices of the Sheriff Roodepoort, at the abovementioned address, tel: 011 760-1172/3
A unit consisting of:
(a) Section No 132 as shown and more full described on Sectional Plan No SS88/1997 in the scheme known as Kingston Village in respect of the land and building or buildings situate at Weltevredenpark Ext 103 township, Local Authority: City of Johannesburg of which section the floor area according to the said Sectional Plan is 52 (fifty two) square meters in extent; and
(b) An undivided share in the common property in the scheme apportioned to the said section in accordance with the participation quota as endorsed on the said sectional plan
Held by Deed of Transfer ST53666/2006
Also known as: 132 Kingston Village, Dopprium Street, Weltevredenpark
The following information is furnished with regard to improvements on the property although nothing in this respect is guaranteed.
The property consist of:
1 bathroom, 2 bedrooms, kitchen, lounge and a carport
Dated at Pretoria on this day of February 2013

**HACK STUPEL & ROSS**
Attorneys for Plaintiff
2ND FLOOR, STANDARD BANK CHAMBERS
CHURCH SQUARE,
PRETORIA
REF:
T. DE JAGER/YOLANDI/HA10418
TEL: 012 325 4185

**01U1LT**

11060 Sale in Execution

**NOTICE OF SALE IN EXECUTION**

IN THE HIGH COURT OF SOUTH AFRICA (NORTH GAUTENG HIGH COURT, PRETORIA)
CASE NUMBER: 50886/2009
In the matter between:
FIRST RAND BANK LIMITED (formerly known as FIRST NATIONAL BANK OF SOUTHERN AFRICA LIMITED)
Plaintiff
And
CYBERBUSINESS PROPERTIES (PTY) LTD
Defendant

A sale in Execution of the undermentioned property is to be held without reserve at THE OFFICES OF THE ACTING SHERIFF: WONDERBOOM at COR. VOS & BRODRICK AVENUE, THE ORCHARDS, X3 on 12 APRIL 2013 at 11H00.
Full Conditions of sale can be inspected at THE OFFICES OF THE ACTING SHERIFF: WONDERBOOM at COR. VOS & BRODRICK AVENUE, THE ORCHADS X3 and will also be read out by the Sheriff prior to the sale in execution.
The Execution Creditor, Sheriff and/or Plaintiff's Attorneys do not give any warranties with regard to the description and/or improvements.
PROPERTY: SECTION NO.7 IN THE SCHEME KNOWN AS AMANDASIG 717 SITUATED AT AMANDASIG EXTENSION 12 TOWNSHIP
MEASURING: 70 SQAURE METRES
AND
AN EXCLUSIVE USE AREA DESCRIBED AS PARKING NO. P7 IN THE SCHEME AMANDASIG SITUATED AT AMANDASIG EXTENSION 12 TOWNSHIP
MEASURING: 15 SQAURE METRES
AND
AN EXCLUSVE USE AREA DESCRIBED AS GARDEN W7 IN THE SCHEME AMANDASIG 717 SITUATED AT AMANDASIG EXTENSION 12 TOWNSHIP
MEASURING:4 SQUARE METRES
KNOWN AS: UNIT NO. 7 DOOR NO. 7 IN THE SCHEME KNOWN AS AMANDASIG 717 (BERGVILLAS 1), 1 BERG STREET, AMANDASIG EXTENSION 12, PRETORIA
IMPROVEMENTS:
LOUNGE, DINING ROOM, KITCHEN, 2 BEDROOMS, 2 BATHROOMS, SHOWER, 2 TOILETS, CARPORT

**HACK STUPEL & ROSS**
Attorneys for Plaintiff
P O Box 2000, Pretoria
Tel: 012 325 4185
REFERENCE:DU PLOOY/JD GP10671

**01U0AZ**

11060 Sale in Execution

**NOTICE OF SALE IN EXECUTION**

PH 308
IN THE MAGISTRATES' COURT FOR THE DISTRICT OF PRETORIA HELD AT PRETORIA (CIVIL)
Case No. 288/2012
In the matter between:
ABSA BANK LIMITED
Applicant / Plaintiff
and
HORNTHORN INDUSTRIES (PTY) LTD
(ID NO. 1953/001379/07)
First Respondent / Defendant
LEON BENJAMIN VAN ECK
(ID NO. 661102 5173 087)
Second Respondent / Defendant

In pursuance of a judgment granted on 18 May 2012 in the above Honourable Court and under a writ of execution issued thereafter the immovable property listed hereunder will be sold in execution on 4 April 2013 at 11H00 by the Sheriff of the Magistrates' Court, Pretoria South-West, at Azania Building, Cor Iscor Avenue And Iron Terrace, West Park, to the highest bidder:
Description:
Remaining extent of Erf 1554 Pretoria Township;
Registration Division J.R., Province of Gauteng
In extent: Measuring 714 (Seven hundred and fourteen) square metres;
Street Address: Known as 473 Frederick Street, Pretoria;
Zoned: Residential;
Improvements: The following information is given but nothing in this regard is guaranteed:
The improvements on the property consist of the following:
Main Dwelling Comprising Inter Alia:
3 x Bedrooms,
1 x Lounge
1 x Kitchen
1 x Bathroom
2 x Servants Rooms
1 x Garages
Held by the First Defendant (Hornthorn Industries (Pty) Ltd in its name under Deed of Transfer No T40826/1998
The full conditions may be inspected at the offices of the Sheriff of the Magistrates' Court, Pretoria South-West, Azania Building, Cor Iscor Avenue and Iron Terrace, West Park
Dated at Pretoria on this the 4th day of March 2013.

**NEWTONS**
Plaintiff's Attorneys
2nd floor, Lobby 3
Brooklyn Forum Building,
337 Veale Street
Nieuw Muckleneuk, Pretoria
Tel: (012) 425 0200 /
Telefax: (012) 460 9491
Ref. F01573/ Nelene Venter

**01U1CU**

11100 Notice to Creditors

**NOTICE TO CREDITORS AND DEBTORS**

In the Estate of the Late: Johan Jacques De Lange
Identity Number: 6807255106082
Date of Death: 6 August 2009
Address: 4 Cross Street South, Johannesburg North, 2188
Estate No: 5374/2013
Creditors and Debtors in the above Estate are hereby required to file their claims with and pay their debts to the undersigned within 30 days from the date of publication hereof.
Attorneys/Agents:
**TELO BAILE MBIMBA IN HER CAPACITY AS NOMINEE OF SANLAM TRUST LIMITED**
Address: Private Bag X137
Halfway House, 1685
Telephone: 012 4700020

**01U24W**

11100 Notice to Creditors

**NOTICE TO CREDITORS AND DEBTORS**

In the Estate of the Late: Maureen Shirley Newman
Identity Number: 3610020091180
Date of Death: 9 February 2013
Address: Wilropark Retirement Village, Roodepoort
Estate No: 5097/2013
Creditors and Debtors in the above Estate are hereby required to file their claims with and pay their debts to the undersigned within 30 days from the date of publication hereof.
Attorneys/Agents:
**TELO BAILE MBIMBA IN HER CAPACITY AS NOMINEE OF SANLAM TRUST LIMITED**
Address: Private Bag X137
Halfway House, 1685
Telephone: 012 4700020

**01U24V**

11100 Notice to Creditors

**NOTICE TO CREDITORS AND DEBTORS**

In the Estate of the Late: Hluphekile Ephraim Ndabezitha
Identity Number: 5111095489084
Date of Death: 3 January 2013
Address: 627 Zikode Street, Jabulani, 1868
Surviving Spouse: Noliqchwa Ivy Ndabezitha
Identity Number: 5210190499087
Estate No: 5104/2013
Creditors and Debtors in the above Estate are hereby required to file their claims with and pay their debts to the undersigned within 30 days from the date of publication hereof.
Attorneys/Agents:
**TELO BAILE MBIMBA IN HER CAPACITY AS NOMINEE OF SANLAM TRUST LIMITED**
Address: Private Bag X137
Halfway House, 1685
Telephone: 012 4700020

**01U24X**

11110 Notice to Debtors

**INSPECTION OF ACCOUNTS**

In the Estate of the Late: Irene Verdun Webster
Identity Number: 1602110028083
Date of Death: 6 July 2013
Address: Room 97B, Frail Care Centre, St George's Village South, 1 Economides Road, Bedfordview, 2007
Estate No: 24728/2012
The Amended First and Final Liquidation and Distribution Account in the above Estate will lie for inspection at the office of the Master of the South Gauteng High Court – Johannesburg ( and at the office of the Magistrate at Germiston) for a period of three weeks from the date of publication hereof.
Attorneys/Agents:
**TELO BAILE MBIMBA IN HER CAPACITY AS NOMINEE OF SANLAM TRUST LIMITED**
Address: Private Bag X137
Halfway House, 1685
Telephone: 012 4700020

**01U28K**

11110 Notice to Debtors

**INSPECTION OF ACCOUNTS**

In the Estate of the Late: Trevor Bruce Drummond
Identity Number: 2901265002086
Date of Death: 5 January 2013
Address: 517 Nightingale, San Sereno, Bryanston, 2021
Estate No: 1796/2013
The First and Final Liquidation and Distribution Account in the above Estate will lie for inspection at the office of the Master of the South Gauteng High Court – Johannesburg ( and at the office of the Magistrate at Randburg) for a period of three weeks from the date of publication hereof.
Attorneys/Agents:
**TELO BAILE MBIMBA IN HER CAPACITY AS NOMINEE OF SANLAM TRUST LIMITED**
Address: Private Bag X137
Halfway House, 1685
Telephone: 012 4700020

**01U28L**

**NOTICE OF PUBLIC PARTICIPATION PROCESS**

**PROPOSED OIL AND GAS EXPLORATION ACTIVITIES IN THE TRANSKEI/ALGOA AREA, OFF THE EASTERN CAPE COAST OF SOUTH AFRICA**

ERM

Notice is hereby given in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) and Regulations thereto of the intent to carry out oil and gas exploration activities as described below.

Impact Africa Limited lodged an application for an Exploration Right with the Petroleum Agency of South Africa (PASA) in terms of Section 79 of the MPRDA in order to explore for oil and gas reserves in the Transkei/Algoa Area off the Eastern Cape Coast of South Africa. PASA accepted Impact Africa Limited's application on March 1st, 2013.

The proposed Exploration area (45,838 km²) extends from the coast out to a maximum water depth of approximately 4000 m. Impact Africa Limited's proposed initial three-year exploration work programme would consist of the following:

- Phase 1: Airborne geophysics acquisition (gravity & magnetics) to define existing structural trends, identify additional features and to address depth to basement / magnetic source.
- Phase 2: 2D and / or 3D seismic surveys followed by processing and interpretation.
- Phase 3: Surface heat flow measurements to determine thermal regime and calibrate thermal models.
- Phase 4: Multi-beam bathymetry acquisition to look for seepage and constrain boundary conditions for airborne geophysics acquisition.
- Phase 5: Sea and seabed sampling programme, which would include piston coring and/or water column sampling, to sample for hydrocarbon seepage.

It is anticipated that the exploration programme would commence with the Airborne geophysics acquisition (gravity & magnetics) in 2014. It should, however, be noted that some of the phases might occur in parallel or the final order of activities may change.

**Invitation to comment**

In terms of the MPRDA, a requirement for obtaining an Exploration Right is that an Environmental Management Programme (EMPr) must be compiled and submitted to PASA for consideration and for approval by the Minister of Mineral Resources. Environmental Resources Management Southern Africa (Pty) Ltd (ERM) has been appointed to compile the EMPr to meet the relevant requirements of the MPRDA and the Regulations thereto. A Background Information Document, providing initial project information, has been compiled and is available online at www.erm.com/TranskeiAlgoa-EMPR or from ERM on request. If you or your organisation would like to register as an Interested and Affected Party (I&AP) or receive more information, please contact Claire Alborough or Tougheeda Aspeling of ERM on:

Tel. 021 681 5400; Fax. 086 662 2228;
Address: Postnet Suite 90, Private Bag X12, Tokai 7966; or
Email: claire.alborough@erm.com or tougheeda.aspeling@erm.com
on or before **12 April 2013**.

IMPACT AFRICA

Date of advert: 22/03/2013

## Roeiers gaan weer op Cradock toesak

CRADOCK. – Die bestuur van die Groot Visrivier-kanomarathon het pas die datums vir vanjaar se marathon bekend gemaak.

Roeiers uit alle dele van die wêreld gaan vanjaar weer op 27 en 28 September op Cradock saamtrek om kragte teen die waters van die wispelturige Groot Visrivier te meet.

Volgens die organiseerders is dit vanjaar 'n K2-wedvaart, maar is deelnemers met K1's en selfs die lywige K3-bote ook welkom om in te skryf. Die wedvaart word vanjaar die 31ste keer aangebied en na verwagting sal die milpunt van 1 500 deelnemers weer bereik word.

Roeiers trek die Vrydag weg by Grasrugdam, 84 km buite die dorp, op die eerste skof tot by Kruitsford-brug en voltooi Saterdag die tweede skof tot by Cradock.

Corné Krige, die voormalige Bok-kaptein wat verlede jaar vir die eerste keer deelgeneem het, het reeds bevestig dat hy vanjaar weer gaan inskryf. Krige en verskeie ander deelnemers het ten bate van plaaslike liefdadigheidsorganisasies geroei.

Theuns Jordaan sal ook Vrydagaand by die sportterrein optree.

Verblyf in bed-en-ontbyt-plekke, skoolkoshuise en private wonings op die dorp word gewoonlik lank voor die marathon vol bespreek.

Vir meer inligting oor verblyf, bel Jeanette Geldenhuys by ☎ 084 508 0499. – **Wilna de Klerk**

## Te kos en te keur op Cradock se fees

CRADOCK. – 'n Kosfees word die naweek hier gehou waar 'n aanslag op die wêreldrekord vir die grootste potjiekosbyeenkoms gemaak gaan word.

Een van die streek se beste sjefs, Engela Joubert, gaan nuwe ontbytneigings op die fees bespreek en die Karoo Croissant bekend stel. Dit word gevolg deur praatjies deur verskeie ander kenners oor "voedsel vir skoonheid", spesery vir die kombuis, en 'n demonstrasie oor wildsvleiswors.

Dieselfde middag bied Joubert, 'n spesialis op die gebied van fyngebak en sjokolade, en Roger Jorgenson, 'n wyn-, spiritualee- en kaaskenner, 'n demonstrasie aan.

Charl Leslie van Radio Algoa gaan Vrydagmiddag se potjiekoskompetisie, gebore deur Radio Algoa en die plaaslike ouditeursfirma Theron Du Plessis, beoordeel.

Sydda Essop, outeur van die kookboek *Karoo Kitchen / Karoo Kombuis*, gaan Saterdag haar boek bekend stel en van haar erfenisresepte met feesgangers deel.

Die fees vind by die Hoërskool Cradock in Naestedstraat plaas en Saterdag word 'n verskeidenheid ware te koop aangebied.

Die organiseerders sê die fees word oor die langnaweek gehou sodat almal dit kan bywoon en saam die Karoo se erfenis en kultuur kan vier. Vir meer inligting, bel Melina Smit by ☎ 082 570 0680. – **Wilna de Klerk**



**Ford van Jaarsveldt (14) van Kommetjie oefen vir sy deelname in die o.16-kategorie vir seuns as deel van die RVCA Junior-branderryreeks die naweek op Jeffreysbaai.** Foto: VERSKAF

# Jonges na Jeffreys vir branderry-kompetisie

**Ilse Krige**

PORT ELIZABETH. – Byna 100 van Suid-Afrika se beste jong branderplankryers onder die ouderdom van 20 jaar het gister al die branders op Jeffreysbaai geklief.

Hulle is in dié gewilde Oos-Kaapse surf-mekka om te oefen vir die jaarlikse RVCA Junior-branderryreeks, wat van vandag tot Sondag by Lower Point uitgespook word.

Robin Kietzmann, bemarkingsbestuurder van RVCA, het gesê met prysgeld van meer as R100 000 en spesiale toekennings op die spel, asook die feit dat die uitslae punte tel vir die 2013-ranglys van die Pro Surf Tour (PST), is inskrywings van elke uithoek van die Suid-Afrikaanse kuslyn ontvang.

Selfs die Mexikaanse super-"grom", Sebastian Williams (12), wat in die o.16 seuns-kategorie deelneem, besoek die land vir die eerste keer. Williams kom ry branders in sy pa, Tim, 'n voormalige Durbaniet, se vaderlandswaters.

"Sebastian is waarskynlik die beste 12-jarige om hier in Suid-Afrika mee te ding. Hy is tans nommer 12 op die ranglys van die gesogte 2012 Surfer Mag Hot 100 Groms en het van die 19de plek in 2011 opgeskuif," volgens Kietzmann.

Plaaslike deelnemers in die o.20-meisies-afdeling, die huidige SA o.17-kampioen Gina Smith, haar suster, Emma, en mede-Jeffreysbaaier Tahra Uren, hoop om die uitdaging van Nicole Pallet (La Lucia), Inge McLaren (Oos-Londen) en Nina Woermann (Kenilworth) die hoof te bied.

Die hoogs mededingende o.16-seuns sluit die kampioen van Jeffreysbaai, Matt McGillivray, in, sowel as sy mede-spanlede Jordy Maree (Kalkbaai), Steff Burrows (Stellenbosch) en Simo Mkhize (Umzumbe) en die opkomende sterre Bevan Willis (Umdloti) en Nthando Msibi (Durban).

KAPTEIN PRYS OUDBREIER

# 'Hoe kón julle vir Jake laat gaan?'

**Stephen Nell**

KAAPSTAD. – Beste professor in Australië; uitgeworpene in Suid-Afrika.

Dit is die storie van die Brumbies se afrigter, Jake White – voorheen die Springbokke se breier, wat die Stormers se ondergang beplan voor môreaand se Superrugby-wedstryd op Nuweland.

"Ek weet nie waarom julle hom weggegee het nie, maar ons gaan hom beslis nie teruggee nie," het die Brumbies se kaptein, Ben Mowen, gister in die Moederstad oor White gesê.

White, wat as Bok-breier in 2004 die Drienasiesreeks en in 2007 die Wêreldbeker-toernooi gewen het, is ook vroeër vanjaar as 'n adjunkprofessor by die Universiteit van Canberra (UC) aangestel.

Hy het die Brumbies verlede jaar begin afrig en hulle is nou ná vier wedstryde in vanjaar se Superreeks onoorwonne en bo-aan die algehele puntelys.

Mowen meen die Brumbies se verbetering die afgelope twee seisoene kan toegeskryf word aan die bestuurspan wat White saamgestel het en die spankultuur wat hy gevestig het.

"Dis veral opvallend dat hy bekwame mense aangestel het wat nie noodwendig sy beskouing sal deel nie. Ek dink dit sê reeds baie van iemand as hy nie jasbroers aanstel nie," het Mowen gesê.

"Hy het ouens soos Laurie Fisher (voorspeler-afrigter), Stephen Larkham (agterlyn-afrigter) en Tony Thorpe (spanbestuurder) aangestel. Dis ouens wat hom sal uitdaag."

White is ook geprys vir die familie-atmosfeer wat hy by die Brumbies geskep het.

"Hy verwag baie van die spelers, maar dra self baie by. Ek dink mense kan sien dat ons vir meksaar speel," het Mowen gesê.

"Hy het vir my gesê dit voel of die span 'n familie is. Dis wat die Brumbies van jare gelede gehad het toe hulle op hul kruin was. Ek het met van daardie oudspelers gepraat en hulle het hul tyd by die Brumbies as hoogtepunte in hul loopbaan uitgesonder toe daar 'n soortgelyke gevoel was.

"Dis baie moeilik om só 'n kultuur te vestig. Dit kom nie sommer vanself nie en ons het baie hard daaraan gewerk. Jake het dit sterk gedryf en die span voel bevoorreg om hom te hê," het Mowen bygevoeg.

White gee lesings by die UC, ontwikkel afrigtingsprogramme en verskaf tegniese insigte vir die ontwikkeling en bedryf van sportakademies. Hy is ook verantwoordelik vir die werwing van internasionale studente – spesifiek jong sporthui.

Die Suid-Afrikaanse Rugbyunie (Saru) het destyds White se pos geadverteer terwyl die Springbokke nog midde-in hul Wêreldbeker-veldtog in Frankryk was.

Hy moes ook in 2006 'n mosie van wantroue in sy afrigting deur die Blou Bulle-rugbyunie afweer.



**Ben Mowen, Brumbies-kaptein, gister in Kaapstad.** Foto: GALLO IMAGES | GRANT PITCHER

■ **Môre se wedstryd begin om 10:10.**
■ **Nog 'n berig op bl.20.**

# Tretchikoff-skildery vir R13,8 miljoen verkoop

**Martiens van Bart**

KAAPSTAD. – Een van die bekendste olieverfskilderye deur die Russies-Suid-Afrikaanse kunstenaar Vladimir Griegorovich Tretchikoff (1913-2006), *Chinese Girl*, is vandeesweek in Londen vir R13,8 miljoen, belasting en afslaerkommissie ingesluit, opgeveil.

Altesaam nege kunswerke deur Tretchikoff is teen meer as R17,7 miljoen opgeveil.

Die koper van *Chinese Girl* is 'n Britse sakeman met Suid-Afrikaanse belange, Laurence Graff, en die veiling is deur die Suid-Afrikaanse tak van die afslaer Bonhams georganiseer.

Graff is 'n juwelier en voorsitter van Graff Diamonds International. Hy besit die plaas Delaire Graff naby Stellenbosch. Die skildery sal daar in sy private kunsmuseum deur die publiek besigtig kan word.

Dié werk is voorverlede jaar die eerste keer in Suid-Afrika ten toon gestel toe 'n retrospektiewe uitstalling, *Tretchikoff – The People's Painter*, van 'n groot verskeidenheid van Tretchikoff se kunswerke in die SA Nasionale Galery in die Kompanjiestuin in Kaapstad gehou is.



**Vladimir Tretchikoff se *Chinese Girl*.**

Die kurator van die tentoonstelling, Andrew Lamprecht, het *Chinese Girl* indertyd bestempel as "Suid-Afrika se *Mona Lisa*". Tretchikoff het die portret in 1951 van 'n Kaapse vrou, Monika Pon Su San, gemaak en dit in Amerika ten toon gestel. Sowat halfmiljoen volgroote afdrukke is wêreldwyd verkoop.

"'n Negentienjarige Amerikaanse vrou het destyds haar bankrekening leeggetrek vir 'n deposito om dit te kon koop. Sy het toe verder 'n ooreenkoms met Tretchikoff aangegaan om dit maandeliks af te betaal," het Lamprecht in 'n onderhoud met Laetitia Pople, kunsredakteur van *Die Burger*, gesê.

Pon Su San het 2011 se uitstalling bygewoon.

Nog vyf olieverfskilderye en drie pastelportrette deur Tretchikoff is ook op vandeesweek se veiling verkoop. Eersgenoemdes is *Balinese Dancer*, *Herb Seller*, *Lady with Crayfish*, *Old Lady with Dahlias* en *Veld Fire*, wat onderskeidelik R605 500, R1,7 miljoen, R521 500, R605 500 en R224 000, kommissie en belasting ingesluit, behaal het. Vir die pastelle is altesaam R280 000 betaal. Dit bring die groottotaal op R17 736 500 te staan. 'n Biografie oor Tretchikoff deur Richard Buncher het R6 118 gehaal.



**Shane Louw, 'n gestremde inwoner van die Cheshire-tehuis vir gestremdes in die Baai, word deur ingenieurstudente van die Nelson Mandela Metropolitaanse Universiteit (NMMU) hul sonkragmotor gewys. Dié tegnologie gaan ook ingespan word om vir hom 'n meer bruikbare rystoel te maak.** Foto: VERSKAF

# Studente verbeter kwadrupleeg se lewe

**Ilse Krige**

PORT ELIZABETH. – 'n Gemeenskapsprojek deur 'n student van die Nelson Mandela Metropolitaanse Universiteit (NMMU) het beter lewensgehalte aan 'n Baaise kwadrupleeg geskenk.

Veelvuldige sklerose is by Shane Louw (26), wat nie kan praat of enige beheer oor sy ledemate het nie, gediagnoseer toe hy een jaar oud was.

Sy arbeidsterapeut, Adri Mentz, was instrumenteel om hom meer mobiel te maak nadat sy groot vordering in sy liggaamlike toestand opgemerk het.

Sy het met Claudia Powell, 'n meganiese ingenieurswese-student van die NMMU, kontak gemaak, wat op haar beurt haar medestudente Louis Pretorius, Jacques Kotzé en Jacques Smith genader het.

Dié inwoner van die Cheshire-tehuis is só deur sy houtraam bemagtig dat hy verlede jaar aan die Discovery Walk kon deelneem. Hy het nou selfs sy visier op die Paralimpiese Spele gestel.

Powell het verduidelik die "Run with Shane"-projek het Louw gehelp om oor 'n tydperk van vier jaar te vorder van 'n rystoel tot waar hy nou met behulp van die spesiaal ontwerpte houtof loopraam kan staan én kan loop.

Powell is ook besig om met die hulp van mede-studente wat verlede jaar betrokke was by die bou van 'n sonkragmotor, 'n nuwe rystoel-sitplek vir Louw te ontwerp.

"Die span sal sy vaardighede gebruik om vir Shane 'n nuwe ergo-

## Lady Gaga herstel ná heup-operasie

NEW YORK. – Lady Gaga herstel "ongelooflik goed" ná haar heupoperasie verlede maand wat haar genoop het om 'n konserttoer te kanselleer. Só het haar bestuurder, Vincent Herbert, vroeër die week in 'n onderhoud gesê.

Gaga is beseer toe sy vroeër opgetree het en haar *Born This Way Ball*-toer moes vervolgens in dele van Amerika gekanselleer word.

Herbert het gesê sy is gereed om verder te werk aan haar nuwe album, *ARTPOP*. Hy het gesê dié album gaan "baie verfrissend" wees en dat die omstrede popster – soos gewoonlik – grense gaan oorsteek. – **Sapa-AP**

**KENNISGEWING VAN OPENBARE DEELNAME PROSES**
**VOORGESTELDE OLIE EN GAS EKSPLORASIE WERKSAAMHEDE IN DIE TRANSKEI / ALGOA GEBIED, AAN DIE OOS KAAP KUS VAN SUID AFRIKA**

ERM

Kennisgewing word hiermee gegee ingevolge die Wet op Minerale en Petroleum Hulpbronneontwikkeling (Wet 28 van 2002) (WMPHO) en Regulasies uitgevaardig kragtens hierdie wet, van die voorneme om olie en gas eksplorasie werksaamhede te onderneem soos hieronder uiteengesit.

Impact Africa Limited het 'n aansoek ingedien by die Petroleum Agentskap van Suid Afrika (PASA) ingevolge Artikel 79 van die WMPHO om die Eksplorasie Regte te bekom vir die eksplorasie van olie en gas reserwes in die Transkei/Algoa omgewing aan die Oos Kaap Kus van Suid Afrika. PASA het Impact Africa Limited se aansoek ontvang op 1 Maart 2013.

Die voorgestelde eksplorasiegebied (46,838 km²) strek vanaf die kus seewaarts tot 'n maksimum waterdiepte van ongeveer 4000m. Impact Africa se voorgestelde aanvanklike drie jaar eksplorasie werksprogram sluit in die volgende:

- Fase 1: Geo-fisiese lugopnames (gravitasie & magnetics) om strukturele tendense te bepaal, addisionele eienskappe te identifiseer en om diepte tot by die ondergrondse vlak /magnetiese bronte bepaal.
- Fase 2: 2D en/ of 3D seismiese opnames gevolg deur die prosessering en interpretasie daarvan.
- Fase 3: Meting van oppervlak hittevloei om sodoende die termiese stelsel te bepaal en om termiese modelle te kalibreer.
- Fase 4: Multi-straal dieptepeilings om enige lekkasies te identifiseer en om die grenslandsies vir die geo-fisiese lugopnames te definieer.
- Fase 5: Program om see en seebodem monsters te neem, wat sal insluit die neem van suigkorn monsters en/ of waterkolom monsters om enige koolwaterstof deurspoeling te bepaal.

Daar word verwag dat die eksplorasie program in 2014 sal afskop met die geo-fisiese lugopnames (gravitasie en magnetics). Dit moet agter daarop gelet word, dat sommige van die fases teen in parallel kan voorkom, of die finale volgorde van aktiwiteite kan verander.

**Uitnodiging om kommentaar te lewer**

Ingevolge die WMPHO, is dit 'n vereiste dat alvorens Eksplorasie Regte verkry kan word dat 'n Omgewingsbestuursplan (OBP) opgestel en ingedien moet word aan PASA vir oorweging en goedkeuring deur die Minister van Minerale Hulpbronne. Environmental Resources Management Southern Africa (Pty) Ltd (ERM) is aangestel om so 'n OBP op te stel wat die relevante vereistes van die WMPHO en enige regulasies ingevolge hierdie wet sal nakom. 'n Agtergrond Inligtingsdokument is opgestel, wat voorlopige inligting omtrent die projek bevat en hierdie document is beskikbaar aan lyn by: www.erm.com/TranskeiAlgoa-EMPR of op aanvraag by ERM, indien u of u organisasie wil registreer as 'n Geïnteresseerde of Belanghebbende party (G&BP) of graag verdere inligting wil bekom, skakel asseblief vir Claire Alborough of Toughseda Aspeling van ERM by:

Tel: 021 681 5400; Faks: 0866622228;
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# Gaza unrest as Obama arrives

PRESIDENT Barack Obama travelled to the West Bank yesterday to meet Palestinian leaders dismayed by his failure to meet expectations that he could help deliver them a state.

Obama met Palestinian President Mahmud Abbas and then Prime Minister Salam Fayyad, on the second day of his visit to Israel, the West Bank and Jordan, which is dominated by challenges posed by Iran and Syria.

Hours before Obama was to board his helicopter to fly to Ramallah to meet the Palestinian leadership, two rockets fired by militants in the Hamas-run Gaza Strip hit southern Israel.

The rockets crashed down in Sderot, a border town often targeted by rockets, which Obama visited as a presidential candidate in 2008.

A senior Israeli official said they were watching for Palestinian leadership's response to the rocket fire.

"Israel will be watching very closely Abbas's remarks in Ramallah to see if he condemns the rocket attacks," the official said, adding "last year ... he refused to condemn rocket attacks on Israeli civilians."

"We will also want to see if he ceases the unity talks with Hamas," he added of the rockets fired from Hamas-controlled territory.

The Islamist group's spokesman Sami Abu Zohri told reporters: "Hamas considers talk of rocket fire to be merely Israeli accusations aimed at gaining sympathy from Obama... and inciting him against Palestinians."

There was no immediate White House comment.

Obama, on the first foreign trip of his second term, says he has come to the Holy Land simply "to listen" to the parties about how to resume peace talks frozen for two-and-a-half years.

At a news conference with Israeli Prime Minister Benjamin Netanyahu on Wednesday, Obama said: "It's been lingering for over six decades. And the parties involved have, you know, some profound interests that you can't spin, you can't smooth over."

Obama's new approach was a stark contrast to early in his first term, when he declared Israeli settlement building to be illegitimate and promised to dedicate himself to peace.

He admitted on Wednesday he had perhaps made mistakes, but argued he was not the only US leader to have come a cropper on the issue. — *Sapa-AFP*



**DISSATISFIED: Palestinians burn pictures of US President Barack Obama and an Israeli flag during a protest against Obama's visit, in Gaza City yesterday. Two rockets fired from the Gaza Strip landed yesterday in a southern Israeli border town that Obama had mentioned in a speech on his arrival in Israel a day earlier**

Picture: REUTERS

# Cyprus scrambles to head off meltdown

## EU threatens cutoff without R5.8bn

By MICHELE KAMBAS and LIDIA KELLY

CYPRIOT politicians searched desperately yesterday for a Plan B to find billions needed to clinch an EU bailout and avert a financial meltdown after parliament rejected a bank deposit levy.

President Nicos Anastasiades, a month in office and facing his country's worst crisis since a 1974 Turkish invasion, met party leaders to work out how to raise €5.8-billion (R70-billion) demanded by the EU under a €10-billion (R120.7-billion) rescue.

Cyprus has faced the prospect of bankruptcy since Tuesday, when its tiny parliament voted unanimously against a levy on bank deposits to raise the cash.

Officials said new options discussed yesterday could include nationalising pension funds of parastatals, issuing an emergency bond linked to future natural gas revenue or a revised bank deposit levy hitting only large investors.

Cyprus was also looking to Russia, whose citizens have billions of euros to lose in the island's outsized and now-teetering banking sector.

In Moscow since Tuesday, Cypriot Finance Minister Michael Sarris said the two countries were discussing cooperation in the banking and energy sectors in addition to a new loan of €5-billion (R60.4-billion).

The EU believes at least some of the amount they demand should come from the €68-billion (R820-billion) in Cypriot banks, €38-billion (R460-billion) of which is in the form of big deposits of more than €100 000 (R1.2-million), mainly from foreigners.

Hitting small depositors causes visceral outrage, but the government believes hitting large depositors too hard would destroy the offshore financial industry that forms much of the country's economy.

Banks, shut since the weekend, will stay closed till Tuesday and the Cypriot stock exchange has suspended trade.

Cypriots still have access to cash for now as ATMs, emptied at the weekend, have been restocked. — *Reuters*

# Mumbai bomber gets death

INDIA'S top court upheld the death penalty yesterday for the mastermind of a series of bombings which killed 257 people in Mumbai in 1993, the deadliest set of attacks in the country's history.

Yakub Memon, brother of the alleged main plotter and fugitive Tiger Memon, was the only one of 11 convicts to see his death sentence upheld by the Supreme Court for his role in the blasts, which wounded more than 800 people.

The judges also handed down a five-year term for prominent Bollywood actor Sanjay Dutt for possessing illegal weapons bought from gangsters accused of orchestrating the bombings.

Announcing the sentences, supreme court judge P Sathashivam said the Memon brothers and another suspect, Dawood Ibrahim, who is said to be living in Pakistan, "were archers, and the rest of the appellants were arrows in their hands".

"They were the architects of the blasts," Sathashivam said.

The remaining convicts who appealed against the death penalty saw their sentences commuted to life in jail.

The attacks on March 12 1993 were believed to have been staged by Mumbai's Muslim-dominated underworld in retaliation for anti-Muslim violence that left more than 1 000 dead in the city a few months earlier. — *Sapa-AFP*

# Global alert over deadly bat virus

EXPERTS on infectious diseases yesterday warned people to stay away from bats worldwide after the recent death of an eight-year-old boy bitten in Australia.

The boy last month became the third person in the country to die of Australian bat *lyssavirus* (ABLV), for which there is no effective treatment.

Doctors Joshua Francis and Clare Nourse of Mater Children's Hospital in Brisbane warned an infectious diseases conference that human-to-human transmission of the virus may be possible.

Francis said the boy was bitten during a family holiday to Queensland in December but did not tell his parents. Three weeks later he began to suffer convulsions, abdominal pain and fever, followed by progressive brain problems.

Doctors frantically tried to establish what was wrong and on day 10 of his admission the *lyssavirus* was detected.

He fell into a coma and died on February 22. — *Sapa-AFP*

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# Ethnic fights kill 35 in Nigeria

INTERCOMMUNAL clashes in Jos, central Nigeria, have left at least 35 people dead and caused extensive damage to property.

The clashes, which took place on Wednesday, are the latest in tit-for-tat raids between communities in Jos, which has seen some of the most violent ethno-religious fighting in the country in recent years.

The Tribune reported that after hours of violence police forces and an elite crack squad stepped in and calm was returned to the area. Three people were arrested and are being questioned.

Jos is predominately Christian but sits just over the fault line between the mostly Muslim north and the south, which is largely Christian. — *Sapa-DPA*

**UMASIPALA WASE NKONKOBE** — **NKONKOBE MUNICIPALITY**

**COUNCIL MEETING**

Mr K.C Maneli, the Municipal Manager, as duly instructed by the Speaker of Nkonkobe Municipality (Cllr N.P.Mlamla), hereby gives notice that, in terms of Section 19(a) of the Municipal Systems Act, Act 32 of 2000, an ordinary Council meeting of the Nkonkobe Municipality will be held on **Wednesday, 27 March 2013 at 09:00 at TRC Hall, Alice.**

**The scheduled council meeting is for the:**
1. Adoption of the Reviewed Draft Integrated Development Plan (IDP) 2012/13
2. Adoption of Reviewed Draft Budget 2012/13
3. Tabling of the Oversight Committee Report 2010/11

In terms of Section 20(1) of the Municipal Systems Act, members of the public, the media and other interested parties or bodies are invited to attend the meeting.

**INTLANGANISO YEBHUNGA LOLAWULO LIKAMASIPALA**

Umnu. K.C Maneli, uMphathi ka Masipala, njengoko eyalelwe nguSomlomo kaMasipala waseNkonkobe (uCeba NP Mlamla), uyazisa, ngokwe Candelo 19(a) lomthetho wohlobo lokusebenza kooMasipala, Act 32 of 2000, ukuba intlanganiso yebhunga likaMasipala iyakubanjwa **ngoLwesithathu umhla we 27 kweyo Kwindla 2013 ngentsimbi yesithoba e TRC Hall e Dikeni.**

**Kulentlanganiso kuzakube:**
1. Kupasiswa uMqulu wezophuhliso okwisigaba sohlengahlengiso ka 2012/13
2. Kupasisiwa uhlahlo lwabiwo-mali lukaMasipala wase Nkonkobe olukwisigaba sohlengahlengiso ka 2012/13
3. Kusithiwa thaca ingxelo ye komiti ephicotha iziphene kwingxelo yomphicothi zincwadi zika Masipala ka 2010/11

NgokweCandelo 20(1) loMthetho woMasipala, uluntu ngokubanzi, iintatheli kwakunye namanye amaqela anomdla ayamenywa ukuba abeyinxalenye yalentlanganiso.

**K.C Maneli**
**Municipal Manager**
**Nkonkobe Municipality**

**NOTICE OF PUBLIC PARTICIPATION PROCESS**

**PROPOSED OIL AND GAS EXPLORATION ACTIVITIES IN THE TRANSKEI/ALGOA AREA, OFF THE EASTERN CAPE COAST OF SOUTH AFRICA**

ERM

Notice is hereby given in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) and Regulations thereto of the intent to carry out oil and gas exploration activities as described below.

Impact Africa Limited lodged an application for an Exploration Right with the Petroleum Agency of South Africa (PASA) in terms of Section 79 of the MPRDA in order to explore for oil and gas reserves in the Transkei/Algoa Area off the Eastern Cape Coast of South Africa. PASA accepted Impact Africa Limited's application on March 1st, 2013.

The proposed Exploration area (45,838 km²) extends from the coast out to a maximum water depth of approximately 4000 m. Impact Africa Limited's proposed initial three-year exploration work programme would consist of the following:

* Phase 1: Airborne geophysics acquisition (gravity & magnetics) to define existing structural trends, identify additional features and to address depth to basement / magnetic source.
* Phase 2: 2D and / or 3D seismic surveys followed by processing and interpretation.
* Phase 3: Surface heat flow measurements to determine thermal regime and calibrate thermal models.
* Phase 4: Multi-beam bathymetry acquisition to look for seepage and constrain boundary conditions for airborne geophysics acquisition.
* Phase 5: Sea and seabed sampling programme, which would include piston coring and/or water column sampling, to sample for hydrocarbon seepage.

It is anticipated that the exploration programme would commence with the Airborne geophysics acquisition (gravity & magnetics) in 2014. It should, however, be noted that some of the phases might occur in parallel or the final order of activities may change.

**Invitation to comment**

In terms of the MPRDA, a requirement for obtaining an Exploration Right is that an Environmental Management Programme (EMPr) must be compiled and submitted to PASA for consideration and for approval by the Minister of Mineral Resources. Environmental Resources Management Southern Africa (Pty) Ltd (ERM) has been appointed to compile the EMPr to meet the relevant requirements of the MPRDA and the Regulations thereto. A Background Information Document, providing initial project information, has been compiled and is available online at www.erm.com/TranskeiAlgoa-EMPR or from ERM on request. If you or your organisation would like to register as an Interested and Affected Party (I&AP) or receive more information, please contact Claire Alborough or Tougheeda Aspeling of ERM on:

Tel. 021 681 5400; Fax. 086 662 2228;
Address: Postnet Suite 90, Private Bag X12, Tokai 7966; or
Email: claire.alborough@erm.com or tougheeda.aspeling@erm.com
on or before 12 April 2013

IMPACT AFRICA

Date of advert: 22/03/2013

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# Bay hots up with Chilli Fest

**Shaanaaz de Jager**
dejagers@timesmedia.co.za

THOSE in pursuit of a "hot time" should visit the annual chilli festival in Nelson Mandela Bay this weekend.

The 10th annual Chilli Festival, which takes place from tonight until Sunday at the Morewag Primary School sports fields in Harrower Road, Port Elizabeth, has attracted 50 stall holders from Nelson Mandela Bay, Jeffreys Bay, Bloemfontein and Worcester.

Event organiser Cathy van der Merwe said because of the 10th anniversary "we have gone big with advertising" and they hoped to attract more people to the event than last year.

"In the past we have always received between 3 000 and 4 000 people. Hopefully this time we'll attract more people," she said.

Each year the event is held at a different venue, which also benefits financially from the festival.

From 6pm there will be a karaoke party and the entry fee is "a tin of food which will be donated to a charity".

Tomorrow there will be a Miss Chilli event and a potjiekos competition. Entertainment for the day will be provided by 23 "great" singers from Nelson Mandela Bay, dancers and two bands.

Chilli lovers will go head to head at the chilli competition on Sunday, with chillies imported from the Hotazel farm in Oudtshoorn.

"There's a shortage of chillies in Nelson Mandela Bay, so we have to 'import' the chillies. I don't know what happened to the big chilli growers," Van der Merwe said.

Stall holders will sell "chilli-related food", plants and home-made sauces among other items.

She said party packs would be handed out to children who did not have money to pay the entry fee.

Van der Merwe this week also donated party packs to the grade 0 and Grade R classes at Morewag Primary School and Dr Viljoen Primary School, respectively. The packs were donated by McDonald's in Newton Park and Linton Grange.

Children are in for a treat as there will be a playland, paintball games and mini train rides.

The entrance fee tomorrow and on Sunday is R10 for adults and R5 for children.



**READY TO ROLL: Parsons Hill Primary School headmaster Clinton 'Teach' Saddler gets best wishes from pupils as he leaves for his 25th Buffalo Rally in Mossel Bay. Pupils, from left, Zizipho Pango, Shawn van Wyk, Scott Tyrer (under bike), Zoe Williams, Christiaan Rademeyer, Cassidy Cedras and Dillon Loxton, who are all seven and in Grade 2, were on hand to wish him a safe trip** Picture: MIKE HOLMES

# Principal revs it up for rally

## Thousands of motorcycles to descend on Mossel Bay for weekend event

**Shaun Gillham**
gillhams@timesmedia.co.za

TATTOOS, tights, denims and donuts will be the order of the day when thousands of bikers from around the country descend on Mossel Bay today for the annual Buffalo Rally.

The renowned rally, which ends on Sunday, is a major annual event on South Africa's motorcycling calendar and is traditionally characterised by massive parties, leather-clad riders with beards, thousands of badges and plenty of beer and braais. Along for the ride will be popular Bay biker Clinton "Teach" Saddler, who is the principal of Parsons Hill Primary School and who is a regular participant at rallies, such as the Dolphin Rally which is hosted at Beachview outside of Port Elizabeth.

Speaking from Mossel Bay yesterday, Luderick Jacoby, who is the chairman of Nomads Motorcycle Club – one of the largest bikers organisations in South Africa – said more than 1 000 riders had arrived in the town by yesterday.

"It is going to be huge and a fantastic event. And we expect the big parties to start from [tonight]," Jacoby said.

He said organisers anticipated similar numbers of participants as last year which included about 3 800 bikes and between 4 000 and 6 000 people.

"The rally will be held at two different camp sites, De Bakke and Santos in Mossel Bay. The Le Riche brothers, who are the two top trials riders in South Africa, will be performing an amazing stunt show. There will be lots of riding and I'm sure lots of donuts being performed."

Jacoby said that as is traditional at the rally, the bikers would be riding through the centre of the town tomorrow morning. A concours d'elegance will also be held.

Commenting on the weather outlook for the thousands of campers, Jacoby said "so far so good".

"Overcast weather has however been predicted for Saturday, but we hope that it will not impact on the ride or the camping," he said.

Jacoby said the police and traffic department would be out in full force for the event, but that the two arms of the law had been very co-operative and supportive.

"As long as people behave themselves, everything will be OK," he said.

One of the biggest attractions at the event, some proceeds of which are usually donated to a local charity, will be a lucky draw for R100 000, R20 000 and R10 000.

## IN BRIEF

### Yoko Ono backs US anti-gun lobby

YOKO Ono has taken up arms against gun violence with a raft of Twitter postings, including a photograph of blood-stained glasses apparently worn by John Lennon when he was shot and killed.



**YOKO ONO**

"Over 1 057 000 people have been killed by guns in the USA since John Lennon was shot and killed on 8 Dec 1980," Ono, the former Beatle's widow, tweeted.

Below the message she included a photo of what appears to be Lennon's blood-stained glasses. – Reuters

### Ambitious teen targets R5m

A 19-YEAR-OLD entrepreneur, who wants to educate children about personal finance, hopes to win R5-million to make her dream come true.

Tsepiso Makhubedu of Nelspruit in Mpumalanga is one of the 12 recently announced finalists for the second season of the SABC2 entrepreneurship reality show, *Big Break Legacy*.

Makhubedu's vision is to "publish financial literacy and entrepreneurship books for primary school children". The first two books have been printed, she said. – Dimakatso Motau

### Songbird Kelly is rolling again

FRESH from the drama of parting ways with her on–off manager Sarah Setlaelo, Kelly Khumalo seems to be smiling again.



**KELLY KHUMALO**

The songbird has been nominated for album of the year, female artist and best contemporary awards, at the 19th South African Music Awards (Sama).

The nominations come as a result of her fifth studio album *The Past, The Present, The Future*.

# Debut album for jazz singer



**FRESH VIBES: Nomfundo Xaluva has released a jazz album, *Kusile*** Picture: JUDY DE VEGA

**Yoliswa Sobuwa**
sobuway@timesmedia.co.za

JAZZ singer Nomfundo Xaluva, 28, has released her debut album just three years after she made her first public appearance at the Cape Town Jazz Festival.

The New Brighton-born singer's album, *Kusile,* includes a song, *Babephi na* (Where were they?) which is a tribute to her late father, Sam Xaluva, who introduced her to jazz.

"I recorded this album in 2011 as an individual. Last year, I approached Universal Records who were impressed and decided to sign me immediately. The album has 12 tracks and 10 of the tracks are all original songs that I wrote myself. And then there are two bonus tracks *Yakhal'i nkomo* and *Jerusalem*," she said.

"People will enjoy my CD as I have worked with very seasoned jazz artists. It also has a fresh sound and a different approach to what people think of as jazz. There are a lot of different elements and I know it will change people's minds about what they think of jazz."

Xaluva's love for music started when she was just 12. In 2003, she joined the National Youth Choir but it was only in 2009 that she made her solo debut. She has also performed with Sibongile Khumalo in a tribute concert to the late Miriam Makeba.

"In 2011 I got a chance as an opening act for American jazz vocalist Dianne Reeves at Montecasino," she said.

And, when the University of Cape Town Bachelor of Music in Jazz Studies student is not performing or attending university, she is back in Port Elizabeth spending time with her family in New Brighton.

# Top Bollywood actor faces jail

BOLLYWOOD actor Sanjay Dutt was sentenced to five years' jail by India's Supreme Court yesterday for possession of illegal weapons in a long-running case linked to the 1993 Mumbai bombings.

Dutt, 53, popular for his role as a do-good gangster in the "Munnabhai" films, was sentenced to six years in prison in 2007 for acquiring illegal weapons from the men convicted for the Mumbai attacks that killed 257 people.

But he appealed against the sentence and was released on bail, pending a further hearing.

The court rejected Dutt's final appeal and ordered him to return to custody in four weeks' time. – Reuters

# Tretchi's 'Chinese Girl' is home

VLADIMIR Tretchikoff's iconic painting, *Chinese Girl*, said to be one of the most reproduced in the world, is coming home to South Africa after more than half a century in a private Chicago collection, Bonhams auction house said yesterday after a record sale.



**'CHINESE GIRL'**

The picture of the beauty with a green-hued skin, ruby-red lips and luscious black hair, which features on mugs, T-shirts, posters and wallpaper, on Wednesday sold for £982 050 (R13.92-million) – double the expected price and a record for Tretchikoff or any South African artist, according to Giles Peppiatt, director of South African art at Bonhams.

"This was an exceptional price for a work which really does merit the word 'iconic'," he said.

Bonhams was packed on Wednesday with about 120 buyers, interest having been generated by putting the painting on display. But the winner of the auction was on the phone and only allowed his identity to be revealed shortly before the sale was sealed. He is British diamond jewellery magnate Laurence Graff, who told Bonhams the painting would be displayed at the Delaire Graff wine estate outside Stellenbosch, The estate is decorated by other works in his art collection.

Manchurian-born Tretchikoff escaped from Soviet Russia and emigrated to South Africa after World War 2. Along the way he lived in Shanghai.

His official website says the artist started the famous portrait in Java in 1946. But biographer Boris Gorelik, for his book *Incredible Tretchikoff*, said the artist came from Russia to South Africa in search of the inspiration for the painting, and found Monika Sing-Lee in Cape Town.

She told him Tretchikoff spotted her while she was working at her uncle's launderette in Sea Point, and begged to paint her. – Sapa-AP

**NOTICE OF PUBLIC PARTICIPATION PROCESS**

**PROPOSED OIL AND GAS EXPLORATION ACTIVITIES IN THE TRANSKEI/ALGOA AREA, OFF THE EASTERN CAPE COAST OF SOUTH AFRICA**

ERM

Notice is hereby given in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) and Regulations thereto of the intent to carry out oil and gas exploration activities as described below.

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- Phase 5: Sea and seabed sampling programme, which would include piston coring and/or water column sampling, to sample for hydrocarbon seepage.

It is anticipated that the exploration programme would commence with the Airborne geophysics acquisition (gravity & magnetics) in 2014. It should, however, be noted that some of the phases might occur in parallel or the final order of activities may change.

**Invitation to comment**

In terms of the MPRDA, a requirement for obtaining an Exploration Right is that an Environmental Management Programme (EMPr) must be compiled and submitted to PASA for consideration and for approval by the Minister of Mineral Resources. Environmental Resources Management Southern Africa (Pty) Ltd (ERM) has been appointed to compile the EMPr to meet the relevant requirements of the MPRDA and the Regulations thereto. A Background Information Document, providing initial project information, has been compiled and is available online at www.erm.com/TranskeiAlgoa-EMPR or from ERM on request. If you or your organisation would like to register as an Interested and Affected Party (I&AP) or receive more information, please contact Claire Alborough or Tougheeda Aspeling of ERM on:

Tel. 021 681 5400; Fax. 086 662 2228;
Address: Postnet Suite 90, Private Bag X12, Tokai 7966; or
Email: claire.alborough@erm.com or
tougheeda.aspeling@erm.com
on or before **12 April 2013**.

Date of advert: 22/03/2013

IMPACT AFRICA




# Tightrope walk plan over Grand Canyon

AERIALIST Nik Wallenda plans to cross the Grand Canyon in June on a tightrope 450m in the air, without a safety harness – a feat to be televised live.

Wallenda said he would traverse a remote section of the crimson-hued canyon owned by the Navajo Nation on June 23 in what will be his first major stunt since he last year became the only person to walk a wire over the brink of Niagara Falls.

"This is another one of my dreams coming true," Wallenda, 34, said. "This is one that has been on my bucket list for some time."

Wallenda said he would use the walk to honour his great-grandfather, Karl Wallenda, who died in 1978 during a walk between two buildings in Puerto Rico. – Reuters

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Appendix B-2

# I&AP Correspondence

# Initial Notification

**Environmental Resources Management**

*Cape Town Office*
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7725
Cape Town
South Africa
Tel: +27 (0) 21 681 5400
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www.erm.com

*Postal Address:*
Postnet Suite 90
Private Bag X12
Tokai, 7966

22 March 2013

*ERM Ref: 0194759*

Dear Stakeholder

**Re: Proposed Oil and Gas Exploration Activities in the Transkei Algoa Exploration Area, off the Eastern Cape Coast of South Africa**

Notice is hereby given in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) and Regulations thereto of the intent to carry out oil and gas exploration activities as described below and in the attached Background Information Document (BID).

Impact Africa Limited lodged an application for an Exploration Right with the Petroleum Agency of South Africa (PASA) in terms of Section 79 of the MPRDA in order to explore for oil and gas reserves in the Transkei/Algoa Area off the Eastern Cape Coast of South Africa. PASA accepted Impact Africa Limited's application on March 1st, 2013.

In terms of the MPRDA, a requirement for obtaining an Exploration Right is that an Environmental Management Programme (EMPr) must be compiled and submitted to PASA for consideration and approval by the Minister of Mineral Resources. Environmental Resources Management Southern Africa (Pty) Ltd (ERM) has been appointed to compile the EMPr to meet the relevant requirements of the MPRDA and the Regulations thereto. A BID, providing initial project information, is attached and is available online at www.erm.com/TranskeiAlgoa-EMPR. If you or your organisation would like to register as an Interested and Affected Party (I&AP) or receive more information, please contact Claire Alborough or Tougheeda Aspeling on or before **12 April 2013**.

Please note that the draft EMPr will be released for a 30-day comment period once completed.

Yours sincerely



Claire Alborough
*Project Manager*

*Registered Company address:*
Environmental Resources Management
Southern Africa (Pty) Ltd
Building 32, 1ST Floor
The Woodlands Office Park,
Woodlands Drive, Woodmead, 2148

*Company registration number*
2003/001404/07

*Directors*
Bruce Walker (Managing)
Grant Bassingthwaighte
Jeremy Soboil
John Simonson (UK)
Tania Swanepoel

*Offices worldwide*

A member of the Environmental Resources Management Group

# Draft EMPr Notification

**Environmental Resources Management**

*Cape Town Office*
2nd Floor, The Great Westerford
240 Main Road
Rondebosch
7725
Cape Town
South Africa
Tel: +27 (0) 21 681 5400
Fax:+27 (0) 21 686 0736
www.erm.com

*Postal Address:*
Postnet Suite 90
Private Bag X12
Tokai, 7966

24 May 2013

*ERM Ref: 0194759*

Dear Stakeholder

**Re: Proposed Oil and Gas Exploration Activities in the Transkei and Algoa Exploration Areas, off the Eastern Cape Coast of South Africa**

Impact Africa Limited lodged an application for an Exploration Right with the Petroleum Agency of South Africa (PASA) in terms of Section 79 of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) in order to explore for oil and gas reserves in the Transkei and Algoa Exploration Areas off the Eastern Cape Coast of South Africa. PASA accepted Impact Africa Limited's application on March 1, 2013.

In terms of the MPRDA and associated regulations, a requirement for obtaining an Exploration Right is that an Environmental Management Programme (EMPr) must be compiled and submitted to PASA for consideration and for approval by the Minister of Mineral Resources. Environmental Resources Management Southern Africa (Pty) Ltd (ERM) has been appointed to compile the EMPr to meet the relevant requirements of the MPRDA and the Regulations thereto.

A Draft EMPr has been compiled and released for a 30-day public comment / review period and is available online: http: / / www.erm.com / TranskeiAlgoa-EMPR. A copy will also be made available at the Port Elizabeth, East London and Port St Johns libraries.

Group meetings will be held in the following locations to discuss the proposed project:

- **Port Elizabeth** (Date: 3 June 2013; Time: 4 – 6pm; Location: Nelson Mandela Bay Business Chamber, KPMG House Norvic Drive Greenacres)
- **East London** (Date: 4 June 2013; Time: 4 – 6pm; Location: Siyakhana Health Trust; 21 St Georges Road, Southernwood)
- **Port St Johns** (Date: 5 June 2013; Time: 4 – 6pm; Location: Port St Johns Community Hall, West Street Port St Johns)

*Registered Company address:*
Environmental Resources Management
Southern Africa (Pty) Ltd
Building 32, 1ST Floor
The Woodlands Office Park,
Woodlands Drive, Woodmead, 2148

*Company registration number*
2003 / 001404 / 07

*Directors*
Bruce Walker (Managing)
Grant Bassingthwaighte
Jeremy Soboil
John Simonson (UK)
Tania Swanepoel

*Offices worldwide*

A member of the Environmental Resources Management Group

Please RSVP to Tougheeda Aspeling of ERM on tougheeda.aspeling@erm.com or Tel: 021 6815400 if you will be attending.

For comments to be included in the Final EMPr to be submitted to PASA they should be sent to Claire Alborough of ERM on or before **24 June 2013**.

Yours sincerely



Claire Alborough
*Project Manager*

Appendix B-3

# I&AP Database

Appendix B-4

# Comments and Responses Report

*Table 1 Comment and Response Report (Initial Notification Period)* (1)

Changes made to the below table subsequent to the release of the draft EMPr are underlined.

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
|---|---|---|---|---|---|---|---|
| 1.1 | Rory Haschick | Email | Eastern Cape Development Corporation | 25/03/2013 | Register | Please register us as an I&AP for the Transkei oil and gas prospecting as sent out by Tougheeda. | Registered as I&AP. |
| 1.2 | | | | 25/03/2013 | Consultation | My only comment at this stage is: there needs to be proper public consultation undertaken. The current BID coming via high level official networks certainly does not constitute PPP. | In terms of consultation, so far we have released the BID to Interested and Affected parties on our database (which covers government, NGO's, fisheries and other relevant stakeholders), as well as advertised in the following newspapers: The Times, The Daily Dispatch, The Herald and Die Burger (Eastern Cape). Further notification and consultation with stakeholders will be undertaken during the draft EMPr comment period.<br><br>Please note that group meetings will be held in Port Elizabeth, East London and Port St Johns during the first week in June. |
| 2 | Sophie Winton | Email | South Africa Heritage Resources Agency | 25/03/2013 | Maritime Heritage | It is noted in the BID that the exploration area extends from the Eastern Cape shoreline to a depth of 4 000m. There are several dozen historical shipwrecks that lie along that stretch of coastline and thus SAHRA would like to register as an I&AP.<br><br>SAHRA recommends that during the development of the Environmental Management Programme, the terms of the National Heritage Resources Act (NHRA, Act 25 of 1999) which refer to the necessity of Heritage Impact Assessments in certain categories of developments, either as a stand-alone assessment or as part of the larger EIA process, should be noted. There are Sections of the Act which refer to the disturbance and removal of | Thank you for your comments and advice. Based on this, Jonathan Sharfman of African Centre for Heritage Activities was appointed to provide us with further information regarding sites/wrecks of importance along the Transkei coast. It is our understanding that he has obtained information from the SAHRA shipwreck database in the compilation of his report. Please see information in *Chapter 3* and the impact assessment in *Chapter 6*.<br><br>The following mitigation measures will be put in place to help reduce possible impacts to historic shipwrecks:<br>• Avoid undertaking any coring/probing activities within areas of the seabed where resources of |

(1) Please note that additional comments/emails received from Ricky Stone and Richard Stephenson after the close of the initial comment period and prior to the start of the Draft EMPr comment period have been included in the table below.

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
|---|---|---|---|---|---|---|---|
| | | | | | | cultural materials and the proposed project should bear this in mind, especially in terms of the proposed drop core sampling.<br><br>SAHRA maintains a shipwreck database and can advise ERM on archaeologically and culturally sensitive areas within the exploration area that should be avoided or treated with care. Furthermore, any information relating the known and unknown wreck sites is greatly appreciated and SAHRA recommends that anomalies detected during geophysical survey be reported to SAHRA so that the coordinates may be cross-checked with our database and a specialist be consulted, in order to help ascertain whether any previously unidentified cultural remains are located in those areas.<br>Should any previously undiscovered cultural material to be discovered during a project, in, SAHRA's maritime archaeologist must be alerted immediately.<br>Should you have any further queries, please contact the designated official using the case number quoted above in the case header. | historic, archaeological and/or cultural interest have been identified (specifically shipwrecks).<br>• Where the activity sequencing allows, analysis of data of the non-interventive surveys should be done by a specialist archaeologist to confirm the presence of any shipwrecks and demarcate areas to be avoided for the piston coring of the seabed.<br>• The neutral observer on board should remain aware of the potential for marine coring/probing activities to disturb and even destroy potentially significant heritage resources. The neutral observer should be present during coring/ probing activities. Should any shipwrecks or sections of shipwrecks be identified in the vicinity of where such activities are being undertaken, SAHRA will be notified. SAHRA will also be notified should any heritage resources show up in removed seabed samples. |
| 3 | Luvuyo Mkontwana | Email | Coega Development Corporation | 25/03/2013 | Registration | I would like to register as an interested and affected party for the OIL AND GAS EXPLORATION ACTIVITIES? | Registered as I&AP. |
| 4 | Deon Kretschmer | Email | Xhora Ski Boat Club | 26/03/2013 | Fish species | I would like to register The Xhora Ski Boat Club as an interested and affected party.<br><br>I have high concerns about the affect this exploration will have on sensitive endemic reef species of the area. *Cymatoceps casutus, Petrus rupestis, Polysteganus undulosus, Chrysoblephus cristiceps, Polysteganus praeorbitalus, Epinephelus marginatus* and *Polyprion americanusto* name but a few.<br>All of these species are under immense pressure and do not need any further disturbance to their environment or directly. Some are found only along the East coast of Africa, within the indicated exploration areas, where their entire life cycle is played out. | Registered as I &AP.<br><br>Impacts to fish are assessed in *Chapter 6*. It should be noted that a specialised Marine Faunal study has been undertaken for the proposed project (see specialist study in *Part C*). |

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
|---|---|---|---|---|---|---|---|
| | | | | | | All of these species are already on the SASSI red list and some are already listed as Moratorium species banning them from any form of capture, trade or disturbance.<br><br>All information on the proposed method of exploration would be a prerequisite to allow our organisations to obtain professional opinion with regards to the proposed exploration. | Please see *Chapter 2* which provides more detail on the methods of Exploration Activities. |
| 5 | Phumeza Gxala | Email | Eastern Cape Economic Development, Environmental Affairs and Tourism | 27/03/2013 | Registration | Registration form submitted | Registered as I&AP. |
| 6 | Paul Martin | Email | Environmental Professional | 29/03/2013 | Marine Fauna | Please register me as an I&AP for the above project.<br><br>I note that you will be assessing the impact of the air gun sounds on marine fauna. My main concern would be the effect of the very loud noises on cetaceans, birds including African Penguin, Cape Gannets and pelagic seabirds and the annual sardine run. What research / impacts are there relating to surveys using air guns from elsewhere in the world? What impacts have been noted from similar surveys here & elsewhere?<br><br>The sound surveys should be timed to avoid the main Humpback Whale routes during migration times (mid-June - early Jan) & the Sardine Run (Easter in Algoa Bay to July off KZN). Where there are concentrations of birds / cetaceans during the surveys monitoring should be done for dead or injured animals behind the air gun array. Dead Cape Gannets in the water in Algoa Bay occurred when seismic surveys were being undertaken in the Algoa Bay area - these may or may not have been related events. | Registered as I&AP.<br><br>Both a Marine Faunal and Fisheries specialist study were undertaken to assess the potential impacts of the proposed activities (including but not limited to the seismic activities) on marine fauna and fish/fisheries. This included a review of current literature/research in South Africa and elsewhere in the world. The timing of the surveys was determined to help avoid sensitive periods for marine fauna, for example during seasonal migration periods and breeding seasons. The specialist impact assessments are summarised in *Chapter 6* of the EMPr report. Please see a summary of mitigation and management measures in the Implementation Plan in Part B. |

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
|---|---|---|---|---|---|---|---|
| 7 | Alice Ford | Email | Interested Party | 02/04/2013 | Registration | I would like to register as an interested & affected party in the exploration for oil & gas from Port Alfred to Port Edward. | Registered as I&AP. |
| 8 | Asanda Sontsele | Email | Eastern Cape Parks and Tourism Agency | 03/04/2013 | Registration | Please register the Eastern Cape Parks and Tourism Agency as an Interested and Affected Party for the above mentioned project. | Registered as I&AP. |
| 9.1 | John Rance | Email | Border Deep Sea Angling Association | 05/04/2013 | Marine Protected Areas and Fishing | Registration and comment sheet attached to email, as well as EWT report and Norweigen fishermans email. The following comments were included:<br>1. See attached documents.<br>2. We (and the public) require the proponents to advise in detail what they have been advised regarding the detrimental effects of seismic surveys on marine life.<br>3. The Marine Protected Areas off the Amatole and Transkei coasts cannot be detrimentally affected by seismic surveys. The proponents are required to advise in detail how these surveys will be carried out without affecting the MPA's.<br>4. Unless detailed scientific research on environmental impacts is provided with the EMPr, a 30-day time period for comment is too little time. Six months would be the minimum time to evaluate this. | Registered as I&AP<br><br>Please see a detailed assessment of potential impacts in *Chapters 5 and 6*. Specialist studies for both marine fauna and fisheries have been undertaken. The full reports can be found in Part C of the draft EMPr. No exploration activities will take place in the declared MPA's. A seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be implemented, within which there will be no firing of airguns.<br><br>We are aware of the recent concerns raised by Norwegian fishermen regarding seismic surveys. A study has been undertaken by Det Norske Veritas ("Effects of seismic surveys on fish, fish catches and sea mammals Report for the Cooperation group - Fishery Industry and Petroleum Industry " Report no.: 2007-0512) which concludes that seismic activities on the Norwegian continental shelf have little effect on fish. Studies show there is negligible direct physical damage, but that there may be a behavioural change in the vicinity of the seismic source. Seismic surveys will have an impact on fish behaviour, but the reported magnitude of an area covered by this impact is variable. Please see a summary of this report here: http://www.offshore- |

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| | | | | | | | mag.com/articles/print/volume-68/issue-8/geology-geophysics/seismic-has-little-effect-on-fish-says-dnv-study.html. |
| 9.2 | | | | 12/04/2013 | Registration | Further to this, a Mr Ricky Stone will be registering to act for a number of I&AP's and he also represents the interests of Border Deepsea Angling Association and Kei Mouth Skiboat Club in this matter. Therefore please list him as a contact person together with my name in the registration above. | Ricky Stone has also registered as an I&AP. See below *Ref 25*. |
| 10 | Greg Shaw | Email | Interested Party | 05/04/2013 | Registration | I would like to register as an I&AP for the oil and gas exploration activities in and around the eastern Cape and east coast of South Africa. | Registered as I&AP. |
| 11 | Mike Denison | Email | African Heartland Journeys | 08/04/2013 | Registration | Please register me as an I&AP for the Gas and Petroleum scoping process. | Registered as I&AP. |
| 12 | Angela Tuson | Email | Interested Party | 09/04/2013 | Registration | I'm an interested party. | Registered as I&AP. |
| 13 | Bruce Jones | Email | South African Deep Sea Angling Association - Environment Officer | 09/04/2013 | Fish/Fishing | Please register the South African Deep Sea Angling Association as well as myself personally as Interested and Affected parties in the Impact Africa application to carry out a seismic survey in the Eastern Cape area.<br><br>COMMENTS<br>Despite specialist studies indicating that these seismic surveys of the ocean floor having a minimal impact on sea life, there is a report from Norwegian fishermen that contradicts this. They claim that serious damage was done to their fishery and that large numbers of fish were killed. | Registered as I&AP.<br><br>We are aware of the recent concerns raised by Norwegian fishermen regarding seismic surveys. A study has been undertaken by Det Norske Veritas ("Effects of seismic surveys on fish, fish catches and sea mammals Report for the Cooperation group - Fishery Industry and Petroleum Industry " Report no.: 2007-0512) which concludes that seismic activities on the |

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| | | | | | | I am investigating these reports and reserve the right to submit further comments once I have received clarity from the Norwegian authorities.<br><br>Kindly acknowledge receipt of this email. | Norwegian continental shelf have little effect on fish. Studies show there is negligible direct physical damage, but that there may be a behavioural change in the vicinity of the seismic source. Seismic surveys will have an impact on fish behaviour, but the reported magnitude of an area covered by this impact is variable. Please see a summary of this report here: http://www.offshore-mag.com/articles/print/volume-68/issue-8/geology-geophysics/seismic-has-little-effect-on-fish-says-dnv-study.html. |
| 14 | Mafumbu Luyanda/ Pamela Ngabase | Email | Amathole District Municipality | 09/04/2013 | Registration | Completed registration form submitted | Mafumbu Luyanda registered as an Interested and Affected Party. |
| 15 | Gerhard du Plessis | Email | THM Engineers E L cc | | Registration | Not sure if you are the correct person, but could you please register us as an I&AP. | Registered as I&AP. |
| 16 | Mel Patrick | Email | Resident | 11/04/2013 | Registration | I am a permanent resident at Chintsa Bay and will be pleased if you can register me as an I&AP regarding the above proposal. | Registered as I&AP. |
| 17 | Mike Denison | Email | WESSA Border Kei Region Marine and Coastal Projects | 11/04/2013 | Registration | Please register the Wildlife and Environment Society of SA (WESSA) Border Kei Region as an Interested and Affected Party. | Registered as I&AP. |
| 18 | Jimmy Calder | Email | Ex-chairman WESSA Border Kei | 11/04/2013 | Registration | Can you please include me as an I&AP in respect of the Seismic Survey Oil & Gas Reserve off East Coast. Any background information would be appreciated. | Registered as I&AP and Background Information Document sent. |
| 19 | Dr Ané Oosthuizen | Email | SANParks - National Marine Coordinator, Park Planning and Development | 11/04/2013 | Marine life | Please register SANParks as an I&AP for the above project. We have a proposed Marine Protected Area within Algoa Bay, and currently manage the two largest breeding colonies of the red listed seabirds, of penguins and Cape Gannets, on the islands in the Bay. | Registered as I&AP.<br><br>It should be noted that the proposed exploration area does not overlap with the proposed MPA in Algoa Bay. Furthermore, no exploration activities will take place within the declared MPA's. A seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be |

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| | | | | | | | implemented, within which there will be no firing of airguns.<br><br>Please note that comment has also been received from Tertius Carinus of SANParks – please see Ref. 24. |
| 20 | Claire & George Kockott | Email | Driftwood Studios Self Catering Cottages | 11/04/2013 | Marine life | Please register my husband and myself as Interested & Affected parties. We are residents and business owners concerned at the effect on marine life of the seismic surveying, let alone the effects on us all if exploration should go ahead. | Registered as I&AP.<br><br>Please see *Chapter 6* for the assessment of potential impacts on marine life. |
| 21 | Rick Tudhope | Email | Interested Party | 11/04/2013 | Registration | Please register me as an Interested and Affected Party in this assessment. | Registered as I&AP. |
| 22 | Dr Trudy Thomas | Email | Interested Party | 12/04/2013 | Registration | Thank you for providing this information and the opportunity to comment. The very short "comment period"-2 days – makes it impossible for me to comment usefully, except to say leave the ocean alone- but I would be very glad if I could be registered as an affected and interested person. | Registered as I&AP.<br><br>Please see *Chapter 4* for a summary of the public consultation undertaken to date. It should be noted that the initial public consultation period was 21 days (22 March 2013 to 12 April 2013). The draft EMPr has also been released for a 30 day public comment period (24 May – 24 June). |
| 23 | Caroline Kruger | Email | Marketing Practitioner | 12/04/2013 | Registration | I would like to register as an interested and affected party with regard to the Proposed Oil and Gas Exploration Activities in the Transkei Algoa Exploration Area, off the Eastern Cape Coast of South Africa. | Registered as I&AP. |
| 24 | Tertius Carinus | Email | SANParks - Conservation Planner | 12/04/2013 | | Here are some comments on the proposed Oil and Gas Exploration activities and can you please register me (SANParks) as an I&aP.<br><br>The seismic equipment is an array of airguns that is towed behind the vessel and could typically produce sound levels in the region of 250 dB re 1 mPA@ 1M. Could you request that: (a) some 10 - 15 minutes prior to starting their survey run that the airgun array is turned | Registered as I&AP.<br><br>No exploration activities will take place in the declared MPA's A seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be implemented, within which there will be no firing of airguns. |

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| | | | | | | on at a relatively low intensity to warn pelagic fish and marine mammals that seismic activity will be occurring in the area and hopefully give them time to take evasive action, and (b) no waste is discharged at sea while the ship is operating off the Agulhas National Park and other protected areas.<br><br>Although most of the seismic work will be done at water depths of approximately 5m – 25m, it should be borne in mind that the Southern Rights whales frequent the inshore waters of the Agulhas & Southern Cape in late winter early spring (August – September), when the females calve in sheltered, sandy-bottom bays. The calves are suckled for about three months before the whales move off towards the Antarctic. Therefore any 'inshore' seismic work should preferably be done during the first seven months of the year (January and July).<br><br>The map shows the interest area including all the MPAs along the Transkei coast. Please, firstly no exploration must occurs within these protected areas and a 2 km buffer zone around these reserves and along the entire coast. Secondly can you temporarily stop the seismic surveys in May, June, July and August during the annual migration of sardines along this coast to KZN (May – July), when vast numbers of sardines, large predatory fish and sharks and dolphins move through the region, while the Redlisted white steenbras move into the nearshore region off the Transkei to breed between June and August. | It should be noted that the exploration activities, and seismic acquisition in particular will be undertaken in water depths up to 4000 m.<br><br>It is acknowledged that Southern Right whales will occur within and traverse through the proposed exploration areas, please note however that the Transkei and Algoa Exploration Areas are offshore of the Eastern Cape Coast and not the Southern Cape.<br><br>A seismic buffer zone of 10 km from the coast, and, as suggested a 2km around the MPAs will be implemented, within which there will be no firing of airguns. No exploration activities will occur within the MPAs (i.e. Amathole, Dwesa-Cwebe, Hluleka and Pondoland MPAs).<br><br>The timing of the surveys was determined to help avoid sensitive periods for marine fauna, for example during seasonal migration periods and breeding seasons. The specialist impact assessments are summarised in *Chapter 6* of the EMPr report. Please see a summary of mitigation and management measures in the Implementation Plan in Part B.<br><br>Please note that comment has also been received from Ane Oosthuizen of SANParks – please see Ref. 19. |
| 25.1 | Ricky Stone | Email | BLC Attorneys | 12/04/2013 | | I trust that my email finds you well.<br><br>I refer to the abovementioned proposal and attach hereto as follows: - | Ricky Stone registered as I&AP. Further contact details requested for the additional stakeholders but not received. A list of the stakeholders reportedly represented by Mr Stone can be found attached to the |

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| | | | | | | 1. BLC Attorneys covering letter;<br>2. Stakeholder Comment Sheet;<br>3. Annexure "A" thereto: List of I & AP's represented by BLC Attorneys;<br>4. Annexure "B" thereto: Motivation and Comments;<br>5. Annexure "C" thereto: Endangered Wildlife Trust Report;<br>6. Annexure "D" thereto: Daily Dispatch Newspaper article;<br>7. Annexure "E" thereto: Email from Bjornar Nicolaisen dated 26/02/2013;<br>8. Annexure "F" thereto: Consequences of seismic surveys (a Norwegian experience).<br><br>Kindly acknowledge receipt of this email.<br><br>I look forward to hearing from you in due course. | stakeholder database in *Appendix B3*. |
| 25.2 | | | | 18/04/2013 | Registration | I trust that you are well.<br><br>Thank you for your email below acknowledging receipt.<br><br>Kindly note that the purpose of representing the 77 clients is that all correspondence is directed to myself and disseminated accordingly.<br><br>Thus, should you require a postal address, email address and telephone number for these parties, then it should be as follows: -<br>☐ Tel– (041) 506 3760<br>☐ Email– rstone@blclaw.co.za<br>☐ Post– 4 Cape Road, Central, Port Elizabeth, 6001.<br><br>Finally, I neglected to include one further I&AP on my 'database' but whom had requested inclusion before the closing date. In this regard please see the email annexed. I would be most grateful if you could add the Rainbow Valley Home Owners Association to the I&AP database. | This is noted and the additional organisation has been included on the list appended to the database. |

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| | | | | | | You will note that they represent some 28 home owners.<br><br>As an aside, it worth mentioning that the opposition to this proposed seismic survey is significant from an Eastern Cape point of view. With the Chinese and Japanese trawlers already 'cleaning-up' our oceans and Marine Protected Reserves, a threat of this magnitude is most disconcerting. As a young (27) environmental attorney I am deeply concerned.<br><br>I look forward to receiving the EMPr in due course.<br><br>Have a lovely day Claire and thank you for your understanding. | |
| 25.3 | Ricky Stone | Email | BLC Attorneys | 12/04/2013 | MPAs | To what extent do the activities impinge of the sanctity of the Amathole off-shore MPA's along the Border coastline and the Dwesa/Cwebe, Hluleka and Pondoland MPA's along the Transkei coastline? | No exploration activities will take place in the declared MPA's. A seismic buffer zone of 10 km from the coast, and 2km around the MPAs will be implemented, within which there will be no firing of airguns. |
| | | | | | Noise | What are the effects of the low frequency infrasound generated by the sound gun?<br>Does this low frequency sound affect a fishes swim bladder? | Impacts relating to the effects of sound on marine fauna are assessed in *Chapter 6*. |
| | | | | | Advertising | What advertisements of this proposal have been placed i.e. in which newspapers? | Adverts were placed on Friday, 22 March 2013 in the Times, Die Burger (Eastern Cape), The Herald and the Daily Dispatch informing the broader public about the proposed exploration activities. Copies of the adverts are provided in *Appendix B-1*. |
| | | | | | Environmental Authorisation | Does Impact Africa have an Environmental Authorisation (EA) to conduct this proposal because a 'reconnaissance permit' is a listed activity under NEMA? | There appear to be two issues here which require clarification, the first relating to the nature of the proposed activities and the second relating to the application of the listing notices which trigger the need for an environmental authorisation. We deal with each issue in turn. |

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| | | | | | | | Firstly, the activities that Impact Africa proposes to undertake require an "exploration right" rather than a "reconnaissance permit".<br><br>Secondly, the regulations governing the environmental authorisation process are promulgated in terms of NEMA. In this regard, GNR 544 and GNR 545 of 18 June 2010 list activities requiring environmental authorisation from the Department of Environmental Affairs (or provincial departments).<br><br>Activity 21 of GNR 545 lists "any activity which requires an exploration right or renewal thereof as contemplated in sections 79 and 81 respectively of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)" as requiring an environmental authorisation.<br><br>However, in terms of Section 14(2) of the National Environmental Management Amendment Act No. 62 of 2008, the provisions of NEMA and the listed activities made under NEMA relating to prospecting, mining, exploration and production will only commence 18 months after the commencement of the Mineral and Petroleum Resources Development Amendment Act, 2008.<br><br>The MPRD Amendment Act came into force on 7 June 2013 and as such the activity listed in GNR 545 regarding the requirement for an exploration right (or renewal) will commence on 7 December 2014. As the activity has not as yet commenced, the proposed exploration activities, including the environmental aspects, are currently regulated solely by the MPRDA.<br><br>Notwithstanding the above, should any additional exploration or production activities be undertaken after the initial period, Impact Africa would be required to apply for a renewal of the exploration right or a production right in terms of the MPRDA and may, |

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| | | | | | | | depending on the nature of the proposed activities, also be required to apply for environmental authorisation in terms of NEMA and the Environmental Impact Assessment (EIA) Regulations.<br><br><u>Note that the above changes are as a result of the MPRD Amendment Act coming into force on 7 June 2013, subsequent to the release of the draft EMPr for comment.</u> |
| | | | | | | The requirement of an EA is furthermore necessary, and confirmed to be a requirement, on account of the recent (April 2012) Constitutional Court Judgment (Maccsands v City of Cape Town) regarding mining and the related interplay with other relevant law; | As far as we are aware the application, in *Maccsand (Pty) Ltd v City of Cape Town* ("*Maccsand*"), for a declaratory order that "no person may commence or continue with a mining activity listed in terms of section 24 of NEMA without an environmental authorisation" was unsuccessful.<br><br>We understand that the Supreme Court of Appeal refused the declaratory order on the basis that it was "hypothetical in nature and the Constitutional Court declined to grant leave to cross-appeal against the Supreme Court of Appeal's decision on the basis that the cross-appeal had "no prospect of success" because (as explained above) the mining related activities in the EIA listing notices have not commenced and therefore do not find application (as explained above). At paragraph 53 of the judgment, the Court held:<br><br>"*The declaratory order sought is based on an assumption that mining is listed in an operational notice as an activity which may not commence without an environmental authorisation. This assumption is wrong.*" |
| | | | | | NEMA | Has the National Environmental Management Act (NEMA) been complied with in all respects? | This EMPr is compiled according to the principles of Integrated Environmental Management (IEM). These IEM principles are listed in terms of Section 2 of NEMA. They apply to all organs of State and alongside other considerations (including socio- |

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| | | | | | | | economic considerations) and guide the administration and interpretation of environmental management legislation in South Africa. Relevant NEMA principles include the following:<br><br>• Development must be socially, environmentally and economically sustainable.<br><br>• Promotion of environmental justice and equitable access to environmental resources.<br><br>• Avoidance, minimisation and remediation of ecosystem disturbance and biodiversity loss.<br><br>• Waste must be avoided or reduced, reused and recycled.<br><br>• Participation of interested and affected parties must be promoted and their views must be taken into account.<br><br>• Specific attention must be given to sensitive, vulnerable and highly dynamic ecosystems.<br><br>• Lifecycle responsibility must be ensured. |
| | | | | | ICMA | The 'seabed' is deemed to be 'public coastal property' in terms of the Integrated Coastal Management Act and for this reason alone should be protected for the public and used ONLY for the benefit of the public. As such, how will this survey benefit the public? | Although there are potential impacts associated with the proposed exploration activities (as assessed in *Chapters 5* and *6* of the EMPr), the exploration for oil and gas could have substantial potential benefits (social and economic) for South Africa should commercially viable oil or gas discoveries be made. |
| | | | | | Impact Africa | Are all the members of Impact Africa citizens of the Republic of South African?<br>It is arguable that the Mineral and Petrolueum Resources Development Act only allows permits to be awarded to South Africans; | We understand that local and international companies and persons may hold rights and permits under the MPRDA and we are aware of many international companies which hold such rights and permits.<br><br>Petroleum exploration and production is a highly |

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| | | | | | | | specialised and capital intensive field. Consequently, there are few South African companies with the technical expertise and financial resources to explore for petroleum. |
| | | | | | Sustainable development | Would you consider seismic surveys to be a sustainable developmental practice? If so, in what way? | Sustainable development is a complex issue which involves social, economic and environmental considerations. The main purpose of this EMPr is to assess the environmental impacts of the proposed exploration activities (including seismic surveys) and verify that mitigation measures are put in place to help minimise potential impacts. |
| | | | | | Noise | What are the effects of surveys conducted in cold water versus warm water? | As described in *Chapter 6* the transmission and attenuation of seismic sound is important to the assessment of impacts associated with this activity. The velocity of seismic sound in the ocean can vary as a result of changes in salinity, temperature, and gas and sediment content. The signal character of seismic shots also changes considerably with propagation effects. Reflective boundaries include the sea surface, the sea floor and boundaries between water masses of different temperatures or salinities, with each of these preferentially scattering or absorbing different frequencies of the source signal. The speed of sound in water increases with increasing temperature, salinity and pressure. |
| | | | | | Noise | How do salinity concentrations and changing salinity affect the survey operation? | See response above. |
| | | | | | Ocean Currents | Do the ever changing ocean currents and their differing velocity impact on such a survey? | Ocean currents can indeed impact surveys and cause delays and problems with equipment, however the vessels used for these surveys are equipped to deal with harsh and changing conditions and as such these issues are usually manageable. |
| | | | | | Fish | How will this survey impact the Eastern Capes "resident" reef species? Has this effect been studied? | Both a Marine Faunal and Fisheries specialist study were undertaken to assess the potential impacts of the proposed activities (including but not limited to the seismic activities) on marine fauna and fish/fisheries. This included a review of current literature/research in |

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| | | | | | | | South Africa and elsewhere in the world. The timing of the surveys will as far as possible avoid sensitive periods for marine fauna, for example during seasonal migration periods and breeding seasons. The specialist impact assessments are summarised in *Chapter 6* of the EMPr report. Please see a summary of mitigation and management measures in the Implementation Plan in Part B. |
| | | | | | Research | What experiments have Impact Africa performed?<br>When were they performed?<br>Where were they performed?<br>What are the actual results of these experiments? | Only desk-based work has been permitted under the Technical Cooperation Permit for the Transkei and Algoa Exploration Areas held by Impact Africa from 4/09/2012 to 3/09/2013. No exploration activities have been conducted by Impact Africa within the Transkei and Algoa Exploration Areas.<br><br>It should be noted that although not part of this project Impact Africa do have an Exploration Right for the Tugela South Exploration Area and have conducted seismic surveys in this area. |
| | | | | | Research | Have any such experiments been conducted locally, in our conditions, to determine what the effects are of these explosions? | As far as we are aware there have been limited/no 'experiments' in seismic noise undertaken in South Africa specifically. However a literature review of current international research was undertaken by the marine faunal specialist to understand the potential impacts of the exploration activities on marine fauna. The specialist study can be seen in Part C of the report. It should also be noted that extensive seismic survey activity has been undertaken along the entire South African coastline in the past (1970's and 80's). |
| | | | | | Pollution | How will Impact Africa prevent direct or indirect contamination (of the reserve, beach, rock shelf, shoreline and ocean) as effectively as possible? | Mitigation measures are included in *Chapter 6* and the Implementation Plan which deal with potential air and water pollution by the exploration vessels. This includes compliance with MARPOL 73/78. |
| 25.4 | Ricky Stone | Email | BLC Attorneys | 18/04/2013 | Mandate | Kindly find annexed email from the Wild Coast Jikeleza Association authorising my involvement on their behalf. You will note from the email that they represent some 52 organisations/restaurants/businesses etc. It is these | The comment is in response to ERM's request to Mr Stone for proof of his mandate/power of attorney to act on behalf of the list of stakeholders identified. |

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| | | | | | | organisations (and others), and certain of their members/directors, which form part of the 77 I&AP's in my initial letter. Most of these organisations telephoned me or sent me an email requesting that I protect their interests by keeping them involved as far as this proposal is concerned.<br><br>The members of the above organisations didn't want to be referred to merely through the listing of Wild Coast Jikeleza Association as a single I&AP, when in fact each member is concerned and for this reason they must be listed separately.<br><br>Resolutions and Powers of Attorney from each and every I&AP will necessarily form part of the papers filed in any proposed Court action down the line. This in line with the principles of agency.<br><br>At this stage I merely play the role of facilitating a group of I&AP's and do so for organisational reasons. You may appreciate that I am assisting these I&AP's on a pro bono (no fee) basis due to my commitment to environmental law and sustainable development.<br><br>Kindly confirm the date the EMPr is to be made available? This document will then be circulated to each I&AP on my database and all comments collated for submission to yourself. | Note that this correspondence and the email from Mr Stone occurred after the close of the initial comment period (22 March – 12 April). |
| 26 | Stephanie Plon | Email | Nelson Mandela Metropolitan University | 14/04/2013 | Marine Fauna | My apologies for the late response to below e-mail- I was away from the office with limited e-mail access. Unfortunately I do not have a scanner at hand, so have to send comments and contact details here.<br>Please register me as an I &AP for this project.<br><br>My comments:<br>Besides the obvious implications of noise produced by the airguns and its potential effects on marine mammals and fish (potentially also seabirds), I would also like to caution that no seismic exploration should be conducted | Registered as I&AP.<br><br>Both a Marine Faunal and Fisheries specialist study were undertaken to assess the potential impacts of the proposed activities (including but not limited to the seismic activities) on marine fauna and fish/fisheries. This included a review of current literature/research in |

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| | | | | | | during the annual Sardine Run, which usually occurs between May and July every year. Given the potential impacts on a number of marine vertebrates I would like to see specialist studies being commissioned on these taxa and the potential impacts the seismic explorations may have. | South Africa and elsewhere in the world. The timing of the surveys will as far as possible avoid sensitive periods for marine fauna, for example during seasonal migration periods and breeding seasons. The specialist impact assessments are summarised in *Chapter 6* of the EMPr report. Please see a summary of mitigation and management measures in the Implementation Plan in Part B. |
| 27 | Marius van Jaarsveldt | Email | LEGACY POWER SYSTEMS | 15/04/2013 | Registration | I would like to register the Eastern Province Deep Sea Association as an interested party.<br><br>Comment: The Eastern Province Deep Sea Angling Association is concerned about the impact of the seismic exploration on the fish life and fishing. | Registered as I&AP.<br><br>Please see the impact assessment in *Chapter 5* and *6* and the specialist fisheries study in Part C. |
| 28 | Mieke Porter | Email | Interested Party | 16/04/2013 | Registration | Please register me as an Interested and Affected Party in this assessment. | Registered as I&AP. |
| 29 | Alan Shaw | Email | Landowner | 18/04/2013 | Registration | As a resident of East London and an owner of property at Kleinemonde/Seafield and Port Elizabeth, I would like to be registered as an Interested and Affected Party. | Registered as I&AP. |
| 30.1 | Richard Stephenson | Email | Royal Representative to Pondoland and Xhosaland | 22/04/2013 | Registration | Thank you for your prompt response. I am mandated and acting on behalf of the following communities;<br><br>1. Eastern Pondoland. I am on mandate with The Royal family whom are currently discussing succession due to the passing of King Justice Mpondombini Sigcau a few weeks ago. Once the new King or Queen is elected a Trust will be registered to protect all the natural assets on behalf of all the people of their Kingdom.<br>2. Western Pondoland. I am the managing Trustee for the Western Pondoland Trust on behalf of King Ndamase Mangaliso Ndamase and all the people of his Kingdom.<br>3. Xhosaland. I have a power of attorney from King Zwelonke Sigcau (whilst the Xhosaland Trust is being registered) to represent his Kingdom relating to matters affecting the Kingdom on behalf of the King and all the | Registered as I&AP.<br><br>Requested proof of mandate/power of attorney to act on behalf of those referenced, as well as contact details for King Dalindyebo of the Tembus.<br><br>Confirmed that we would be in touch regarding potential future consultation activities. |

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| | | | | | | people of his Kingdom.<br><br>The coastline and seabed adjacent to their Kingdoms stretches for approx. 250km from Kei River up to the Umtamvuna River. Please note that at this stage I do not speak for King Dalindyebo of the Tembus, which is the Kingdom between Western Pondoland and Xhosaland.<br><br>It is therefore in this capacity and behalf of these affected Kingdoms that I hereby register as a Interested and Affected Party and request that you keep us fully informed and updated with any and all progress relating to this proposed project. | |
| 30.2 | Richard Stephenson | Email | Royal Representative | 06/05/2013 | Mandate | Further to the previous email herewith the Power of Attorney from King Zwelibanzi Dalindyebo, King of the AbaThembu People.<br><br>My mandate is then recorded as follows;<br><br>1. Verbal mandate from Senior Royal Daughter, Princess Wezizwe Sigcau. The mandate is verbal due to the recent passing of her father, King Justice Mpondombini Sigcau, and the family is now in official mourning period. Written mandate will be obtained after that.<br>2. I am the Managing Trustee for Western Pondoland Trust on behalf of King Ndamase Mangaliso Ndamase and the Trustees passed a Resolution further mandating me to investigate this matter further on behalf of the Kingdom.<br>3. I have Power of Attorney from King Zwelibanzi Dalindyebo, from AbaThembu Kingdom.<br>4. I have Power of Attorney from King Zwelonke Sigcau from AmaXhosa Kingdom.<br><br>These four Kingdoms are recognised by the South African Government and cover the whole Wild Coast from The Umtamvuna River in the north east to The | Receipt of email acknowledged. |

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| | | | | | | Great Kei River in the south west. | |
| 31 | Stewart Wernberg and Richard Stephenson | Email | Western Pondoland Trust | 03/05/2013 (Letter dated 29/04/2013) | Mandate | Please be advised that in accordance with Trustee, Mr Richard Stephenson's mandate from Eastern and Western Pondoland and Xhosaland, we wish to make representations in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) ("the Act") and the Mineral and Petroleum Resources Development Regulations ("the Regulations") regarding Impact Africa Limited's application for an exploration right.<br>Whilst we are cognizant of the provisions of section 3 of the Regulations as read with sections 10 and 69(2)(a) of the Act regarding consultation with interested parties, we draw your attention to the following aspects of the Act, namely:<br>1. The preamble which, inter alia, affirms<br>1.1 the State's obligation to protect the environment for the benefit of present and future generations;<br>1.2 the need to promote local and rural development and the social upliftment of communities affected by mining;<br>1.3 the State's commitment to reform and to bring about equitable access to South Africa's mineral and petroleum resources and to eradicate all forms of discriminatory practices in the mineral and petroleum industries and concomitant obligation under the constitution to take legislative and other measures to redress the results of past racial discrimination.<br>2. Paragraphs (c), (d) and (h) of section 2 of the Act,<br>3. Subsection (2) of section 104 of the Act.<br>We further draw your kind attention to the fact that the people of the various kingdoms in question are in effect historically disadvantaged persons (including women) and are entitled to substantial and meaningful expansion of opportunities to enter into and actively participate in the mineral and petroleum industries. Further they are interested parties in the sense that it is principally theses people who will be affected by the proposed exploration and, in due course, by any | Receipt of this email was acknowledged and further correspondence entered into with Richard Stephenson regarding additional consultation to be undertaken. A focussed group meeting was held with Richard Stephenson and 2 of the 4 Kings that he represents on 6 June 2013. Through Richard the Kings have indicated their support of project, along with a request for future engagement in this regard. |

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| | | | | | | production which may result therefrom.<br>Against this background it is our view that the mere notification process referred to in the Act and Regulations to which we have made reference above are wholly insufficient to achieve the overall objectives referred to. Moreover, we are dealing with people of a rural background whose circumstances may deny them access to technological information of the level referred to in your website at http://www.erm.com/PageFiles/11332/Impact%20Africa_Transkei%20Algoa%20BID20Final.pdf.<br>It is our view that given the enormity of the proposed exploration and the potential consequences of any subsequent exploration that might follow, it would be prudent for the applicant to arrange consultations with the kings in their respective kingdoms and in their capacity as the representatives of their people to be able to properly explain these implications and to answer questions arising. Some of the issues that we envision that would arise are pertinently listed on your website, including matters such as:<br>"Noise effects on marine fauna from multi-beam bathymetry survey, seabed sampling programme and seismic survey; Effects of activities on the fishing industry, including effects on fish behaviour, fish catches and cessation or displacement of fishing activities, as a result of noise effects and presence of survey vessels; Impact on tourism and recreation as a result of noise effects and presence of survey vessels; Interference with marine recreational facilities and transport routes; and Waste discharge to sea and emissions to the atmosphere.<br>You'll readily appreciate that matters such as a 'multi-beam bathymetry survey' are highly technical. Further, the people would doubtless want to be assured that exploration and eventual production is not going to result in a disaster or oil spillage which could be of the most drastic consequences. The people, through their representatives, are entitled to be privy to matters such | |

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| | | | | | | as these and to fully understand the correlation between them and any potential knock-on effects that may damage or limit their incomes from fishing, tourism and the like.<br>In view of the substantial cost of such exploration it would doubtless be in everyone's interests that the eventual exploration permit, if granted, not be the subject of challenges from communities which feel that there has been insufficient consultation, both with respect to the technical aspects referred to previously, and also apropos their right to discuss the manner, if any, in which they might stand to benefit economically or otherwise from the proposed activities.<br>We enclose herewith copies of the mandates given by their highnesses King Zwelonke Sigcau in his capacity as King of Xhosaland and King Ndamase Mangaliso Ndamase and his Inkosis for your kind attention.<br>With regard your request for the contact information for King Dalindyebo, we confirm that Mr Stephenson is currently in a meeting with the King and we anticipate that we will shortly be able to add a mandate from King Dalindyebo which we will forward to you directly it is to hand. | |

*Table 2 Comment and Response Report (Draft EMPr Comment Period)*

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
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| 32 | Provincial Environmental Authority Meeting | Meeting | Representatives from Eastern Cape Parks and Tourism and the Eastern Cape Department of Economic Development, | 04/06/2013 | | A concern was raised regarding the potential impact of the activities (specifically the coring) on cold water corals which can be located in deeper waters and potentially relatively far offshore. In particular there are reports of corals off of the Amatole Marine Protected Area. It was suggested that perhaps Kerry Sink of South African National Biodiversity Institute (SANBI) would be able to provide some more information on this aspect. | It was indicated by the applicant that it was their intention to reduce the likelihood of coring over any cold water coral species. If possible the non-intrusive surveys would be done first and the results used to inform the locations of the coring activities. Further information will be requested from Kerry Sink if available. |

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
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| | | | Environmental Affairs and Tourism | | | Participants questioned the likely the timing of the activities. | As per the recommendations in the EMPr the seismic and bathymetric activities would be scheduled to occur outside of key whale breeding and migration times as well as the Sardine Run. This is likely to be between January and May. The other activities may happen at any time of year, but are more likely to occur during the summer when the weather is more conducive. |
| | | | | | | Participants questioned the nature of night-time activities. | It was responded that seismic activities continue overnight, with Passive Acoustic Monitoring (PAM) used instead of Marine Mammal Observers (MMOs) prior to soft starts in order to identify if there are cetaceans in the vicinity. The most sensitive period is at the start-up of the seismic as most animals move away from the noise source. |
| | | | | | | Participants questioned whether the animals actually move away? | Yes it has been shown that they generally do move away from the noise source. The Marine Faunal Study provides some more description and further information. |
| | | | | | | Participants questioned whether the Bathymetric information gathered be available for scientific purposes? | The information is all provided to PASA and although uncertain it was indicated that the information was usually available within 2/3years, however this would have to be confirmed. |
| | | | | | | Participants questioned the width (on the seabed) of the bathymetry data collected? | It was responded that it is twice the water depth. |
| | | | | | | Participants questioned what the distance of impact from the seismic airgun? Particularly in relation to buffers around the Marine Protected Areas (MPAs). | It was responded that this depends largely on the propagation of the sound which differs in different water depths, temperatures and salinity. The zone in which physical damage could potentially occur is generally immediately around the firing airguns. The 500 m zone around the vessel which is monitored for cetaceans by the MMO and PAM is the most sensitive area, however the sound would likely be heard by animals in the water relatively far away. There is currently no buffer proposed around the MPAs however this aspect is still being looked into further by the project teams. SANParks requested a 2km buffer around the MPAs and this is being considered. |

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
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| | | | | | | | Please note: Subsequent to this meeting it has been decided to implement a 2km seismic buffer around the MPAs. |
| | | | | | | A query was raised regarding what happens if production does occur? Particularly in terms of long-term planning and development onshore. Will Coega be used or will there be development along the Transkei coastline. | Impact Africa indicated that it was too soon to tell what the likely onshore development would look like, but that as far as possible existing facilities would likely be used. This is not only the more sensible option from an environmental standpoint but also an economic standpoint. |
| | | | | | | It was also indicated that as long as the development is done responsibly, it is a positive thing for the economics of the region. | |
| | | | | | | A query was raised regarding whether Impact Africa would undertake production if anything is found? | The potential future operator (subject to government approval) indicated that should they find anything they would most likely wish to produce it. Impact Africa indicated that they are a company specialising in exploration and would likely not be involved in any future production. |
| 33 | Traditional Authority Meeting | Meeting | Richard Stephenson | 06/06/2013 | Consultation | A question was raised regarding the 120 days in which to conclude the preparation and submission of the EMPr is almost over (refer 28 June 2013) yet the consultation with the community at large is not concluded. How will that be dealt with? What will ERM's role in further consultation with the communities be? | It was indicated that ERM did not envisage being a part of further consultation with the communities and expected that if necessary the Monarchs and their Traditional Councils would take the project information to the communities. |
| | | | | | | It was indicated that ERM is best placed to present the technical information to the community. The Monarchs would prefer a member of the project team to be available to attend any further meetings. | |
| | | | | | Benefits | The presentation was acknowledged by the Monarchs but they wanted to know what business potential the project brought to them – in their words – "What is in it for us?" | Impact Africa indicated that the License contains an option for a 10% empowerment stake to be taken up at the cost thereof. For the next 3 – 9 years the project will only be spending money – in the order of 100 to 200 million US dollars. There is no guarantee that the exploration will yield any results. |
| | | | | | | Responded by indicating that perhaps they would be willing to share in the risk of losing money over the next years in the hope that they can gain something at the time of production if anything is found. They requested | Impact Africa indicated that they will take the matter up with their Directors for discussion. |

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
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| | | | | | | Impact Africa to further consider their offer of risk sharing. | |
| | | | | | SOEKOR data | Requested access to the SOEKOR data from the 1960's and 1970's. | Impact Africa explained that the data is not captured in report format but on tapes and requires highly specialised skills and equipment to understand it. No wells were drilled at that point in the Transkei Algoa area. |
| | | | | | Jobs | A query was raised regarding what on-land jobs will be created? | Impact Africa indicated that during the exploration phase the job opportunities will be of a highly skilled and specialised nature. Most of the required people will have to be sourced from overseas since the skills and equipment to conduct the studies with are not available in South Africa. There will be Marine Mammal Observers (MMO) and Fisheries Liaison Officers (FLO) that will have to be sourced possibly from nearby universities. An attempt will always be made to source employees locally before appointing people from elsewhere or overseas. In short – for the first years, the projects will yield almost no local benefits and over time may start holding some limited ancillary benefits. |
| | | | | | | The requirement of specialised resources can act as motivation to children in the area to study some of the fields of specialisation that will be required over time. | |
| | | | | | Employment | It was highlighted that the sea is part of their ancestral heritage and that it is used and appreciated as such by the people in the Transkei. Further, some of the children of the area have qualified in the environmental and engineering fields of study and the Project was requested to consider these students for possible employment in future. | It was indicated that Impact Africa was committed to working with local people but if people are not available locally then others will have to be employed. The exploration industry is still very new in South Africa and people are not used to its requirements yet. It was indicated that they invest in working with "in-country people" during the production phase of a project. At which time local people are appointed to learn from their international counterparts with the ultimate aim of handing over the positions to local staff members. |
| | | | | | | It was reiterated that the Kings and their traditional councils (with Richard Stephenson mandated to communicate on their behalf in this matter) were the | |

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| | | | | | | correct structures to work through as representative of the people. They want to promote the local people and their possible role in the project in the future. | |
| | | | | | | The Monarchs suggested that 5 additional meetings should be held (1 per Monarchy jointly with their Traditional Councils) at which the project purpose and background is presented again. They indicated that they would prefer representatives of the Project Team there to assist with the technical discussion. These meetings will result in the confirmation of support to the project already given by the Kings present. This level of consultation is sufficient and it will not be necessary to host further community level meetings. Richard Stephenson will document the matter and submit it to ERM. There was a request that the presentation should be simplified and shortened for the meetings with the Kings and their Traditional Authorities. | Note email received from Richard Stephenson, dated 18 June 2013 (included in Appendix B-2 which indicates that in principle and based on the presentation made, the traditional leaders present at the meeting would support the EMPr on behalf of the applicant to be submitted to PASA. He went on to indicate that the RMC's support is conditional to on-going consultation and open communication between all the role players in this project in the future. |
| 34 | Ricky Stone | Email | BLC Attorneys | 24/06/2013 | Seismic surveys | Seismic surveys have been conducted in SA since the early 1960's and there now seems to be no-holding-back approach on the part of the oil companies. This so-called flood of seismic activity is noted to stem primarily from the fact that South African legislation in the mining arena is hopelessly inadequate insofar as aligning itself with environmental principles is concerned. In the result, South Africa has been 'targeted' for mass surveys due to the above; | Offshore seismic surveys are regulated by the MPRDA and require the preparation of an EMPr and review and approval by the government prior to execution. The preparation of the EMPr includes an assessment of impacts and the development of mitigations and controls to avoid or reduce effects.<br><br>Other countries around the world have similar approval regimes. |
| | | | | | Moratorium on seismic surveys | Certain civilised nations of the world have place a moratorium on all seismic activity – why is this so? | The approach to regulating offshore seismic surveys varies by country and is somewhat dependant on the specific environment. We are aware that some countries have restrictions on seismic surveys. |
| | | | | | Cradle to grave | South African environmental legislation contains 'cradle to the grave' provisions relating to damage/pollution to the environment and in this regard the responsibility for any damage which may occur during or after the survey MUST necessarily be borne by Impact Africa; | As indicated in *Chapter 1* of the report, the financial provision for the proposed exploration work programme is estimated to be USD 10.1 million, which is the estimated cost for management and/or rehabilitation of potential negative impacts that may be incurred during the proposed exploration work |

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| | | | | | | | programme. The determination of the amount of the financial provision is set out in Part C. Discussions are being held with PASA regarding the method to put in place the financial provision. |
| | | | | | Report similarities | Vast similarities are noted in the instant EMPr against other such EMPr's submitted for surveys in the Western Cape and KZN area etc. These similarities relate to content, methodology and comparative studies; | As indicated in the EMPr the report is based on the PASA approved Generic EMPr. As per guidance provided by PASA, the Generic EMPr is used as the basis for describing the environmental conditions and for the best practice mitigations that should be implemented. The same specialists have been used for the fisheries and marine faunal studies, who use the same methodology for assessing impacts. The project activities are also similar in nature and as such it is acknowledged that there would indeed be similarities between the reports for these reasons. |
| | | | | | Error in disclaimer | Strikingly, and of utmost concern, is the fact that the first page of the Executive Summary, which contains the approval of the report by Mr Henry Cramp together with the disclaimer, encloses the following entry "The report has been prepared for submission to the Petroleum Agency of South Africa (PASA) in support of Impact Africa's application for an Exploration Right for the West Bredasdorp Exploration Area." (My emphasis); | This is indeed an error made only on the sign-off page of the report. This error has been corrected. |
| | | | | | | Although this is may be simple typo – the oversight cannot be overlooked as it goes to the heart of the flaws in these Reports and related mining applications. The results are always similar no matter what area they are surveying or what ocean currents they find themselves in; | As per guidance provided by PASA, the Generic EMPr is used as the basis for describing the environmental conditions and for the mitigations that should be implemented. |
| | | | | | Date | Furthermore, the specialist Report concerning Marine Life and Fisheries Impact is dated 9 January 2013. I&AP's submitted comments by 19 April 2013 and thus raised numerous concerns which aren't addressed in the Reports, naturally. In effect then, the EMPr is technically flawed; | It should be noted that both the Fisheries and Marine Faunal Reports are dated April 2013. An error occurred on the Declaration of Independence page of the Fisheries Report only and this has been corrected. |
| | | | | | Commission of Inquiry | Therefore, and in essence, it is requested that PASA pend all applications for exploration rights in South | Responding to this comment is outside the scope of the EMPr and should be directed to PASA. |

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| | | | | | | Africa until such time that the Minister of Mineral Resources has, TOGETHER with the Minister of Environmental Affairs & Tourism and the Minister of Agriculture, Forestry and Fisheries, conducted a Commission of Inquiry (or the like) into the effect of applications of this nature on future South African Resources; | |
| | | | | | Diversity | It is noted that South Africa is the third most biologically diverse country the world over and certainly deserved of the measure referred to at (8.) above; | The comment is noted. |
| | | | | | Science | The public cannot make informed decisions when the 'science' they are overpowered with is misleading from the get-go; | As described in *Chapter 4*, the process that was followed included stakeholder engagement which involved distribution of materials describing the proposed activities as well as face-to-face meetings. This was done in consideration of the PASA's consultation with I&APs guidelines, which provide a framework to assist applicants in undertaking public consultation. |
| | | | | | | Finally, and drawing wisdom from a Native American Proverb, it is "Only when the last tree has died and the last river has been poisoned and the last fish has been caught will we realize that we can't eat money." | The comment is noted. |
| 35 | Claire Kockott | Email | Personal | 24/06/2013 | General | Well put Ricky. Claire. I personally totally support these comments. But it seems that the short term view is winning the day and sadly we will kill our seas in our life times for the greed of a few. | Receipt of email acknowledged. |
| 36 | Stephanie Plon | Email | NNMU | 24/06/2013 | Marine Faunal Assessment | In my opinion the marine impact assessment, particularly the marine fauna aspect, is very poor and disappointing and does not at all reflect our current knowledge of the area and the potential impacts seismic surveys may have. The proposed exploration areas, located between Port Elizabeth in the Eastern Cape Province (33° 54 'S, 23° 36'E) and Ramsgate in the KwaZulu-Natal Province (30°40'S, 30°20'E), belong to the least studied marine areas off the South African coastline, particularly as far as marine fauna is concerned. In this respect it is disappointing that the annual Sardine Run, which is the largest marine | The EMPr was informed by a marine study conducted by a qualified specialist.<br><br>The sardine run is discussed in the report (in the baseline section, impacts to fish and impacts to seabirds); and importantly it should be noted that surveys will be avoided during the sardine run as indicated in the mitigation measures established for the potential impact to seabirds. |

| Ref. | Name | Type | Organisation | Date Received | Category | Comment | Response |
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| | | | | | | migration that we know of and which occurs annually in June/ July in these waters, is not mentioned as a key aspect to be considered in the study. | |
| | | | | | Marine Faunal Assessment | In addition, it is particularly appalling to read the following statement on page VII: 'The potential impacts on cetaceans is deemed to be of low to medium significance (prior to mitigation) and of negligible to low significance after the implementation of mitigation measures such as soft-starts and not initiating shooting until confirmation that there are no cetaceans within 500 m of the seismic vessel', when anthropogenic noise in the oceans is known to be one of the major disturbances to marine life, PARTICULARLY cetaceans, worldwide (Richardson et al., 1995; Koper and Plön 2012 and literature therein)and currently is of major concern to researchers in Europe, North America and Australasia. Considering the absence of any data on the hearing capabilities as well as the paucity of data on reactions towards anthropogenic sounds of Southern Hemisphere species, the utmost caution (and precautionary principle!) should be employed, rather than suggesting that any impact will be low to negligible?! | It is acknowledged that anthropogenic noise is a concern to marine life, however the specialist is of the opinion that sufficient evidence in the literature reviewed suggests that short-term surveys do not significantly affect marine mammals, particularly if appropriate mitigation measures are implemented.<br><br>A precautionary approach has been taken. As stated in Chapter 6, to the extent possible seismic surveys will be planned to avoid key cetacean migration periods. A 10 km coastal seismic survey buffer zone and a 2km seismic buffer zone around the MPAs will be established in which no air-gun firing will occur. The proposed operational approach is to implement internationally accepted mitigation measures (soft starts, exclusion zone around vessel, seismic buffer zone, MMOs, PAM, etc). If these mitigation measures are implemented then it is the specialist's view that the overall significance of impacts can be considered low. Particularly as the sensitive times for migratory species are avoided. |
| | | | | | Marine Faunal Assessment | It is furthermore surprising that the study states on p. 3-34 that' 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 of south and east South Africa'. Obviously the assessors were not familiar with the numerous surveys and data from the region from the1980's and 1990's (Ross 1984; Ross et al., 1987, 1989; Cockcroft and Peddemors 1990; Cockcroft *et al*., 1991, 1990) or more recent literature from the area (O'Donoghue *et al*., 2010a, b, c).<br>The above publications and circumstantial evidence indicate that both the Indo-Pacific humpback dolphin (*Sousa chinensis*) and the Indian Ocean bottlenose | Best 2007 was used and referenced but it is acknowledged that other publications exist.<br><br>Both the Indo-Pacific humpback dolphin and the Indo Pacific bottlenose dolphin are reported in the specialist study as occurring in the area. The following mitigation measure is to be implemented with respect to dolphins specifically (please note that modification to this mitigation measure is underlined):<br>'In the case of small cetaceans (particularly dolphins), which are common in inshore waters and 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 |

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| | | | | | | dolphin (*Tursiops aduncus*) (migratory stock) are present in the area (Best, 2007). These species are currently listed as "vulnerable " and "endangered", respectively, in the South African Red Data Book (Peddemors *et al*., 2004; Peddemors and Oosthuizen 2004). The fact that we know so little about these small cetaceans off the Transkei coastline highlights an important data gap in our knowledge on these animals, particularly since the last studies on small cetaceans carried out in this region date back about 20 years ago. Thus we actually do not have any data outside the Sardine Run period or can assess the potential impact of the planned seismic surveys outside the whale migration (June –DEC). | within 500 m of the airguns, in particular the Indo-Pacific humpback dolphin (*Sousa chinensis*) or the Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus),* listed in the South African Red Data Book as 'vulnerable' and 'endangered' respectively. If after a period of 30 minutes small cetaceans are still within 500 m of the airguns, the normal soft start procedure will be allowed to commence for at least a 20-minute duration. The MMO will monitor small cetacean behaviour during soft starts to determine if the animals display any observed negative responses to the airguns and gear or if there are any signs of injury or mortality as a direct result of seismic shooting operations.'<br><br>Although the limitation of available data is acknowledged, the mitigation measures to be implemented (including a 10km seismic buffer zone along the coast and a 2km seismic buffer zone around MPAs) support the findings of the impact assessment contained within *Chapter 6*. |
| | | | | | Marine Faunal Assessment | In addition, a lot of the oceanographic references are also outdated and more recent literature should have been consulted, such as Lutjeharms 2006 and Roberts et al., 2010. | Comment noted. |
| | | | | | Marine Faunal Assessment | In general, the document is a very poor assessment of the marine fauna in my eyes and I would suggest to contact local experts in the Eastern Cape for their input for any future assessment of this kind. In addition, it would be advisable to maintain close communication with the marine science community at both Nelson Mandela Metropolitan University (NMMU) and Rhodes University as well as the South African Institute for Aquatic Biodiversity (SAIAB) and the South African Environmental Observation Network (SAEON), since a number of research projects are currently being conducted or are planned for the proposed survey area, which may heavily be impacted by the seismic surveys. | Comment noted.<br><br>A mitigation measure has been added to the Implementation Plan regarding specific notification of research organisations regarding the proposed surveys and communication with potential research projects. |

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Impact Africa EMPr Transkei and Algoa
Exploration Areas

# PART B

# Implementation Plan

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# 1 INTRODUCTION

This section provides the plan for the implementation of the requirements and recommendations identified through the impact assessment process. It provides a description of the environmental management organisation (including roles and responsibilities); and monitoring and auditing requirements. It also provides a detailed description of the mitigation measures that the operator will implement to verify protection of environmental resources.

## 1.1 OBJECTIVES

The objectives of this plan are to:

- verify compliance with applicable South African legislation and other requirements;
- demonstrate to regulators and stakeholders that environmental issues have been addressed and that plans are in place to verify protection of environmental resources;
- provide a means for verifying that mitigations are implemented and environmental impacts are managed;
- provide a means for verifying that mitigations are being properly implemented and that they are effective through monitoring, inspection, and auditing; and
- provide a mechanism for identifying and mitigating impacts that may be determined in the future.

# 2 PLAN CONTENTS

### 2.1.1 Commitments

The mitigation measures that were identified in the impact assessment along with the mitigations that are 'built in' to the project design (in the way of technology specifications or operational controls) form the operator's environmental management commitments. The commitments are consolidated and tabulated in this plan and provide:

- comprehensive listing of the actions that the operator will implement according to project phase and activity;
- designation of responsibilities for verifying implementation of that action;
- source of the mitigation measure or standard;
- timing and/or frequency of the action; and
- requirements for the close-out report.

The Implementation Plan also serves as a set of specifications that will define the survey contractors' environmental responsibilities at the tendering stage. Timing and immediate responsibility for implementing each commitment will be agreed between the operator and its contractors. While the operator may require contractors to execute certain actions, the operator will remain ultimately responsible for the implementation.

### 2.1.2 Guidelines and Standards

Environmental issues relevant to aspects of the proposed exploration activities are governed or guided by the following standards:

- Applicable South African legislation;
- Operator's environmental, health and safety policy; and
- Recognised industry codes of practice (e.g. International Association for Geophysical Contractors (IAGC), International Petroleum Industry Environmental Conservation Association (IPIECA) and Joint Nature Conservation Committee (JNCC); and
- International Convention for the Protection of Pollution from Ships MARPOL 73/78.

Specific to seismic surveys, guidelines have been developed by a number of countries and organisations to protect marine mammals and / or turtles during seismic surveys. Guidelines were issued by the UK Joint Nature Conservation Committee (JNCC, 2009), and are used internationally as guidance for seismic surveys. National guidelines have also been developed by Brazil, Canada, and New Zealand (Weir et al, 2006).

All national guidelines require a safety exclusion zone and visual observation to monitor the zone before beginning the survey each time. The exclusion zone is required to be clear for 20–30 minutes before start-up of the sound source. All guidelines specify that a 'soft-start' be used to allow marine mammals and turtles (and other marine animals) to move away from the seismic activities. The soft-start procedure requires that the seismic sound source begins softly and increases over 20 to 40 minutes. In addition, JNCC guidelines recommend that the surveys be scheduled to avoid breeding and calving seasons.

For this project, adherence to the JNCC seismic survey guidelines is specified, with two additions, namely that sea turtles be included in the visual monitoring prior to start-up and that sound source shutdown occurs if a whale or sea turtle enters the 500 m safety zone during seismic acquisition (rather than 300 m).

The operator will also require that the seismic contractor be a member of the IAGC and adhere to the organisation's code of practice.

Guidelines have also been developed by the JNCC for marine sonar operations and will be implemented as mitigation measures for the multi-beam bathymetric survey component of this project.

*MARPOL, 1973*

South Africa acceded to the International Convention for the Protection of Pollution from Ships (MARPOL) and to its 1978 Protocol by means of Resolution No. 5/2003, of 25 February 2003. MARPOL places restraints on the contamination of the sea, land and air by ships. MARPOL comprises two protocols dealing respectively with reports on incidents involving harmful substances and arbitration; and five annexes which contain regulations for the prevention of various forms of pollution:

- Annex I - Prevention of Pollution by oil;
- Annex II - Control of pollution by noxious substances;
- Annex III - Harmful substances carried in packaged form;
- Annex IV - Prevention of pollution by sewage; and
- Annex V - Prevention of pollution by garbage from ships.

The Southern South African waters have been designated a 'special area' in terms of MARPOL. Special areas are afforded higher levels of protection and therefore require additional mandatory methods for the prevention of sea pollution particularly to additional requirements within Annex I: Prevention of Pollution by Oil. All vessel operations will need to adhere to MARPOL requirements including the additional methods for prevention of sea pollution.

### *2.1.3 Management of Change*

The plan commitments will be further refined as activity proceeds and detailed working methods are developed. Revisions to this plan are envisaged as a result of the following:

- introduction of new parameter or methodology that could change the environmental impact or require amendment to existing mitigation measures;
- changing environmental requirements or standards; or
- as a result of audit or incident.

Although modifications to some of the measures specified in this plan are envisaged, there will be one overriding principle: that none of these measures will be omitted or diluted without further assessment and reporting of the impact.

### *2.1.4 Subsidiary Plans*

The operator will develop the following, which will be subsidiary to and form part of the overall Environmental Management System:

- Emergency Response Plan;
- Geophysical Contractor Emergency Response Plan;
- Helicopter Operator Emergency Response Plan;
- Stakeholder Communication Plan; and
- Oil Spill Contingency Plan.

These plans must contain measures designed to manage these specific aspects and include designations of persons responsible for the implementation, timeframes, resources, legal standards and monitoring and auditing requirements to be able to verify compliance. The operator will need to submit these plans to PASA for their approval prior to commencement of activities.

As further planning proceeds and contractors are appointed, additional specific plans and procedures may be required to be developed for the management of issues such as shipboard waste and effluent. The operator will be required to develop these plans with the necessary specialist input, and will submit these to PASA for their approval. The operator will be responsible for implementation of these plans and any additional measures.

### *2.1.5 Monitoring*

This plan makes provision for regular monitoring to achieve the following objectives:

- verify that the specified requirements are implemented;
- assess the effectiveness of the mitigation measures with respect to the predicted impacts;
- provide on-going feedback to authorities and stakeholders; and
- gather environmental performance data for close-out reporting.

# 3 ROLES AND RESPONSIBILITIES

This section defines the roles and responsibilities for the entities involved in the exploration activities. These include following:

- Exploration Area Operator;
- Programme Manager;
- Environmental Control Officer (ECO);
- Fisheries Liaison Officer (FLO);
- Marine Mammal Observer (MMO);
- PAM Operator;
- Contractor; and
- Vessel Master.

## 3.1.1 Exploration Area Operator

The Exploration Area Operator (operator) has the overall responsibility for all Safety, Health and Environmental (SHE) matters. As part of this, the operator will ultimately be responsible for carrying out all exploration activities safely and in accordance with the requirements of the EMPr. The operator will verify that the EMPr requirements and other SHE related requirements are implemented in full, both by operator staff and by contractors.

During the exploration activities, the operator will be responsible for the management of medical and health issues and the provision of appropriate care. The operator will verify there are sufficient plans and resources in place for worker health care and contingency plans to respond to workplace accidents. The plans for this will be documented in Safety, Health and Environment Management Plan (to include an Emergency Response Plan).

A pre-operational start-up induction on SHE requirements will be conducted by the operator with contractors prior to commencement of the activities. As part of their operating and SHE procedures, the operator will undertake regular environmental, social, safety and health inspections and provide reports that enable the operator to monitor and evaluate performance against the measures and objectives established in the EMPr.

Exact details of the planned exploration activities including the details of the seismic survey (including coordinates of seismic lines, schedule and seismic vessel specifications) will be submitted in advance of the operations to PASA for approval.

The operator will be ultimately responsible for all other operations permissions including relevant clearances, permits, licences and necessary

approvals from the relevant authorities prior to commencing the seismic survey.

### *3.1.2 Programme Manager*

The operator will designate a programme manager who will have overall responsibility for the execution of all phases of the of the planned exploration activities. The programme manager will be directly responsible for the appointment and management of contractors and the ECO.

### *3.1.3 Environment Control Officer (ECO)*

The operator will appoint an Environmental Control Officer (ECO) to verify the implementation of the requirements of the EMPr. The ECO will focus on verifying and assessing compliance with the Implementation Plan through monitoring, auditing and reporting (*Section 4*) and verifying that the Fisheries Liaison Officer (FLO) and Marine Mammal Observers (MMOs) carry out their required functions. This will include compilation of reports and submission of these reports to the programme manager and PASA. In particular, the ECO is responsible for the following:

- Verification of the implementation of the measures contained within the EMPr;
- Regular monitoring of progress towards objectives and targets within the EMPr;
- Conducting regular inspections; and
- Compilation of reports for submission to the programme manager and PASA on the status of EMPr implementation.

### *3.1.4 Marine Mammal Observer (MMO)*

Qualified and independent Marine Mammal Observers (MMOs) (also referred to as Independent Observers (IOs)) will be used during the seismic and multibeam seabed bathymetry surveys. The MMOs will carry out observations during daylight hours (during operations) of the survey area and record presence and responses of marine mammals, turtles and seabirds to exploration activities, including distance from the vessel, swimming speed and direction and observed changes in behaviour and displacement or attraction. It is important that the identification and the behaviour of the animals are recorded accurately along with noise levels, if PAM is required.

Furthermore MMOs must:

- Record incidence of feeding behaviour of predators within the hydrophone streamers (mass disorientation and stunning of fish by seismic surveys is unlikely, although if it occurs, may result in attraction of predatory seabirds, sharks and mammals);

- Record all initiation of seismic firing activity and associated soft starts and pre-firing observation regimes; and
- Have experience in both cetacean identification, and observation techniques; in particular, the MMO will have experience in identification and differentiation of both large baleen whale and beaked whale species.

While the MMO will report to the ECO, the MMO will be required to acknowledge and act in accordance with the authority of the Vessel Master while on-board and during operations. The MMO has the authority to stop the survey activities (including seismic shooting) in response to certain circumstances related to marine mammal risk. However, due to the cost associated with terminating activities (e.g. an entire survey line may need to be repeated), it is recommended that the decision to terminate firing be made by the operator in consideration of the MMO's advice. The MMOs must provide full reporting of all termination decisions (including behaviour and distance of marine mammals) in a daily close out report.

### *3.1.5 PAM Operator*

If necessary, the seismic survey vessel will be fitted with PAM technology and efforts are to be made for the multibeam bathymetric vessel to also be fitted with PAM technology. A suitably qualified PAM operator will be appointed to verify that the PAM system functions correctly and results can be interpreted.

The JNCC (2010) guidelines regarding the use of PAM technology, including the determination of range and delays to soft starts, will be implemented. In the absence of visual confirmation, the detection of large cetaceans by the PAM operators, within 500m of the vessel, will require a delay in the start of soft-starts.

While the PAM operator will report to the ECO, the PAM operator will be required to acknowledge and act in accordance with the authority of the Vessel Master while on-board and during operations. If it is necessary for PAM to operate 24 hours a day (see details in *No. 3.6*) the PAM operator will liaise directly with the MMO regarding marine mammal detections during the daylight hours.

The PAM operator must keep records of all detections and delays to soft starts and this input should be included in the reporting compiled by the ECO.

### *3.1.6 Fisheries Liaison Officer (FLO)*

The operator will appoint a dedicated Fisheries Liaison Officer (FLO) to conduct pre-survey consultation with fishing operators and organisations, and to assist with fishing issues before, during and after survey activities. The FLO position is central to the process of mitigating potential impacts on

fishing activities. Appointment of the FLO will be undertaken with enough time to establish a working relationship with the fishing industry and fisheries regulators.

The role of the FLO will include (see *Part C* for additional details):

- Establishing a system of communication with local fishing enterprises (and government fisheries agencies) in advance of surveys;
- Communicating details of the surveys to fishing operators, including the survey plan and schedule, in advance of commencing activities;
- Communicating updates (including changes) to fishing operators during the course of survey activities;
- Liaising with fishing operators with regard to grievances; and
- Coordinating with chase boats during surveys with regards to communicating with fishing operators in the area.

The FLO will be required to acknowledge and act according to the authority of the Vessel Master, while on-board the seismic vessel. The FLO will report directly to the ECO.

As recommendation, the FLO could also be responsible for establishing communication, the dissemination of details, and coordination of queries with tourist operators in the area.

### *3.1.7 Contractors*

The operator will appoint contractors to undertake the various exploration activities including seismic surveys on their behalf. The contractor will be selected through a process that verifies their qualifications to carry out the work and contractors will be required to comply with environmental requirements through contractual obligations. Contractor requirements with respect to environmental controls will be made available the tender stage to give contractors opportunity to budget time, resources and costs.

As part of the selection process, contractors will need to demonstrate to the operator's satisfaction how compliance with the requirements will be carried out. This will be verified through review and approval of contractor's detailed plans for complying with environmental requirements prior to selection. Contractors will also be required to demonstrate commitment to the requirements at all levels of management and contractors will be required to identify individuals responsible for environmental during the operations. In the selection process, special attention will be paid to international reputation, qualifications, accreditations, relevant experience and past performance. All seismic survey contractors will be required to be a member of the IAGC.

Contractors will be responsible for training of their staff and for ensuring that staff are fully qualified, sufficiently experienced and certified in accordance with the operator's requirements.

### *3.1.8 Vessel Master*

Exploration activities will involve the operation of marine vessels. Each survey will be carried out under the management of the Vessel Master who will have overall authority and responsibility for ship's operation and navigation, and safety of the vessel and the crew in accordance with applicable laws and regulations. The Vessel Master will train, or verify that the crew receives the necessary training with regard to on-board safety and environmental control requirements.

# 4 MONITORING AND AUDITING

The operator will undertake regular checks and audits in accordance with the requirements of this EMPr. The operator will be responsible for monitoring, surveillance and decision-making on all matters related to environmental protection during operations. In addition to assessing operational aspects and monitoring, checks will assess compliance with agreed objectives and targets, and the effectiveness of the EMPr and its implementation. The EMPr will therefore be subject to on-going review and development to verify that is remains appropriate to the exploration activities.

Monitoring and auditing findings will be reviewed by the operator and where corrective actions are deemed necessary, specific actions will be developed, with designated responsibility and timing, and implemented. In this way, continuous improvement in performance will be achieved.

## 4.1 REPORTING

### 4.1.1 Reporting during Final Planning

The operator will submit formal notification to PASA prior to initiating major exploration activity. Notification will include details of the activity location, survey schedules, vessel specifications and contractor details. Specifically for the seismic surveys, notification will include specification of the airguns, array, and streamer lengths.

### 4.1.2 Public Disclosure and Notification Prior to Start

The operator will notify the public and mariners of planned exploration activities. Surveys will be disclosed by public notice at least 30 days prior to commencement of survey activities. The operator will announce the activities in newspaper local to the survey area. Notification to mariners will be made through the SAN Hydrographic office and the Port Captains of the Ports of Cape Town, Port Elizabeth and Durban. In addition, the operator will notify operators of the neighbouring exploration areas.

Fishing operators will be notified through recognised fishing associations and Marine and Coastal Management Section of DEA (e.g. the RSA Deep Sea Trawling Association, Inshore Pelagics, Rock Lobster and Tuna associations). The FLO will co-ordinate this notification and will hold at least one meeting with fishing operators to discuss mitigation measures and avoidance planning during the survey.

### *4.1.3 Status Reporting During Surveys*

The ECO will prepare a report on a weekly basis during each survey summarising the survey activities. The report will contain details on the area surveyed, progress toward completion (e.g. percentage), detail of the survey activities (e.g. shooting data for the seismic survey), and interactions with marine mammals, turtles, seabirds and fishing vessels and gear. The report will be submitted to the programme manager who will submit the report to PASA.

The operator will conduct audits during the course of each survey on a monthly basis. The audits will be undertaken by the ECO and will check compliance of activities against the requirements of the EMPr. Findings will be documented in an audit report which will be submitted to the programme manager for action and follow-up. The incident reports will be submitted to PASA as part of the close-out report.

Following any emergency of incident, the operator will prepare an incident report detailing the events and any corrective and preventative measures implemented as a result. The incident reports will be submitted to the programme manager for action and follow-up. The incident reports will be submitted to PASA as part of the close-out report.

### *4.1.4 Close-out Reporting*

At the conclusion of each of the exploration activities, a formal close-out report will be prepared in accordance with MPRDA requirements. The report will summarise the exploration activities, describe the implementation of the EMPr, any emergency and other incidents, and highlight any problems and issues that were encountered during the survey. The close out report will include copies of notifications, audit reports, weekly reports and any other communications with I&APs.

# 5 *ENVIRONMENTAL REQUIREMENTS*

This section details the environmental requirements and specific actions required to address issues raised by specialists, government and other marine resource managers, users and interested and affected parties. Requirements are presented in tabular form and organised to align with the phases of each exploration activity.

## *Box 5.1 Organisation of Environmental Requirements*

| | |
|---|---|
| 1. | PRE-ESTABLISHMENT PHASE |
| 1.1 | Pre-survey planning |
| 1.2 | Financial provision |
| 1.3 | Preparation for emergencies |
| 1.4 | Approval of EMPr and Environmental Notifications |
| 1.5 | Appointment of survey Contractor |
| 1.6 | Liaison with and notification of key stakeholders regarding survey details |
| 1.7 | Planning of Airborne Geophysical Surveys |
| | |
| 2. | ESTABLISHMENT PHASE |
| 2.1 | Compliance with legal requirements |
| 2.2 – 2.4 | Notification of other marine users |
| 2.5 | Safety zone determination |
| | |
| 3. | OPERATIONAL PHASE |
| 3.1 | Compliance with legal requirements |
| 3.2 | Communication with other users of the sea and stakeholders |
| 3.3 | Management of the Seismic Vessel Exclusion Zone |
| 3.4 – 3.9 | Acoustic emissions from seismic sources (Impact to Marine Biota) |
| 3.10 | Acoustic emissions from seismic sources (Impact to Underwater Users) |
| 3.11 | Multibeam Bathymetric Survey Operations |
| 3.12 | Seabed Sampling Activities |
| 3.13 | Prevention of emergencies |
| 3.14 – 3.17 | Emergency response |
| 3.18 – 3.25 | Pollution control and waste management |
| 3.26 | Equipment loss |
| 3.27 | Oil bunkering / refuelling at sea |
| 3.28 | Airborne surveys and logistical helicopter support |
| 3.29 | Monitoring during the survey |
| 3.30 | Reporting during the survey |
| | |
| 4. | DECOMMISSIONING AND CLOSURE PHASE |
| 4.1 | Survey vessel to leave area |
| 4.2 | Inform relevant stakeholders and mariners of survey completion |
| 4.3 | Final waste disposal |
| | |
| 5. | MONITORING, AUDITING AND REPORTING PHASE |
| 5.1 | Monitoring compliance auditing and the submission of information |
| 5.2 | Monitoring activities and effects |
| 5.3 | Compile Close out report for activities related to environmental management |

*Table 5.1 Implementation Plan*

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| **1. Pre-establishment Phase (pre-survey)** | | | | | | | |
| **Pre-survey planning** | Reduce environmental impact of surveys<br><br>Planning to be able to implement mitigation measures during the operational phase | 1.1 | Finalise negotiations and resolve any conflict over the allocation of user fishing/ mining/ exploration rights prior to the commencement of operation.<br><br>Establish whether or not a local fishing vessel should be chartered to function as a 'sweeper' vessel (checking ahead of the vessel for any unattended fishing gear). If such a vessel is also to perform the functions of a chase /support vessel, verify that it is appropriately licensed by the South African Marine Safety Authority (SAMSA) to perform these functions.<br><br>Make provision for an adequately qualified and experienced fisheries liaison officer (FLO) to be on board the survey vessel for the duration of the survey.<br><br>Make provision for an adequately trained Marine Mammal Observer (MMO) to be onboard during the seismic and multibeam bathymetric surveys.<br><br>Develop a monitoring programme for monitoring of marine mammal interactions and fishing catches. | Generic | Operator | Prior to commencement of the survey | Environmental Control Officer's report |
| **Financial provision** | Compliance with legislative requirements | 1.2 | Verify that financial provision is in place to execute the requirements of this EMPr. | Mineral and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA) and MPRDA Regulations GN 527 of 2004 | Operator | Prior to commencement of the survey | Confirm that financial provision has been made for the Implementation Plan |
| **Preparation for emergencies** | Preparation for any emergency that | 1.3 | Have the following emergency plans, procedures, equipment and personnel in place to deal with all | Department of Mineral Resources (DMR), | Operator and survey contractor | Prior to commencement of the survey | Confirm compliance and justify any |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | could result in an environmental impact | | emergencies:<br>• Company (or representative) Emergency Response Plan<br>• Geophysical Contractor Emergency Response Plan<br>• Helicopter Operator Emergency Response Plan<br>• South African Search and Rescue (SASAR) Manual<br>• Note that in case of a major oil spill from the vessel, emergency responses and/or Oil Pollution Emergency Plan(s) must refer to the coastal oil spill contingency plan(s) of the South African Department of Environmental Affairs<br><br>In addition to the above, verify that:<br>• There is adequate protection and indemnity insurance cover for oil pollution incidents<br>• There is a record of the vessel's seaworthiness certificate and/or classification stamp | Petroleum Agency and DEA Requirements | | | omissions |
| **Approval of EMPr and environmental notification** | Compliance with legislative requirements | 1.4 | Verify that the following documents have been approved by PASA:<br>• EMPr for sub-lease area<br>• Standard or Expanded Environmental Notification document | MPRDA and MPRDA Regulations GN 527 of 2004 | Operator | Prior to commencement of the survey | |
| **Appointment of survey contractor** | Compliance with the Implementation Plan | 1.5 | For the seismic survey, appoint a contractor who is registered with the International Association for Geophysical contractors (IAGC) and therefore familiar with international best practice and understands the commitments of the EMPr. | | Operator | Prior to commencement of the survey | |
| **Liaison with and notification of key stakeholders regarding survey details** | Timeous notification of all relevant stakeholder to verify effective planning and minimise disturbance and interference | 1.6 | FLO is to identify all commercial fishing operators and recreational charter companies that frequent the seismic survey area to verify that all stakeholders are notified and kept informed of the seismic activities.<br><br>An appropriate stakeholder communication plan is to be developed to guide the consultation, communication with and notification of stakeholders. This would include the | | Operator | At least two weeks prior to commencement of survey | Documentation of notification |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | identification of and consultation with, relevant government departments, ports authorities, maritime associations, fishing associations and other stakeholders.<br><br>Stakeholders are to be advised of planning programme in good time, checks to be made regarding the dissemination of warnings at a regional and local level and follow-up to verify that information has been received as well as feedback obtained on the adequacy. | | | | |
| **Planning of Airborne Geophysical Surveys** | Minimise disturbance to migratory cetaceans | 1.7 | Avoid planning airborne geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November). As no seasonal patterns of abundance are known for odontocetes occupying the proposed Exploration Area, a precautionary approach to avoiding impacts throughout the year is recommended.<br><br>Flight paths must be pre-planned to avoid flying occurs over bird and seabird colonies, coastal reserves or marine islands as far as possible.<br><br>No flights within Marine Protected Areas (MPAs). | Specialist guidance | Operator | During survey planning | |
| **2. Establishment Phase (survey mobilisation)** | | | | | | | |
| **Compliance with legal requirements** | Permit holder and contractor to commit to adherence to legal requirements | 2.1 | Verify that a copy of the approved EMPr is on the vessel during the survey.<br><br>Train all relevant shipboard personnel on the purpose and requirements of the EMPr.<br><br>Verify correct equipment, personal protective equipment (PPE) and personnel are available to meet the requirements of the EMPr.<br><br>Commit to operator and contractor compliance with the EMPr.<br><br>The regulations for Boat-based Whale Watching and | MPRDA and MPRDA Regulations GN 527 of 2004<br><br>Marine Living | Programme Manager, Vessel Master and ECO | Prior to commencement of the survey | Copy of EMPr signed for by vessel Master and/or operator's representative on board |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | Protection of Turtles (R 725) as part of the Marine Living Resources Act (Act No. 18 of 1998) stipulate that an aircraft or survey vessel must maintain a minimum distance of 300 m from any whale. As this may be both impractical and impossible, an exemption permit must be applied for through the Department of Environmental Affairs and Tourism. | Resources Act (Act No. 18 of 1998) | | | |
| **Notification of other marine users** | Verify that other marine resource users are aware of the forthcoming survey | 2.2 | Verify that seismic vessel communication systems are in working order.<br><br>In writing, request the SAN Hydrographic Office, Silvermine, to put out Radio Navigation Warnings throughout the survey.<br><br>Inform the relevant Port Captains of planned operations (at minimum Ports of Cape Town and Port Elizabeth). | Safety of Life at Sea Convention and Maritime Safety Authority Act 5 of 1998<br><br>EMPr requirements | Programme Manager and Vessel Master | Notice to mariners to be issued 24 hours prior to start | Confirm that notices were sent to relevant parties<br><br>Provide copy of standard notice and list of those to whom it was sent |
| | | 2.3 | Prior to the commencement of the survey, the fishing industry, DAFF (Branch: Fisheries) and other IAPs should be consulted and informed of the pending activity and the likely implications for the various fishing sectors in the area as well as research surveys planned to coincide with the proposed seismic operations. IAPs should include; South African Deepsea Trawling Industry Association (SADSTIA), South East Coast Inshore Fishery Association (SECIFA), Small Hake Quota Holders Association, South African Tuna Longline Association, Hake Longline Association, South Coast Rock Lobster Association, Shark Longline Association, South African Marine Linefish Management Association (SAMLMA) and Blue Continent Products.<br><br>Appointment of a fisheries liaison officer (FLO) to communicate with and meet with the various fisheries stakeholders and to inform all fishery stakeholders of the seismic plan and associated timeframes. The FLO should liaise with all affected fishing vessels, particularly all lobster | Specialist guidance | Programme Manager and FLO | All 30 days prior to commencement of the survey | |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | fishing vessels as well as those involved in midwater trawl activities in the region to plan the placing of fishing gear, if possible, or provide additional notice of the areas of exclusion.<br><br>Verify that the survey area is free of fishing gear that could be physically contacted prior to the seismic vessel undertaking its operation in that area. This should be arranged through an FLO and his/her land-based communication network.<br><br>Advertise the start of the seismic surveys in at least two local newspapers providing details of the confirmed seismic survey area and scheduled dates for start and completion of the survey.<br><br>A communication plan with regards to the exploration activities timing and potential impacts should be implemented. The communication plan should include information on the grievance mechanism as outlined in Chapter 4 of the EMPr. Direct notification of tourism operators in the area between Jeffery's Bay in the west, to Port Shepstone in the east should be undertaken prior to the exploration activities.<br><br>If formally requested, notification of relevant individuals at local research organisations (including Nelson Mandela Metropolitan University (NMMU) and Rhodes University as well as the South African Institute for Aquatic Biodiversity (SAIAB) and the South African Environmental Observation Network (SAEON)) regarding the timing of proposed surveys. | | | | |
| | | 2.4 | Notify overlapping and neighbouring users with delineated boundaries in the offshore petroleum and offshore mineral prospecting/mining industries. | Generic EMPr | Programme Manager | 30 days prior to commencement of the survey | Copies of notification |
| **Safety zone** | Confirm 500 m | 2.5 | Once seismic source levels are known the safety distances | | Programme | Prior to | |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| **determination** | safety zone distance for marine fauna | | will be calculated using transmission loss models and verified on site. Use of the lowest practicable airgun volume shall be defined and enforced<br><br>A conservative safety distance is defined by received sound pressure levels of 180dB re 1 µPa (rms) for baleen and sperm whales, and 210 dB re 1 µPa (rms) for toothed whales. Either this safety zone distance, or 500 m, whichever is larger, will be used for all seismic and multibeam bathymetric activities in the concession area | | Manager in consultation with the MMO | commencement of the survey | |
| **3. Operational Phase** | | | | | | | |
| **Compliance with legal requirements** | Operate in an environmentally responsible manner | 3.1 | All activities must comply fully with the EMPr, which includes undertaking all activities successfully and record details and include these in the close-out report<br><br>Subscribe to the principles of an internationally acceptable Environmental Management System onboard the vessels. This includes environmental awareness training, waste management and environmental monitoring, record keeping and continuous improvement.<br><br>Comply with the 'Environmental Guidelines for Worldwide Geophysical Operations' issued by the IAGC | MPRDA and MPRDA Regulations GN 527 of 2004<br><br>PASA requirements<br><br>IAGC Guidelines | Programme manager | Throughout programme | |
| **Communication with other users of the sea and stakeholders** | Promote co-operation and successful multiple uses of the sea, including promotion of safe navigation | 3.2 | Keep the following interested and affected parties updated on the survey through normal communication channels (including progress notices via email), Radio Navigation Warnings and Notices to Mariners:<br>• Overlapping and neighbouring users with delineated boundaries in the marine petroleum and mineral prospecting and mining industries<br>• South African and foreign fishing vessels, who can be informed through the recognized fishing associations and Department of Environmental Affairs, examples include the South African Deep Sea Trawling Association<br>• Other relevant fisheries organisations as listed in *Activity 2.3* | PASA EMPr requirements<br><br>Maritime Safety Authority Act (Act 5 of 1998) | Programme manager and – Vessel Master | During compilation of initial and final EMPr, as well as during operations as required | Provide copy of written notices and list of those to whom it was sent |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | • Government Departments with jurisdiction over marine activities, particularly DEA, DMR, and PASA, SAN Hydrographer, South African Maritime Safety Authority (SAMSA), DAFF (Fisheries) and local Port Captains<br>• The FLO will liaise with fishing operators | | | | |
| **Management of the vessel exclusion zone** | Minimise disruption to other legitimate users of the sea by respecting their rights | 3.3 | Co-operate with other legitimate users of the sea to minimize disruption to other marine activities and marine life.<br><br>Particular attention must be paid to verify good co-operation and information dissemination to fisheries operators.<br><br>Keep constant watch for approaching vessels during operations. Warn by radio and chase boat (if required).<br><br>Use effective communication channels (see *Activity 3.2*) to inform all other potential users about the survey location, timing, priority of passage safety, exclusion zones and general safety distances. | Marine Traffic Act and International Law of the Sea<br>EMPr requirements | Programme manager and Vessel Master | Throughout Planning and Operational phase | Record any incidents outside of normal occurrence |
| **Management of the MPA Exclusion and Buffer Zones** | Minimise disruption to the Marine Protected Area and coastline | 3.4 | No exploration activities are to occur within the Marine Protected Areas (MPAs).<br><br>No firing of seismic airguns within 10km of the coastline and within 2km of the MPAs. | Specialist guidance and EMPr | Vessel Master and ECO | Throughout Planning and Operational Phase | Record any incidents outside of normal occurence |
| **Acoustic emissions from sound sources** | Reduce disturbance of marine biota (1) | 3.5 | Limit, as far as possible, the energy of produced sound to those frequencies required for the survey | IAGC procedures and specialist advice EMPr requirements | Vessel Master | Prior to and during the survey | Provide copies of completed activity log |
| | | 3.6 | Survey vessels will accommodate dedicated independent MMOs with experience in marine mammal, turtle and seabird identification and observation techniques, to carry out continuous daylight observations of the survey region | IAGC procedures and specialist advice<br><br>EMPr requirements | Vessel Master and MMO | Prior to and during the survey | Provide copies of completed marine fauna observation |

(1) These measures assume that every attempt has been made to carry out the seismic survey during periods in which the area concerned is not a critical habitat to marine fauna (e.g. within whale migration, turtle hatching etc)

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
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| | | | and record incidence of marine mammals, turtle and seabird occurrence in the area of survey activities and responses to seismic shooting. Data collected will include position, distance from the vessel, swimming speed and direction, and observed changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns). Both the identification and the behaviour of the animals must be recorded accurately along with current seismic noise levels.<br><br>During night-time line changes low level warning airgun discharges at regular intervals are recommended in order to keep animals away from the survey operation while the vessel is repositioned for the next survey line. This will be done at the discretion of the ECO/MMO and will not occur when the vessel is turning within the defined seismic buffer zones or exclusion zone.<br><br>All data recorded by MMOs will at minimum form part of a survey close–out report. Furthermore, daily or weekly reports will be forwarded to the necessary authorities to verify compliance with the mitigation measures.<br><br>Marine mammal, turtle and seabird incidence data and seismic source output data arising from surveys will be made available on request to the Marine Mammal Institute, Department of Agriculture, Fisheries and Forestry, Department of Environmental Affairs: Oceans and Coasts and the Petroleum Agency of South Africa for analyses of survey impacts in local waters.<br><br>As far as possible, avoid planning seismic surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November), and verify that migration paths are not blocked by seismic operations. In addition, avoid surveying during December when humpback whales may still be moving through the area on | | | | forms and survey activity log (including records of soft starts) |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
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| | | | their return migrations. If surveying during this time cannot be avoided all other mitigation measures must be stringently enforced, and PAM technology, which detects cetaceans through their vocalisations, must be implemented 24-hours a day.<br><br>The seismic survey vessel will be fitted with PAM technology and efforts are to be made for the multibeam bathymetric vessel to also be fitted with PAM technology. PAM is to be used when surveying at night or during adverse weather conditions and thick fog.<br><br>The JNCC (2010) guidelines regarding the use of PAM technology, including the determination of range and delays to soft starts, will be implemented. In the absence of visual confirmation, the detection of large cetaceans by the PAM operators, within 500m of the vessel, will require a delay in the start of soft-starts.<br><br>Communication and implementation protocols between the ECO, MMO and PAM operators should be established prior to the start of surveys.<br><br>No seismic survey shooting is to take place within declared Marine Protected Areas (MPA) and within a seismic buffer of 10km of the coastline and 2km seismic buffer around the MPAs. | | | | |
| | | 3.7 | Initiation of firing is only to begin after observations by MMOs have deemed the visual area around the vessel to a distance of 500 m to be clear of all large cetacean species, diving seabirds and turtles for at least 30 minutes prior to firing. In the case of small cetacean (particularly dolphins), which are common in inshore waters and 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 airguns, particularly the Indo-Pacific humpback dolphin (*Sousa* | IAGC procedures and specialist advice<br><br>EMPr requirements | Vessel Master and MMO | During the survey | Provide copies of completed marine fauna observation forms and seismic activity log showing "soft start" commencement |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
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| | | | *chinensis*) or the Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*), listed as 'vulnerable' and 'endangered' respectively. If after a period of 30 minutes small cetaceans are still within 500 m of the airguns, the normal soft start procedure will be allowed to commence for at least 20-minutes duration. The MMO will monitor small cetacean behaviour during soft starts to determine if the animals display any observed negative responses to the airguns and gear or if there are any signs of injury or mortality as a direct result of seismic shooting operations.<br><br>The MMO to keep accurate records of all soft starts and pre-firing observations, any feeding behaviour within the streamers, sightings (location, time) of injured or dead protected species (irrespective of if caused by the survey vessel) | | | | |
| | | 3.8 | All initiations of seismic surveys to be carried out as soft-starts for a minimum of 20 minutes (JNCC 2010). This requires that the sound source be ramped from low to full power, thus allowing a flight response to outside the zone of injury or avoidance. The rationale for the 20 minute soft-start period is based on the flight speeds of cetacean species.<br><br>All breaks in airgun firing of longer than 20 minutes will be followed by a soft-start procedure of at least 20 minutes prior to the survey operation continuing. Breaks shorter than 20 minutes should be followed by a soft-start of similar duration. | IAGC procedures and specialist advice<br><br>EMPr requirements | Vessel Master | During the survey | Provide copies of completed seismic activity log showing soft start commencement |
| | | 3.9 | Seismic shooting will be terminated when obvious changes to turtle or cetacean behaviour are observed from the survey vessel, or turtles or cetaceans (not seals) are observed within the immediate vicinity (within 500 m) of operating airguns and appear to be approaching a firing airgun.<br><br>Any observed mortality or injuries to cetaceans or turtles as a direct result of the survey will result in temporary | IAGC procedures and specialist advice<br><br>EMPr requirements | Vessel Master on MMO advice | Prior to and during the survey | Provide copies of completed marine fauna observation forms and seismic activity log showing soft start commencement |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
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| | | | termination of operations.<br><br>Verify that 'turtle-friendly' tail buoys are used by the survey contractor or that existing tail buoys are fitted with either exclusion or deflector 'turtle guards'. | | | | |
| | | 3.10 | An area with a radial length of 500 m shall be scanned by an independent observer for the presence of diving seabirds prior to the commencement of "soft starts" and these will be delayed until such time as this area is clear of seabirds.<br><br>Seabird incidence and behaviour should be recorded by an on-board Independent Observer. Any obvious mortality or injuries to seabirds as a direct result of the survey should result in temporary termination of operations.<br><br>Any attraction of predatory seabirds (by mass disorientation or stunning of fish as a result of seismic survey activities) and incidents of feeding behaviour among the hydrophone streamers should be recorded by an on-board Independent Observer.<br><br>The surveys should be scheduled outside of the 'sardine run' period (i.e. June and July). | Specialist recommendation<br><br>EMPr requirements | MMO | During the survey | Provide copies of completed marine fauna observation forms |
| **Acoustic Emissions from Sound Sources** | Reduce possibility of impact to divers and underwater marine users | 3.11 | A detailed communication plan, including a grievance procedure, with regards to the survey timing and potential impacts should be developed. This plan should also list the contact details of dive operators and spearfishing organisations in the region and these groups should be contacted before the commencement of the proposed surveys.<br><br>Should it be shown that diving and seismic activities may occur within 10km of each other, more detailed discussions with dive operators and spearfishing organisations will be required in order to as far as possible avoid diving within 10 km of seismic activities. | DMAC guidance<br><br>EMPr requirements | Vessel Master and operator | Prior to and during the survey | |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | If diving within 10 km of the seismic survey is unavoidable the UK Diving Medical Advisory Committee (DMAC): Safe Distance from Seismic Surveying Operations (DMAC 12 Rev. 1 – July 2011) document guidance should be followed. | | | | |
| **Multibeam Bathymetric Survey Operations** | Minimise impacts to marine fauna | 3.12 | Use of the lowest practicable power levels to achieve the required result.<br><br>Onboard Marine Mammal Observers will scan the area for the presence of cetaceans within 500 m of the working vessel for approximately 30 minutes before commencement of the survey.<br><br>Where equipment allows, use soft starts for a period of at least 20 minutes to give adequate time for marine mammals to leave the vicinity.<br><br>Care must be taken with survey line lay outs to avoid restricting the ability of cetaceans to avoid the source.<br><br>Equipment will be shut down if cetaceans are within a distance of the vessel defined by the power source, directionality and propagation characteristics.<br><br>Minimise impacts in known sensitive areas and Marine Protected Areas (MPA). No exploration activities will occur within the declared MPAs.<br><br>Avoid planning multi-beam surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of June to end of November), and verify that migration paths are not blocked by sonar operations. | Specialist recommendation<br><br>EMPr requirements | Vessel Master, ECO and MMO | During the survey | Provide copies of completed marine fauna observation forms and activity log showing soft start commencement |
| **Seabed sampling activities** | Minimise the chance of impacting heritage resources | 3.13 | Avoid undertaking any coring/probing activities within areas of the seabed where resources of historic, archaeological and/or cultural interest have been identified (specifically shipwrecks). | Specialist advice | Independent Observer/ECO | During the survey | Independent Observer records and record of coring locations and results |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
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| | | | Where the activity sequencing allows, analysis of data of the non-interventive surveys should be done by a specialist archaeologist to confirm the presence of any shipwrecks and demarcate areas to be avoided for the piston coring of the seabed.<br><br>The neutral observer on board should remain aware of the potential for marine coring/probing activities to disturb and even destroy potentially significant heritage resources. They should be present during coring/ probing activities. Should any shipwrecks or sections of shipwrecks be identified in the vicinity of where such activities are being undertaken SAHRA should be notified. These authorities should also be notified should any heritage resources show up in removed seabed samples. | | | | |
| **Prevention of Emergencies** | Minimise the chance of emergency occurring, and subsequent damage to the environment | 3.14 | Verify that all work is in accordance with the Occupational Health and Safety Act (Act 85 of 1993) and any safety provisions listed in the IAGC.<br><br>Implement health and safety procedures for work on the seismic vessel.<br><br>Service equipment regularly, and practice regularly in accordance with the Health and Safety Act and regulations Verifying vessel displays correct signals by day and lights by night.<br><br>Use chase boat to maintain exclusion zone and avoid damage to the array or their own vessels.<br><br>Verify that the vessel's navigational and communication equipment is working and adequately maintained to prevent collisions.<br><br>Establish lines of communication with the following emergency response agencies/facilities:<br>• Department of Transport SAMSA | Navigation rights, safety & licensing requirements<br><br>EMPr requirements | Master of the vessel | Throughout | |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | • The SAN Hydrographic Office at Silvermine<br>• Department of Environmental Affairs<br>• Port Captains of Ports of Cape Town and Port Elizabeth | | | | |
| **Emergency Response** | Minimise damage to the environment by implementing procedures efficiently in response to Emergencies, including Major Oil Spills (from collisions, vessel break-up, refuelling etc) | 3.15 | Implement the Oil Spill Contingency Plan in the event of an oil spill.<br>In the event of an oil spill immediately notify:<br>• the Principal Officer of the nearest SAMSA office<br>• the DEA's Chief Directorate of Marine Pollution in Cape Town<br>• PASA<br>Information that should be supplied when reporting a spill includes:<br>• The type and circumstances of incident, ship type, port of registry, nearest agent representing the ship's company<br>• Geographic location of the incident, distance off-shore and extent of oil spill<br>• Prevailing weather conditions, sea state in affected area (wind direction and speed, weather and swell)<br>• Persons and authorities already informed of the spill | Marine Pollution (Control and Civil Liability) Act 6 of 1981<br><br>(Marine Notices 2 of 1996 and 23 of 1998)<br><br>DEA & SAMSA policy<br><br>DEA Chief Directorate Pollution & Waste Management: policy guidelines<br><br>DEA Coastal Oil Spill Contingency Plan(s)<br><br>EMPr Requirements<br><br>Law of the Sea Convention (LOSC)<br><br>Merchant Shipping Act, Customs and Excise Act | Vessel Master | In event of spill | Attach copy of any information that was supplied to SAMSA and DEA |
| | | 3.16 | Where diesel, which evaporates relatively quickly, has been spilled, the water must be agitated or mixed using a propeller boat/dinghy to aid dispersal and evaporation. | As above | Vessel Master | In event of spill | Attach copy of any information that was supplied to SAMSA and DEA |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
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| | | | | | | | |
| | | 3.17 | Dispersants should not be used without authorisation of DEA.<br>Furthermore dispersants should not be used:<br>• on diesel or light fuel oil<br>• heavy fuel oil<br>• slicks > 0.5 cm thick<br>• all oil spills within 5 nautical miles off-shore or in depths less than 30 m<br>• in areas far offshore where there is little likelihood of oil reaching the shore<br><br>Dispersants are most effective on fresh crude oils; under turbulent sea conditions (as effective use of dispersants requires mixing), when applied within 12 h (24 h max) or where the volume of dispersant doesn't exceed 20-30 percent of the oil volume | As above | Programme Manager and Vessel Master | In event of spill | Attach copy of authorisation |
| | | 3.18 | Adhere to obligations regarding other vessels in distress.<br><br>Notify SAMSA about wrecked vessels (safety and pollution), and the Department of Finance (salvage, customs, royalties). Give location details to SAN Hydrographic office. | As above | Vessel Master | In the event of a vessel in distress or wreck | Copy of notification |
| **Pollution Control and Waste Management** | Minimise pollution, verify safe waste disposal and maximise recycling | 3.19 | Comply with legal requirements for waste management and pollution control (for air and water quality levels at sea), and employ 'good housekeeping' and monitoring practices. | International Convention for the Protection of Pollution from Ships MARPOL 73/78 (in Marine Pollution Act 2 of 1986); Dumping at Sea Control Act; Montreal protocol; Water Act<br><br>EMPr Requirements | Vessel Master | Throughout the survey | Report occurrence of minor oils spills and destination of wastes |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | 3.20 | Food waste may be disposed of overboard after grinding through a 25 mm screen (MARPOL standard) – prohibited if distance to land is < 12 nautical miles.<br><br>Medical waste will be incinerated or sealed in aseptic containers for appropriate disposal ashore.<br><br>Waste oil will be returned to a port with a registered facility for processing/disposal.<br><br>Oily-water separator to only release <l5 ppm oil in water.<br><br>All hazardous waste will be collected and retained onboard for disposal at suitable onshore reception facilities. Metal must be sent to shore for recycling. | ÒGP Waste Management Guidelines (No2.58/196, 1993)<br><br>International Convention for the Protection of Pollution from Ships MARPOL 73/78 | Vessel Master | Throughout the survey | Report occurrence of minor oils spills and destination of wastes<br><br>Attach copy of waste disposal receipts from waste contractor |
| | | 3.21 | Plastic, scrap metal and other solid waste generated on the seismic vessels will be segregated, weighed and accounted for prior to disposal at appropriate facilities.<br><br>Waste will be recycled where possible.<br><br>No disposal of general waste overboard. | | Vessel Master | Throughout the survey | Attach copy of waste disposal receipts from waste contractor |
| | | 3.22 | Sewage discharges will be comminuted and disinfected in an approved treatment plant on the exploration and support vessel(s) and only discharged more than 12 nautical miles (21.6 km) from land.<br><br>Treated effluents will achieve a BOD < 40 ppm, suspended solids < 50 ppm and a coliform count of <200 cells per 100 ml of effluent.<br><br>Sludge will be retained and disposed of in port. | ÒGP Waste Management Guidelines (No2 58/196, 1993)<br><br>International Convention for the Protection of Pollution from Ships MARPOL 73/78 | Vessel Master | Throughout the survey | Report occurrence spills and non-compliance |
| | | 3.23 | Drainage from machinery spaces on deck will be treated to verify that it does not contain more than 15 mg/l of oil. | ÒGP Waste Management | Vessel Master | Throughout the survey | Report occurrence of |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | All other discharges will be treated to verify an average monthly oil content of no more than 40 mg/l. The instantaneous discharges will not exceed 100 mg/l. | Guidelines (No2.58/196, 1993)<br><br>International Convention for the Protection of Pollution from Ships MARPOL 73/78<br><br>International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL)<br><br>International Finance Corporation (IFC) (2000) Offshore Oil and Gas Development HSE Guidelines | | | minor oils spills and destination of wastes |
| | | 3.24 | No CFC based fire-fighting or refrigeration equipment is to be used.<br><br>Manufacturers' instructions for the operation and maintenance of equipment will be followed to verify that equipment operation is carried out at highest possible level of efficiency to maintain minimum level of $CO_2$ and CO emissions. | | Vessel Master | Throughout the survey | |
| | | 3.25 | Record types and volumes of hazardous substances brought on board (e.g. radioactive materials, neon lights, toner cartridges, etc), and destination of wastes.<br><br>Verify that waste returned to port is disposed of by a licensed waste disposal contractor using an approved landfill site | National Environmental Management Waste Act (Act 59 of 2008) | Vessel Master | Throughout the survey | Attach copy of waste disposal receipts from waste contractor |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
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| | | | | | | | |
| | | 3.26 | Verify that monitoring procedures are in place on board in accordance with MARPOL requirements | International Convention for the Protection of Pollution from Ships MARPOL 73/78 | ECO | Throughout the survey | Monitoring data |
| **Equipment loss** | Minimise hazards left on the sea bed or floating in the water column, and inform relevant parties | 3.27 | Keep a record of all items lost overboard and of lost equipment.<br><br>When any items 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.<br><br>Pass information to SAMSA and to DMR to provide to mining companies, and to DEA to provide to fishermen operating in the area.<br><br>Directly inform fishing/trawling associations of any equipment losses. | Dumping at Sea Control Act 73 of 1980<br><br>Mineral and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA) and MPRDA Regulations GN 527 of 2004 | Vessel Master | Throughout survey, as required | Copy of record sheet |
| **Oil bunkering/ refuelling at Sea** | Minimise disturbance/damage to marine life | 3.28 | No discharge of any oil whatsoever is permitted within 50 nautical miles of the coast.<br><br>If refuelling will be required while at sea the contractor must:<br>• submit an application form in terms of Regulation 14 to the Principal Officer at the port nearest to where the proposed transfer to obtain prior permission for transfer of oil at sea<br>• inform SAMSA of location, supplier and timing, five days prior to refuelling at sea<br>• verify that drip trays are in place to collect leakage from connection and discharge points | International Convention for the Protection of Pollution from Ships MARPOL 73/78 (Annex 1)<br><br>Pacoposoa (Prevention and Combatting of Pollution of the Sea by Oil Act) Amendment Act 24 of 91<br><br>Marine Pollution (Control and Civil | Vessel Master | In project description | Copy of application form and any correspondence with SAMSA |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
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| | | | | Liability) Act 6 of 1981 | | | |
| **Airborne surveys and logistical helicopter support** | Minimise disturbance / damage to marine and coastal life | 3.29 | As much as possible, flight paths must be pre-planned to avoid flying over seal and seabird colonies, coastal reserves or marine islands.<br><br>Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should be avoided.<br><br>Aircraft shall not approach to within 300 m of whales in terms of the Marine Living Resources Act, 1998.<br><br>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.<br><br>The contractor should comply fully with aviation and authority guidelines and rules.<br><br>All pilots should be briefed on ecological risks associated with flying at a low level parallel to the coast. | Sea Birds and Seals Protection Act 46 of 73, 1963<br><br>Air Navigation Regulations)<br><br>EMPr requirement<br><br>International Convention for the Protection of Pollution from Ships MARPOL 73/78 | Programme manager and ECO | As required | Submit copies of flight paths and compliance reports |
| **Monitoring during the survey** | Monitor impacts to assist with any possible compensation negotiations | 3.30 | Monitor noise levels during survey at in areas within 25km of the Marine Protected Areas as well as in key fishing areas confirmed through liaison of the FLO with fishing operators.<br><br>Undertake daily monitoring and recording of the following from the vessels:<br>• Marine mammals, seabirds and turtles sighted from the vessels (record numbers in relation to weather and surveying activities on the specific marine fauna sighting record forms - see *Part C Appendix A*)<br>• Any small fish mortality associated with airgun operation (visible by feeding predators)<br>• Record unusual bird sightings associated with the operation of the airgun array, particularly diving birds<br>• Interaction with other vessels, particularly including the use of a chase boat to verify that the survey is not | | ECO, FLO, MMO | Throughout the survey | Monitoring reports |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | compromised<br>• Include comprehensive details of interaction with unattended fishing gear<br><br>Monitor liquid effluent to verify compliance with MAPROL 73/78 limits:<br>• oil from machinery space drainage < 15 mg.l-1<br>• oil from other effluents < 40 mg.l-1 (monthly average)<br>• oil from other effluents < 100 mg.l-1 (instantaneous limit). | | | | |
| **Reporting during the survey** | Report all information gathered during monitoring | 3.31 | Record all initiation of seismic firing activity and associated "soft starts" and pre-firing observation regimes.<br><br>Complete daily marine fauna sighting forms for marine mammal, diving birds and turtle sightings.<br><br>Provide full reporting of all shooting termination decisions (including behaviour and distance of marine mammals) in the close out report. | MPRDA and MPRDA Regulations GN 527 of 2004 | Vessel Master and ECO | Daily, throughout the survey | Data and records |
| **4. Decommissioning and Closure Phase** | | | | | | | |
| **Survey vessel to leave the survey area** | Minimise impact as a result of activities and notify stakeholders | 4.1 | Verify that all deployed equipment is retrieved. | | Vessel Master | On completion of survey | |
| **Inform relevant stakeholders and mariners of survey completion** | Verify that relevant parties are aware that the seismic campaign is complete | 4.2 | Inform PASA and SAN Hydrographer of the survey completion.<br><br>FLO must notify fishing operators and vessels and other Mariners through recognised fishing associations and the SAN Hydrographic office. | | Programme manager | Within two weeks after completion of survey | Copies of notification documentation required. |
| **Final Waste Disposal** | Minimise pollution and verify correct | 4.3 | All waste retained onboard is to be disposed of by a licensed waste disposal contractor at an approved waste landfill site and waste log completed. | National Environmental Management Waste | Vessel Master | When vessel is in port | Receipt required from contractor |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | disposal of waste | | | Act (Act 59 of 2008)<br><br>International Convention for the Protection of Pollution from Ships MARPOL 73/78 | | | |
| **5. Monitoring, Auditing and Reporting Phase** | | | | | | | |
| **Monitoring compliance auditing and the submission of information** | | 5.1 | Undertake appropriate compliance audits against objectives and commitments and document all activities.<br><br>All records to be maintained including MMO daily records, incident reports, waste logs, records of consultation with key stakeholders, records of notices to mariners. | | ECO, MMO | | Monitoring and audit reports |
| **Monitoring activities and effects** | Implement the ongoing monitoring programmes (in conjunction with government if required) | 5.2 | Implementation Plan monitoring programme and EMPr Performance Assessments to be compiled and submitted to PASA.<br><br>Undertake appropriate monitoring of marine mammals and fishing catches and track performance against objectives and targets. Document all activities and results for internal and external auditing. | Mineral and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA) and MPRDA Regulations GN 527 of 2004 | ECO, MMO | Daily throughout the survey | All recorded information |
| **Compile Close out Report for activities related to environmental management** | Verify corrective action and compliance and contribute towards improvement of EMP implementation | 5.3 | Close–out report is to be based on requirements of the monitoring and Implementation Plan Performance Assessment.<br><br>Provide information / records as indicated in the close-out report column of the Implementation Plan within 90 days of the end of the survey.<br><br>Provide copy of report to the relevant regional office of the DMR and PASA.<br><br>A relinquishment close-out report must be compiled before each prospecting area is relinquished. It must refer to and | Mineral and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA) and MPRDA Regulations GN 527 of 2004 | Programme manager and ECO | On completion of survey | |

| Project Phase and Activities | Environmental Objectives | No | Auditable Management Actions to be taken to meet the EMPr Report Objectives | Sources of instructions | Responsibility | Frequency/ Timing | Close-out Report Requirements |
|---|---|---|---|---|---|---|---|
| | | | summarize details contained in each seismic survey close-out report. The report must specifically provide evidence that all aspects of the Implementation Plan have been met.<br><br>A covering letter must formally apply for the issuance of a closure certificate from DMR/ PASA. | | | | |

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Impact Africa EMPr Transkei and Algoa Exploration Areas

# PART C

# Supporting Documentation

1. Financial Provision
2. Assessment Methodology
3. Fisheries Specialist Study
4. Marine Fauna Specialist Study
5. Details of Coordination by Fisheries Liaison Officer (FLO) Prior to Seismic Survey
6. Data Recording Sheets
    - Marine Mammal Search Record
    - Marine Fauna Sighting Record
7. Undertaking by Applicant
8. Curriculum Vitae

## *1 FINANCIAL PROVISION*

## Cost Estimate – Financial Provision

## Work Program

| Activity | Unit Rehab Cost (US$) | Disturbed Area | TOTAL Rehab Cost (US$) |
|---|---|---|---|
| | | | |
| **Mobilisation** | | | |
| Personnel and equipment | 900,000 | | 900, 000 |
| | | | |
| **Clean-up of oil spillages** | | | |
| Oil recovery equipment and absorbent material hire/ purchase. | 1,800,000 | | 1,800, 000 |
| | | | |
| **Waste Management** | | | |
| Handling, storage and final disposal at licensed landfill site onshore. | 600,000 | | 600,000 |
| | | | |
| **Third Party Liabilities** | | | |
| Compensation, damage claims etc. to marine, mining, fishing industry, marine transport route. | 2,200,000 | | 2,200,000 |
| | | | |
| **Project Management** | | | |
| Travel, sundries, appointment of contractors, monitoring, etc. | 600,000 | | 600, 000 |
| | | | |
| **Removal of miscellaneous objects from the sea floor** | | | |
| Retrieving of lost equipments/items through the use of divers/ appointment of specialized contractor, etc. | 750,000 | | 750,000 |
| | | | |
| **Monitoring and Maintenance** | 1,200,000 | | 1,200,000 |
| Contingencies | 800,000 | | 800, 000 |
| | | | |
| **Total Rehabilitation Cost (ex VAT)** | | | **8,850,000** |
| | | | |
| VAT @ 14% | | | 1,239,000 |
| **Total Rehabilitation Cost (inc. VAT)** | | | **10,089,000** |

# 2 ASSESSMENT METHODOLOGY

## IMPACT ASSESSMENT METHODOLOGY

**The assessment of the potential impacts and benefits that will be associated with the project requires a methodology that will reduce the subjectivity involved in the assessment. A clearly defined methodology is used in order to determine the significance of the predicted impact on, or benefit to, the surrounding natural and/or social environment and to therefore be able to compare the significance ratings of the impacts identified. The types of impacts and terminology used in this assessment are shown below in *Table 1*.**

### Table 2: Impact Assessment Terminology

| Term | Definition |
|---|---|
| *Impact Nature* | |
| **Positive** | An impact that is considered to represent an improvement on the baseline or introduces a positive change. |
| **Negative** | An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor. |
| *Impact Type* | |
| **Direct Impact** | Impact that results from a direct interaction between a planned project activity and the receiving environment/receptors (e.g. between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality). |
| **Indirect Impact** | Impact that results from other activities that are enabled as a consequence of the proposed project (e.g. in-migration for employment placing a demand on natural resources). |
| **Induced Impact** | Third level impact caused by a change in the proposed project environment (e.g. employment opportunities created by the increased disposable income of workers hired by the project or its suppliers). |
| **Cumulative Impact** | Impact that acts together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed project. |
| *Impact Magnitude* | |
| **Duration** | *Temporary* - impacts are predicted to be of short duration and intermittent/occasional in nature.<br>*Short-term* - impacts that are predicted to last only for the duration of the construction period.<br>*Long-term* - impacts that will continue for the life of the project, but cease when the project stops operating. These will include impacts that may be intermittent or repeated rather than continuous if they occur over an extended time period (e.g. repeated seasonal disturbance of species as a result of, for example, blasting activities, operational employment, etc.).<br>*Permanent* - impacts that occur during the development of the project and cause a permanent change in the affected receptor or resource (e.g. destruction of ecological habitat) that endures substantially beyond the project lifetime. |
| **Scale** | *On-site or Local* - impacts that affect an area in a radius of 20 km around the project site.<br>*Regional* - impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystem.<br>*National* - impacts that affect nationally important environmental resources, or affect an area that is nationally important/ protected or have macro-economic consequences.<br>*International / Trans-boundary* - impacts that affect internationally important resources such as areas protected by international conventions. |
| **Severity (for environmental receptors)** | *Very Low / Low* – Impact affects the environment in such a way that natural functions and processes are not affected.<br>*Medium* – The affected environment is altered but natural functions and processes continue albeit in a modified way.<br>*High* – Natural functions or processes are altered to the extent that they will *temporarily or permanently cease*. |

| Term | Definition |
|---|---|
| *Impact Likelihood*<br>In addition to predicted impacts, those impacts that could result in the event of an accident or unplanned event (non-routine) within the project (e.g. fuel spill, traffic accident) or in the external environment affecting the project (e.g. flooding, earthquake) are required to be taken into account. In these cases the probability of the event occurring needs to be considered. | |
| **Low** | The impact does not occur. |
| **Medium** | Impact occurs infrequently. |
| **High** | Impact occurs frequently or regularly. |

**Based on the definitions provided above and the broad understanding of categories of significance, impact matrices have been prepared to guide the assessment of project impacts.**

**Table 2 below will form the basis of determining the magnitude of the environmental impacts. The results from this table are then used in the matrix presented in Table 3 to assess the significance of environmental impacts.**

**Table 3: Assessment of Environmental Magnitude**

| Magnitude Rating | Level of Criteria Required |
|---|---|
| Negligible | • Low severity with a site specific extent and exploration period duration.<br>• Very low severity with any combination of extent and duration except for regional and long-term implications. |
| Low | • High severity with a site specific extent and exploration period duration.<br>• Medium severity with a site-specific extent and exploration period duration.<br>• Low severity with any combination of extent and duration except site specific and exploration period or regional and long term.<br>• Very low severity with a regional extent and long term duration. |
| Medium | • High severity with a local extent and medium term duration.<br>• High severity with a regional extent and exploration period duration or a site specific extent and long term duration.<br>• High severity with either a local extent and exploration period duration or a site specific extent and medium term duration.<br>• Medium severity with any combination of extent and duration except site specific and exploration period duration or regional extent and long term duration.<br>• Low severity with a regional extent and long term duration. |
| High | • High severity with a regional extent and long term duration.<br>• High severity with either a regional extent and medium term duration or a local extent and long term duration.<br>• Medium severity with a regional extent and long term duration. |

**Table 4: Overall Significance Criteria for Environmental Impacts**

| SIGNIFICANCE | | | | |
|---|---|---|---|---|
| | | LIKELIHOOD | | |
| | | **Unlikely** | **Likely** | **Definite** |
| **MAGNITUDE** | **Negligible** | Negligible | Negligible | Minor |
| | **Low** | Negligible | Low | Low |
| | **Medium** | Low | Medium | Medium |
| | **High** | Medium | High | High |

# PROPOSED OIL AND GAS EXPLORATION ACTIVITIES IN THE TRANSKEI ANDALGOA EXPLORATION AREAS, OFF THE EASTERN CAPE COAST OF SOUTH AFRICA

Fisheries Impact Assessment

Compiled for:

Environmental Resource Management (Pty) Ltd
(ERM)

On behalf of:

Impact Africa Limited

Prepared by:

*D.W. Japp and M. Smith*
*CapFish SA (Pty) Ltd*
Cape Town

April 2013

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5 April 2013

**Expertise and Declaration of Independence**

This report was prepared by Dave Japp and Melanie Smith of CapFish SA (Pty) Ltd. Dave Japp has a BSC in Zoology, University of Cape Town (UCT) and a MSc degree in Fisheries Science from Rhodes University. Melanie Smith has a MSc in Applied Marine Science from UCT.

Both have considerable experience in undertaking specialist environmental impact assessments relating to fishing and fish stocks. Dave Japp has worked in the field of Fisheries Science and resource assessment since 1987. His work has included environmental economic assessments and the evaluation of the environmental impacts on fishing. Melanie Smith has worked on the spatial (GIS) and temporal (statistical) behaviour of fish stocks for fisheries management as well as specialising in the environmental impacts of fisheries exploitation.

This specialist report was compiled for ERM (Pty) Ltd for their use in compiling an Environmental Management Programme (EMPr) for exploration activities in the Transkei and Algoa Exploration Areas, on the Eastern Cape Coast of South Africa. We do hereby declare that we are financially and otherwise independent of Impact Africa Limited and of ERM (Pty) Ltd.



Dave Japp



Melanie Smith

## Executive summary

Impact Africa Limited is proposing to explore for oil and gas reserves in the Transkei andAlgoa Exploration Areas off the Eastern Cape Coast of South Africa (see Figure 1). They cover an area of approximately 45,838 $km^2$ with water depths ranging from the shoreline to approximately 4000 m. Impact Africa's proposed initial three-year exploration work programme would consist of the following:

The proposed exploration programme consists of the following:

1. Airborne geophysics programme (gravity and magnetic data);
2. Seismic survey(s) programme
3. Surface heat flow measurements, seabed and water column sampling programme
4. Multi-beam echo sounder and sub-bottom profile programme and;
5. Sediment coring programme.

This report gives an assessment of the likely impact of the proposed survey on the fishing industry in terms of disruption to fishing activity and loss of access to fishing grounds. Furthermore, mitigation measures are proposed with a view to reducing potential negative effects between seismic and fishing operations. This report was commissioned as part of the undertaking of an Environmental Management Programme (EMPr), which has to be approved by the Petroleum Agency of South Africa (PASA) prior to the granting of an Exploration Right.

The overall impact of the proposed survey is considered to be of short-term duration and the status of the impact on all fishing sectors is assessed to be negative. The impact on the demersal trawl, midwater trawl, demersal long-line (hake), south coast rock lobster, traditional linefish fisheries and squid jig fishery is assessed to be of local extent, however the impact on the pelagic longline fishery is of regional extent. There is no impact expected by the proposed survey on the small pelagic fishery. The intensity of the impact on these fisheries is assessed to be of LOW intensity and of overall VERY LOW significance, except for pelagic longline fishery which is of MEDIUM intensity and of overall LOW significance. The degree of confidence in the predictions for all fisheries is high except for the squid jig and traditional linefish fishery which is medium.

In terms of minimizing the impact on the fishing industry it is recommended that interested and affected parties (IAPs) are identified and that sufficient notification of the proposed survey operations be given prior to the commencement of the survey and throughout the duration of the survey. IAPs should include; South African Deep-sea Trawling Industry Association (SADSTIA), South East Coast Inshore Fishery Association (SECIFA), Small Hake Quota Holders Association, South African Tuna Longline Association, Hake Longline Association, South Coast Rock Lobster Association, Shark Longline

Association, South African Marine Linefish Management Association (SAMLMA) and Blue Continent Products.

It is recommended that the survey vessel be accompanied by a chase vessel with staff familiar with the fisheries expected in the area. It is also recommended that an experienced on-board Marine Mammal Observer (MMO) should be deployed on the survey vessel to help mitigate negative interaction with marine mammals in the area. It is likely that a Passive Acoustic Monitoring (PAM) system will be needed but this will be determined by the marine mammal experts. In addition, due to the sensitivity relating to the marine reserves as well as due to the high likelihood of encountering marine mammals, a PAM operator may be deployed working in collaboration with the MMO. Because of the likelihood of interaction with fisheries it is recommended that a Fisheries Liaison Officer (FLO) accompanies the vessel to facilitate communication with fishers and to minimise negative interactions.

## 1. INTRODUCTION

Impact Africa Limited is proposing to explore for oil and gas in the Transkei and Algoa Exploration Areas off the Eastern Cape Coast of South Africa (see Figure 1). Together the two exploration areas cover an area of approximately 45,838 km$^2$ with water depths ranging from the shoreline to approximately 4000 m. The purpose of the exploration is to investigate the subsea structures to determine the presence of hydrocarbons (oil and gas).

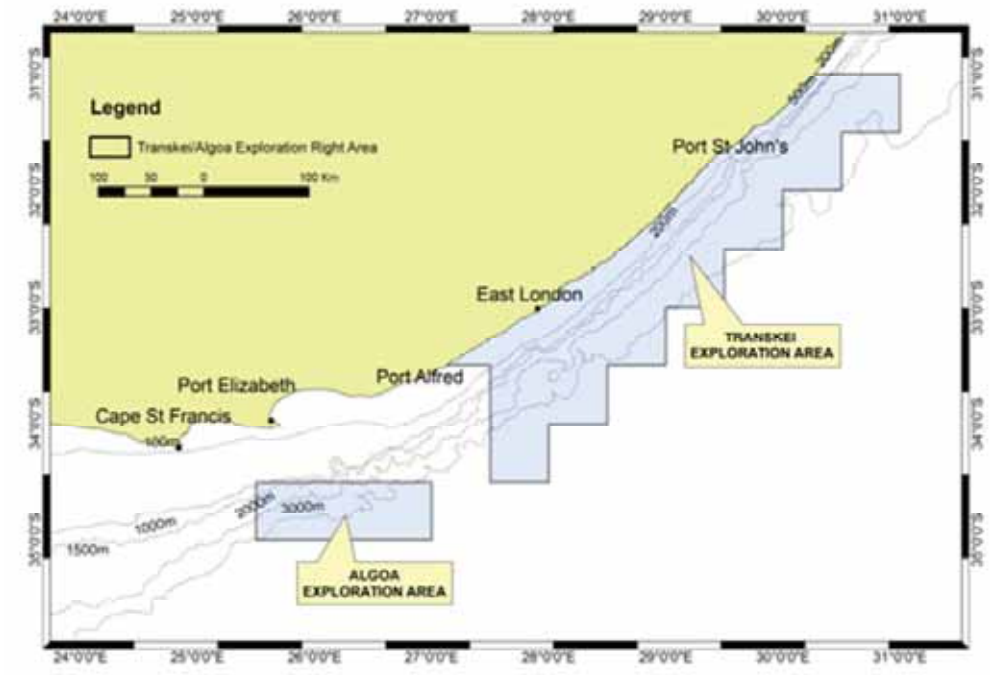



**Figure 1. Location of the Transkei Algoa Exploration Area off the Eastern Cape Coast South Africa.**

Impact Africa has lodged an application for an Exploration Right with Petroleum Resource Agency of South Africa (PASA) in terms of Section 74 of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) which was accepted on 1st March 2013. A requirement of obtaining the Exploration Right is that an Environmental Management Programme (EMPr) has to be compiled and submitted to PASA in terms of Section 39 of the MPRDA. This report was prepared as part of the EMPr, which is being compiled by Environmental Resource Management South Africa (Pty) Ltd (ERM) and gives an assessment of the likely impact of the proposed survey on the fisheries and fishing industries in terms of the possible disruption to fishing activity and loss of access to fishing grounds resulting from the safety zone and larger safe operational limit required around the seismic vessel and gear. Furthermore, mitigation measures are proposed with a view to reducing potential negative effects between seismic and fishing operations

Impact Africa is proposing a three-year exploration programme which will be conducted in a phased approach however some of the phases might occur in parallel or the final order of activities may change. The proposed exploration programme would commence with airborne geophysics acquisition in 2014. Thereafter, a 2D and / or 3D seismic survey would be acquired, followed by processing and interpretation. An integrated seabed sampling programme would be undertaken in order to identify seabed features that are indicative of natural hydrocarbon seepage and to sample sediments and associated hydrocarbons at and just below the seabed.

The proposed exploration programme consists of the following:

- **Airborne geophysics programme** (gravity and magnetic data) to better define existing structural trends, identify additional features and to address depth to basement / magnetic source;
- **Seismic survey(s)** programme to investigate subsea geological formations followed by processing and interpretation;
- **Surface heat flow measurements, seabed and water column sampling programme** to obtain thermal and hydrographic data;
- **Multi-beam echo sounder and sub-bottom profile programme** to image the seabed and near surface geology in the immediate vicinity of each core and test location and;
- **Sediment coring programme,** which would include piston coring methods to sample for hydrocarbon seepage.

It should be noted that this assessment only considers the cumulative impact of the seismic survey, multi-beam bathymetry survey and the seabed sampling using a piston corer.

### 1.1 Seismic survey(s) programme

Seismic surveys are carried out to collect either 2D or 3D data. For this investigation Impact Africa is proposing to undertake a 2D seismic survey. However, if it is determined by subsequent analysis of existing data, that acquisition of a seismic dataset utilising 3D seismic techniques might be a more advantageous approach for data collection, then a 3D seismic survey might be substituted for the 2D survey or may be done in addition to the 2D survey. 2D surveys are typically applied to obtain regional data from widely spaced survey grids (tens of kilometres) and infill surveys on closer grids (down to 1 km spacing) to provide more detail over specific areas of interest. In contrast, 3D surveys are typically applied to promising petroleum prospects to assist in fault interpretation, distribution of sand bodies, estimates of oil and gas in place and the location of exploration wells.

The proposed 2D seismic survey would be at a minimum 5 000 km in total length comprising a number of low density spaced survey lines covering the Transkei and Algoa Exploration Areas. Although survey commencement would ultimately depend on a permit award date, availability of seismic contractors and other factors, it is anticipated that the survey would be undertaken during the summer of 2014/2015 and would take in the order of 150 productive days to complete.

The seismic vessel would travel along transects of a prescribed grid within the survey area that have been chosen to cross any known or suspected geological structure in the area. During surveying the seismic vessel would travel at a speed of between four and six knots (i.e. 2 to 3 metres per second). After a complete transect, the survey vessel would be required to make a "turning circle" in order to shift to the next transect. The vessel may also be required to move out of the acquisition area during periods of inclement weather and adverse sea conditions. Inclement weather conditions would occasionally affect data acquisition and lead to an extended survey duration.

A seismic survey involves a towed airgun array which provides the seismic source energy for the profiling process, and a seismic wave detector system, usually known as the hydrophone streamer. The anticipated airgun and hydrophone array would be dependant 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 are illustrated in Figure 2.

The airgun array would be fired at approximately 10 to 20 second intervals at an operating pressure of between 2000 to 2500 psi and volume 3000 to 5000 cubic inches. Similar airgun arrays are around 220 dB re 1 $mPa^2$-m. However, based on analogue sound sources, sound levels for the seismic survey can theoretically be expected to attenuate below 160 dB less than 1325 m from source array. The sound waves are reflected by boundaries between sediments of different densities and return signals are recorded by hydrophones mounted inside streamer cables and transmitted to the seismic vessel for electronic processing.

Because the sound-waves are extremely weak as they are recorded, the operation is very sensitive to outside sources of vibration, such as vessels, rigs and engineering activity.

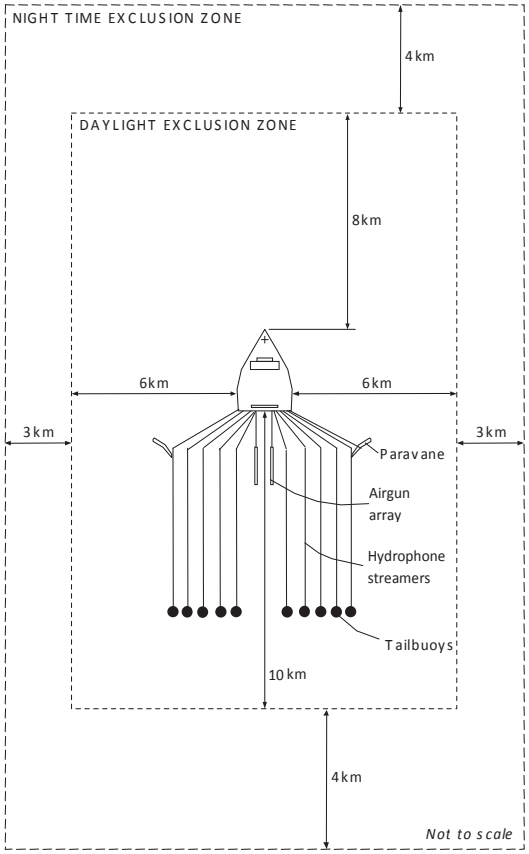



**Figure 2. Typical configuration for a 3D seismic survey operation. Safe operational limits applicable to both 2D and 3D surveys are also shown.**

Under the Convention on the International Regulation for Preventing Collisions at Sea (COLREGS 1972), seismic survey vessels that are engaged in surveying are defined as a *vessel restricted in their ability to manoeuvre*. As such it is a requirement that sea-going vessels that are engaged in fishing activities when surveys are underway shall, as far as possible, keep out of the way of seismic vessels which has restricted manoeuvrability. It should also be noted that under the Marine Traffic Act (Act No. 2 of 1981), seismic survey vessels are considered to be "offshore installations" and are thus protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter these safety zones. In addition to the statutory 500 m safety zone, a seismic contractor may 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 8 km fore and aft of the vessel during daylight hours (this increases to 12 km during hours of darkness) - see Figure 2. Support vessels are usually commissioned as "chase" boats to ensure that other vessels adhere to the safe operational limits.

### 1.2 Multi-beam bathymetry programme

The multi-beam bathymetry survey would be undertaken over the majority of the Transkei Algoa Exploration Right area. This system produces a digital terrain model of the seafloor.

The survey vessel would be equipped with a multi-beam echo sounder to obtain swath bathymetry and a sub-bottom profiler to image the seabed and the near surface geology in the immediate vicinity of each core and test location (see Section 1.1 above). The multi-beam system provides depth sounding

information on either side of the vessel's track across a swath width of approximately two times the water depth.

It is anticipated that data acquisition would take in the order of 150 productive days to complete at a vessel speed of about 5 knots.

### 1.3 Sediment coring programme

The seabed sampling programme would include the piston coring method in order to sample for hydrocarbon seepage.

A piston corer would be used to collect seabed geochemical samples. The piston corer is lowered over the side of the survey vessel and allowed to free fall from about 3 m above the seabed to allow good penetration. Recovered core samples would be visually described and three sets of sub-samples would be retained for further analysis in an onshore laboratory. Any material having geologic or environmental interest would be preserved for further study. The remaining sediment would be returned to the seabed.

It is anticipated that up to 50 core samples would be collected across the Transkei and Algoa Exploration Right areas. Each individual core would have a disturbance area and volume of 0.01 $m^2$ and 0.07 $m^3$, respectively, resulting in a total disturbance area and volume of approximately 0.39 $m^2$ and 3.53 $m^3$, respectively. The number of cores samples and the exact location would be identified following the analysis of the multi-beam bathymetric survey results.

It is anticipated that the initial seabed sampling programme would take in the order of 120 productive days to complete.

## 2. DATA SOURCES

Relevant fisheries data were sourced from the Department of Agriculture, Forestry and Fisheries (Branch: Fisheries) (DAFF) record of commercial catch and effort. Data were obtained for the following sectors; small pelagic (1987 to 2011), demersal trawl (2006 to 2011), mid-water trawl (2000 to 2011), demersal hake long-line (2002 to 2011), demersal shark long-line (2003 to 2008), large pelagic (1998 to 2011), South Coast rock lobster (2001 to 2011), traditional line fishery (1985 to 2011) and squid jig. Catch and effort statistics are captured on grid areas of either $20^2$, $10^2$ or $5^2$ nautical minutes[1]. Additional

[1] Fisheries datasets normally have reporting errors which have been removed from this analysis..

information was obtained from the *South Africa, Namibia and Mozambique Fishing Industry Handbook 2012*.

## 3. BACKGROUND TO FISHERIES

The South African fishing industry consists of at least 20 commercial fishing sectors operating within the country's 200 nautical mile Exclusive Economic Zone (EEZ). The most economically valuable of these are the demersal trawl and long-line fisheries, targeting the cape hakes *Merluccius paradoxus* and *M. capensis*. Secondary commercial species landed in the hake-directed fisheries include an assemblage of demersal fish of which monk fish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*) are the most important. However, the largest fishery by volume is the small pelagic species using small pelagic purse-seine gear. This fishery targets sardine (*Sardinops sagax*), anchovy (*Engraulis encrasicolus*) and round herring (*Etrumeus whitheadii*). Other fisheries active on the South-West Coast are the pelagic long-line fishery for tunas and swordfish, and the tuna pole and traditional linefish sectors (commercial and recreational). South Coast rock lobster (*Jasus lalandii*) is an important commercial trap fishery exploited close to the shoreline. The commercial sectors that operate in the vicinity of the proposed survey area are listed in Table 1 below:

**Table 1. List of commercial fisheries that operate in the vicinity of the proposed survey area**

| No. | Fishery | Gear Type | Targeted Species |
|---|---|---|---|
| 1. | Small pelagic purse-seine | Purse-Seine | Sardine (*Sardinops sagax*), anchovy (*Engraulis encrasicolus*), round herring (*Etrumeus whitheadii*) |
| 2. | Demersal offshore trawl | Demersal trawl | Cape hakes (*Merluccius paradoxus, M. capensis*) |
| 3. | Mid-water trawl | Mid-water trawl | Horse mackerel (*Trachurus capensis*) |
| 4. | Demersal long-line | Demersal long-line | Cape hakes (*M. paradoxus, M. capensis*) |
| 5. | Demersal shark | Demersal long-line | Soupfin shark (*Galeorhinus galeus*), smooth-hound shark (*Mustelus spp*.) |
| 6. | Large pelagic long-line | Pelagic long-line | Yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*), swordfish (*Xiphias gladius*), mako shark (*Isurus oxyrinchus*), blue shark (*Prionace glauca*) |
| 7. | South Coast rock lobster | Long-line trap | *Palinurus gilchristi* |
| 8. | Traditional line fish & Hake handline | Hand line or rod-and-reel | Snoek (*Thyrsites atun*), yellowtail (*Seriola lalandi*) longfin tuna (*Thunnus alalunga*), yellowfin (*Thunnus albacares*), Kabeljou (*Argyrosomus inodorus*), Geelbek (*Atractoscion aequidens*), sparidae, scombridae, sciaenidae |
| 9. | Squid Jig | Hand line jig | *Loligo vulgaris reynaudii* |

## 4. SOUTH AFRICAN COMMERCIAL FISHING SECTORS

### 4.1 Small Pelagic Purse-Seine Fishery

The small pelagic fishery is the largest South African fishery by volume and the second most important in terms of value. Small pelagic species abundance and distribution fluctuates considerably in accordance with the Benguela upwelling ecosystem in which they exist. Annual landings have fluctuated between 300 000 and 600 000 tons over the last decade[2], with landings of 312 000 tons recorded for 2009 (all species). The two main targeted species are sardine and anchovy, with associated by-catch of round herring (red-eye) and juvenile horse mackerel. In 2012 the TAC for sardine was set at 100 595 tons. Fishing grounds occur primarily along the West and South coasts of the Western Cape and the Eastern Cape coast up to a distance of 50 nautical miles offshore, but usually occur closer inshore of the 100 m bathycontour. Ports of deployment correspond to the location of canning factories and fish reduction plants along the coast. The majority of the fleet of 78 vessels operates from St Helena Bay, Saldanha Bay and Hout Bay with fewer vessels operating on the South Coast from the harbours of Gansbaai, Mossel Bay, Port St Francis and Port Elizabeth.

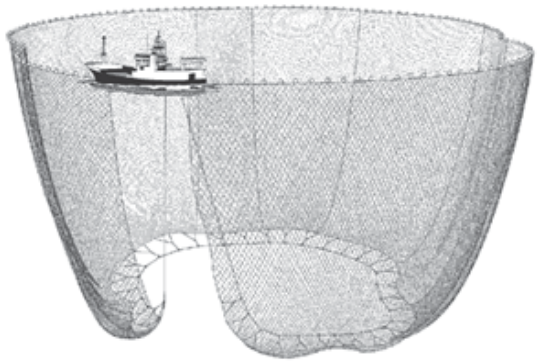


**Figure 3. Typical gear configuration of a pelagic purse-seine vessel targeting small pelagic species.**

The small pelagic sector operates throughout the year with a short break over the Christmas and New Year period. The geographical distribution and intensity of the fishery is largely dependent on the seasonal fluctuation and geographical distribution of the targeted species. The sardine-directed fleet consists of larger vessels that tend 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 similarly the intensity of this fishery is dependent on fish availability and is most active in the period from March to September. Round herring (non-quota species) is targeted when available and specifically in the early part of the year (January to March) and is distributed South of Cape Point to St Helena Bay. This fishery may extend further offshore

[2]Acoustic surveys are conducted to assess the pre- and post-spawning biomass of small pelagic species and the TAC is set and adjusted accordingly each year.

than the sardine and anchovy-directed fisheries. Vessels based in Port St Francis and Port Elizabeth target sardine exclusively.

The fleet consists of wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 11 m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel will steam around it and encircle it with a large net, extending to a depth of 60 to 90 m (see Figure 3). Netting walls surround aggregated fish, 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. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped onboard into the hold of the vessel. It is important to note that after the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered onboard and this may take up to 1.5 hours. Therefore, direct communication from the seismic survey vessel would be required to ensure pure-seine vessels stay clear of the survey vessel. Vessels usually operate overnight and return to offload their catch the following day.

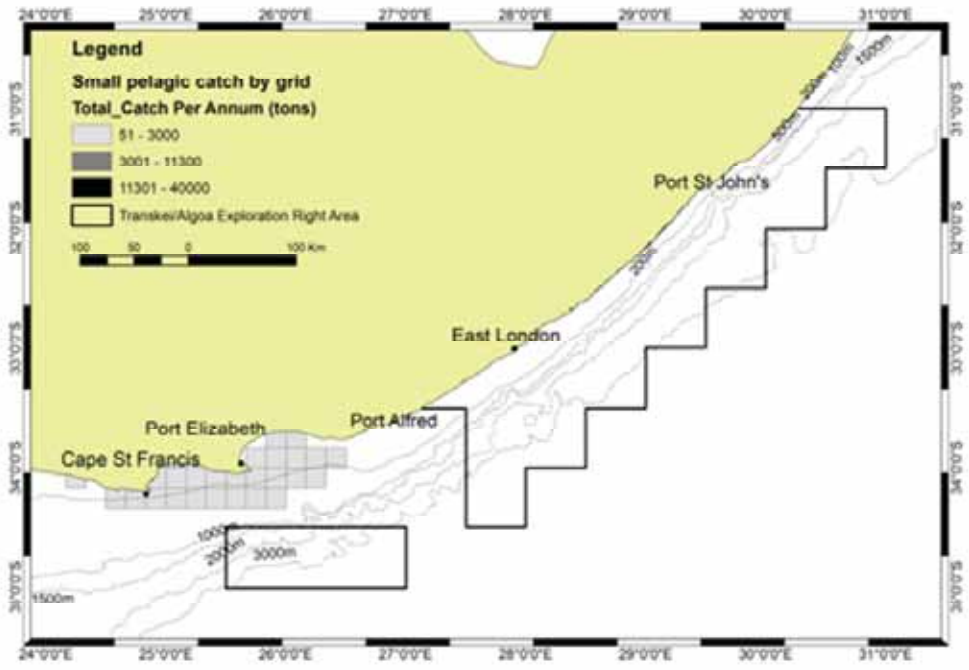



**Figure 4. Distribution of small pelagic purse-seine catches (tons per annum) with respect to the proposed survey area (1987 – 2011)**

The pelagic purse-seine fishery operates predominantly inshore on the West Coast with some fishing activity in the inshore bay areas of the south coast. Fishing effort is not conducted in the vicinity of the proposed survey area. As such, no impact is expected on the small pelagic fishery and the degree of confidence of the assessment for this fishery is high. It should be noted that if the seismic vessel moves

out and inshore of the Algoa Exploration Area, the likelihood of the towed array encountering small pelagic gear increases.

### 4.2 Demersal Trawl Fishery

The demersal trawl fishery is South Africa's most important fishery and, for the last decade, it has accounted for more than half of the income generated from commercial fisheries. Prior to 1978 a single demersal trawl fishery targeted the two Cape hake species off southern Africa. After this date, the fishery was formally separated into an offshore sector targeting deep-water hake (*M. paradoxus)* and an inshore sector targeting shallow-water hake (*M. capensis*) and Agulhas sole (*Austroglossus pectoralis*). These sectors are divided at the 110 m depth contour on the South Coast (the inshore fishery does not occur West of the 20° E line of longitude). Offshore fishing grounds along the West Coast are centred at depths of between 200 m and 900 m and extend from Hondeklipbaai in a southward direction to the southern point of the Agulhas Bank. On the South Coast, deep-sea trawlers may not fish shallower than 110 m depth or within 20 nautical miles of the coast. In this southern region, rocky terrain largely forces trawlers to concentrate on the offshore edge of the Agulhas Bank. Inshore trawl grounds are located between Cape Agulhas and the Great Kei River. In this region hake directed trawling is most intense along the 100 m depth contour, although in the vicinity of Mossel Bay trawling occurs close inshore. Sole directed fishing takes place primarily between Mossel Bay and Struisbaai and there is no sole-directed activity West of the 20° E line of longitude. The Total Allowable Catch of hake for the demersal trawl fishery was set at 144 741 tons in 2012.

The deep-sea fleet is segregated into wet fish and freezer vessels which differ in terms of the capacity for the processing of fish offshore (at sea) and in terms of vessel size and capacity (shaft power of 750 – 3000 kW). Wet fish vessels have an average length of 45 m, are generally smaller than freezer vessels which may be up to 90 m in length. While freezer vessels may work in an area for up to a month at a time, wet fish vessels fish may only remain in an area for about a week before returning to port.

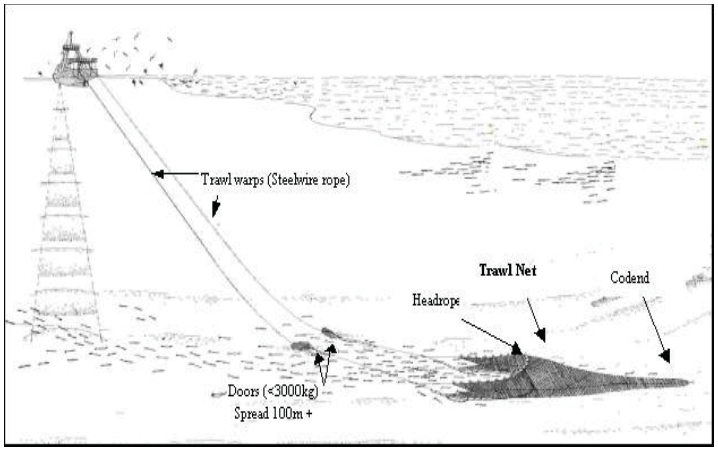



**Figure 5. Schematic diagram of trawl gear typically used by demersal trawl vessels.**

Trawl gear configurations are similar for both freezer and wet fish vessels, the main elements of which are trawl warps, bridles and doors, a footrope, headrope, net and codend (see Figure 5). Generally, trawlers tow their gear at 3.5 knots for up to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net opening may be up to 50 m in width and 10 m in height. The swept area on the seabed between the doors may be up to 150 m.

The majority of vessels licensed to conduct hake deep-sea trawl are registered at the ports of Cape Town and Saldanha Bay, with 15 of a total of 98 vessels registered at South and East Coast harbours. It is highly likely that both freezer and wet fish trawler vessels would be encountered within the proposed survey area and there is generally no seasonal differentiation in effort levels. Although these vessels are restricted in manoeuvrability when gear is deployed the gear can be recovered within a period of 30-minutes or the vessel can take avoiding action at its trawl speed. Therefore, direct communication from the survey vessel would be required in order to keep trawl vessels clear of the survey vessel.

A small proportion of the trawling grounds overlap with the northern boundary of the Algoa Exploration Area, inshore of the 200 m isobath (see Figure 6). Approximately 857 km$^2$ of trawling grounds coincide with the proposed survey area which is equivalent to approximately 0.6 % of the total trawl ground available to the fishery. Over the period 2006 to 2011, 0.08 % of the total effort of the demersal trawl fishery was conducted within the proposed area at an average of 27 trawls per year.

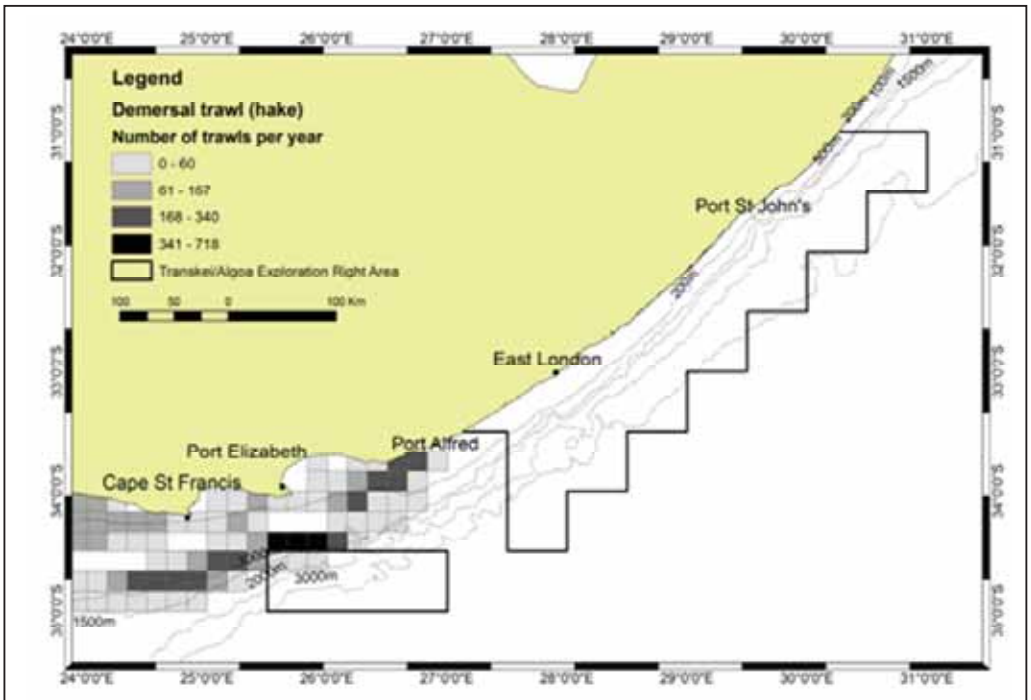



**Figure 6. Distribution of demersal trawling activity over the period 2006 to 2011 in relation to the proposed survey area**

The impact of the proposed survey operations on the demersal trawl sector is considered to be of local extent and short-term duration. The status of the impact is assessed to be negative, of LOW intensity and of overall VERY LOW significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is high.

| *Environmental Impact Assessment of Fisheries: Demersal Trawl* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | High | High |

### 4.3 Mid-Water Trawl

There are currently 15 rights holders within this fishing sector, however the majority of effort is undertaken by a single dedicated vessel, which operates all year round. A large factory vessel capable of sustained operation has made economically viable targeting of horse mackerel possible. The fishery targets adult horse mackerel (*Trachurus capensis*).

Mid-water trawling is defined in the Marine Living Resources Act (No. 18 of 1998) (MLRA) as any net which can be dragged by a fishing vessel along any depth between the sea bed and the surface of the sea without continuously touching the bottom. In practice, mid-water trawl gear does occasionally come into contact with the seafloor.

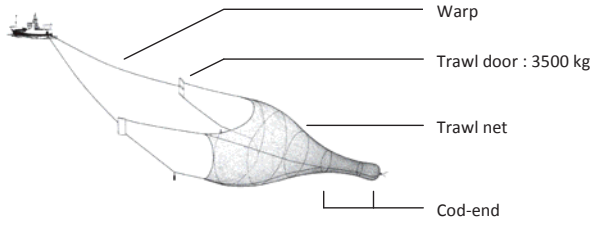



**Figure 7. Schematic diagram showing the typical configuration of mid-water trawl gear**

Mid-water trawling gear configuration is similar to that of demersal trawlers (refer to Figure 7), except that the net is manoeuvred vertically through the water column. Currently the FMV *Desert Diamond* is the only dedicated mid-water trawler and is the largest registered South African commercial fishing vessel. The *Desert Diamond* is 120 m in length and has a Gross Registered Tonnage

(GRT) of 8000 t. The towed gear may extend up to 1 km astern of the vessel and comprises trawl warps, net and codend. Trawl warps between 32 and 38 mm in diameter. The trawl doors (3.5 t each) maintain the net opening which ranges from 120 to 130 m in width and from 40 m to 80 m in height. Weights in front of, and along the ground-rope provide for vertical opening of the trawl. The cable transmitting acoustic signal from the net sounder might also provide a lifting force that maximizes the vertical trawl opening. To reduce the resistance of the gear and achieve a large opening, the front part of the trawl net are usually made from very large rhombic or hexagonal meshes. The use of nearly parallel ropes instead of meshes in the front part is also a common design. Once the gear is deployed, the net is towed for several hours at a speed of 4.8 to 6.8 knots predominantly parallel with the shelf break.

The fishery targets adult horse mackerel which aggregate in highest concentration on the Agulhas Bank. Shoals of commercial abundance are found in limited areas and the spatial extent of mid-water trawl activity is relatively limited when compared to that of demersal trawling. Fishing grounds are condensed into three areas on the shelf edge of the south and east coasts. 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 (See Figure 8). A more recently exploited area lies to the south of the Agulhas Bank 21 °E and 22 °E in depths ranging from 200 m to 400 m).

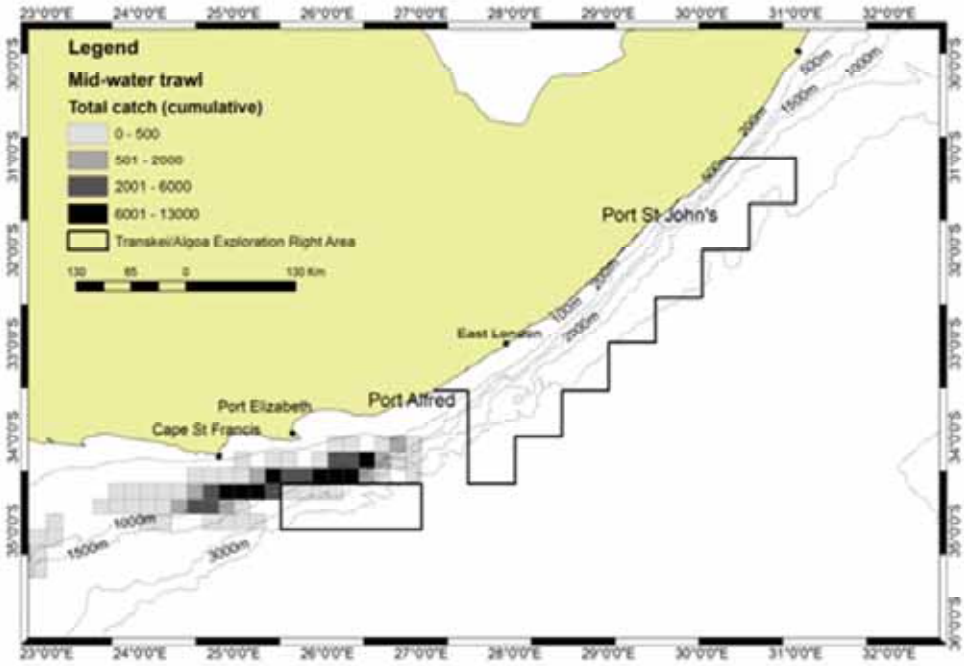



**Figure 8. Distribution of fishing effort of the mid-water trawl fishery in the vicinity of the proposed survey area. Data are presented on a 10' by 10' grid for the period 2000 to 2011.**

The mid-water trawl fishery operates on the South Coast (between 22°E and 28°E) in water depths greater than 100 m and therefore coincides with the proposed survey area. Approximately 4.4% of the midwater trawl fishing grounds overlaps with the Algoa Exploration Right Area which constitutes about 0.3% (or 430 kg) of the total cumulative catch for the years 2000 - 2011.

The impact of the proposed survey operations on the midwater trawl fishery is considered to be of local extent and short-term duration. The status of the impact is assessed to be negative, of LOW intensity and of overall VERY LOW significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is high.

| *Environmental Impact Assessment of Fisheries: Midwater Trawl* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very low | Very low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | High | High |

### 4.4 Demersal Long-Line Fisheries

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 long-line fishery for Cape hakes and the shark long-line sector targeting only the demersal species of shark. A demersal long-line vessel may deploy either a double or single line which is weighted along it's length to keep it close to the seafloor (see Figure 10). Steel anchors, of 40 to 60 kg are placed at the ends of each line to anchor it. These anchor positions are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16 mm diameter) is more buoyant than the bottom line, it is

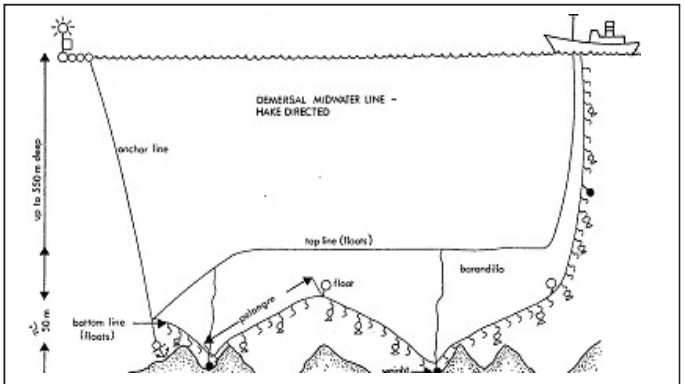



**Figure 9. Schematic diagram showing a typical configuration of long-line gear used to target demersal fish species.**

raised off the seafloor and minimizes the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically 20 – 30 nautical miles in length. 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 5 – 9 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 1 knot) and can take six to ten hours to complete. During hauling operations manoeuvrability would be severely restricted and direct communications from the survey vessel would be required in order to keep vessels and gear clear of the survey vessel.

#### 4.4.1. Hake-Directed Long-line Fishery

Like the demersal trawl fishery the target species of this fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. A total nominal catch weight of 9 493.8 tons was set for this fishery in 2012, which increased 10% from the previous year. The hake long-line fishery is a relatively new fishery in South Africa, having started in 1994 as an experimental fishery, with long-term commercial rights being allocated in 2004. Fishing takes place along the West and South East coasts, in areas similar to those targeted by the demersal trawl fleet. The catch is landed predominantly prime quality hake for export to Europe. The catch is packed unfrozen on ice and the value is approximately 50% higher than that of trawled hake. There are currently 64 vessels licensed within the sector, operating from all major harbours, including Cape Town, Hout Bay, Mossel Bay and Port Elizabeth. Secondary points of deployment include St Helena Bay, Saldanha Bay, Hermanus, Gansbaai, Plettenberg Bay and Cape St Francis; however there is far less activity from these areas than from the main harbours. Vessels based in Cape Town and Hout Bay operate almost exclusively on the West Coast (west of 20° E). Vessels vary from 18 m to 50 m in length and remain at sea for four to seven days at a time. The fishery is directed in both inshore and offshore areas. Inshore long-line operations are restricted by the number of hooks that may be set per line while offshore operations may only take place in waters deeper than 110 m and is restricted to the use of no more than 20 000 hooks per line.

Demersal hake long-line vessels operate in well-defined areas extending along the shelf break from Port Nolloth to Port Elizabeth (Figure 10). Fishing activity would be expected to occur within the survey area along and inshore of the 200 m depth contour. Long-line grounds coincide with approximately 4564 $km^2$ of the proposed survey area which is estimated to be 2 % of the total grounds fished by the hake demersal long-line fishery. A total of about 211 333 hooks were set and 40 tons of hake were caught in the survey area over the period 2002 to 2011, corresponding to 0.5 % of the overall national effort and 0.5 % of the total landings respectively.

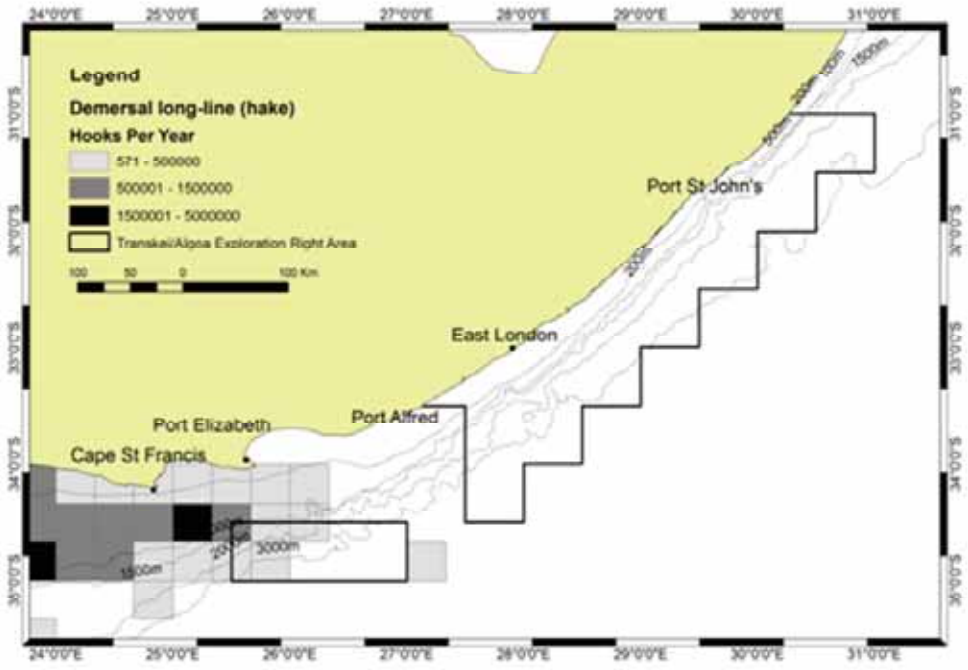



**Figure 10. Distribution of fishing effort of the demersal long-line fisheries for hake (2002 – 2011) in the vicinity of the proposed survey area.**

The impact of the proposed survey operations on the demersal hake-directed long-line sector is considered to be of local extent and short-term duration. The status of the impact is assessed to be negative, of LOW intensity and of overall VERY LOW significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is high.

| *Environmental Impact Assessment of Fisheries: Demersal Long-Line (Hake)* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | High | High |

### 4.4.2. Shark-Directed Long-Line Fishery

Capture of demersal shark species occurs primarily in the demersal shark long-line fishery whilst catches of pelagic shark species occurs primarily in the large pelagic sector that targets tuna and swordfish. Prior

to 2006, both demersal and pelagic shark catches were managed as a single shark fishery. The demersal shark fishery targets soupfin shark (*Galeorhinus galeus*), smooth-hound shark (*Mustelus spp*.), spiny dogfish (*Squalus* spp), St Joseph shark (*Callorhinchus capensis*), *Charcharhinus* spp., rays and skates. Other species which are not targeted but may be landed include cape gurnards (*Chelidonichthys capensis*), jacopever (*Sebastichthys capensis*) and smooth hammerhead shark (*Sphyrna zygaena*). Catches are landed at the harbours of Cape Town, Hout Bay, Mossel Bay, Plettenberg Bay, Cape St Francis, Saldanha Bay, St Helena Bay, Gansbaai and Port Elizabeth and currently six permit holders have been issued with long-term rights to operate within the fishery. The fishery operates relatively close to shore, inshore of the 100 m isobath. Demersal shark longline fishing is also not permitted in False Bay between Cape Hangklip and Cape Point, or in tidal lagoons, estuaries, closed areas and marine protected areas.

The demersal shark-directed longline fishing grounds do not coincide (see Figure 11) with the proposed survey. As such, no impact is expected on the shark directed longline industry and the degree of confidence of the assessment for this fishery is high. It should be noted that if the seismic vessel moves out and inshore of the Algoa Exploration Area, the likelihood of the towed array encountering demersal longline gear increases.

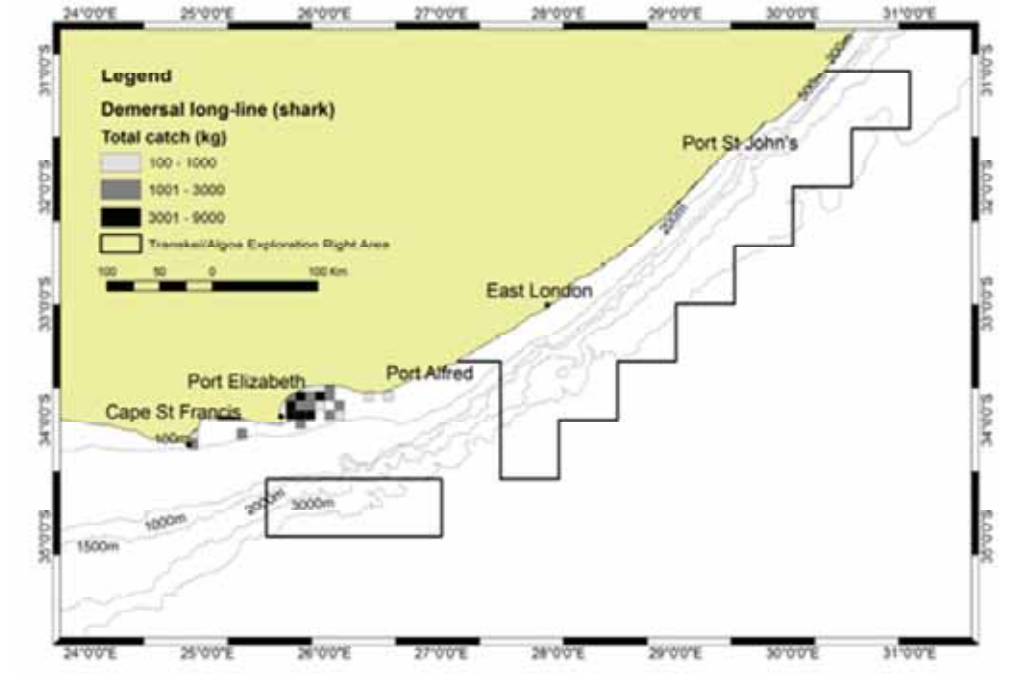



**Figure 11. Catch distribution of the demersal long-line fisheries for shark (2005 – 2008) in the vicinity of the proposed area.**

## 4.5 Large Pelagic Long-Line Fishery

The target species within the South African pelagic long-line sector are yellowfin tuna, bigeye tuna, swordfish and shark species (primarily mako shark). Due to the highly migratory nature of these species, stocks straddle the EEZs of a number of countries and international waters. As such they are managed at an international level through country allocations and global effort control. It is at this level that Regional Fisheries Management Organisations (RFMOs) such as the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC) and the Commission for the Conservation of Southern Bluefin Tuna (CCBT) are instrumental in managing the pelagic long-line sector around the South African coast. Nominal reported landings of 2 136 tons were recorded within the fishery for the year 2009 within the South African EEZ and on the high seas.

Twenty-nine foreign and South-African-flagged vessels operate within South African waters. Trip lengths range from three weeks to three months in duration. Although most vessels operate from the Cape Town harbour, the areas of operation are extensive within the entire South African EEZ. Tuna are targeted at thermocline fronts, predominantly along and offshore of the shelf break. Pelagic long-line vessels set a drifting mainline, up to 50-100 km in length, and are marked at intervals along its length with radio buoys (Dahn) and floats to facilitate later retrieval (see Figure 12). 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. Between radio buoys the mainline is kept near the surface or at a certain depth by means of ridged hard-plastic buoys, (connected via a "buoy-lines" of approximately 20 to 30 m). The buoys are spaced approximately 500 m apart along the length of the mainline. Hooks are attached to the mainline on branch lines, (droppers), which are clipped to the mainline at intervals of 20 to 30 m between the ridged buoys. The main line can consist of twisted tarred rope (6 to 8 mm diameter), nylon monofilament (5 to 7.5 mm diameter) or braided monofilament ~6mm in diameter. A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. During hauling a vessel's manoeuvrability is severely restricted, however, in an

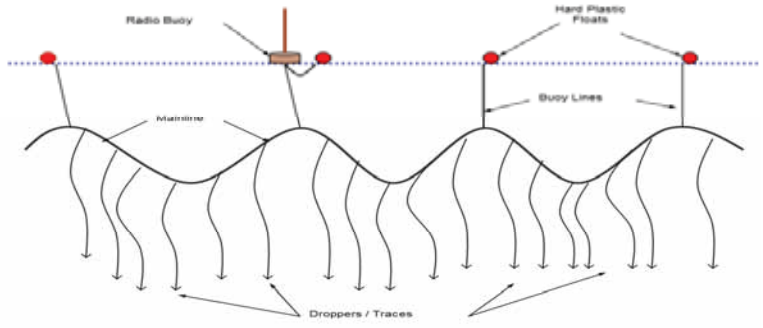



**Figure 12. Typical pelagic long-line gear configuration targeting tuna, swordfish and shark species. Note the gear floats close to the surface of the sea and would present a potential obstruction to surface navigation.**

emergency situation, the line may be dropped to be hauled in at a later stage. Note that the gear is set close to the sea surface and will present a potential obstruction to surface navigation and the towed seismic array if encountered. Therefore, direct communication between the survey vessel and the pelagic long-line vessels is important.

Pelagic long-line effort extends along and offshore of the 200 m isobath. A high proportion of the pelagic longline grounds occur within the proposed survey area (in both the Transkei and Algoa Exploration Areas) (see Figure 13). Within the South African and foreign-flagged fleets combined approximately 7 % of the total national effort is conducted within this area (approximately 130 800 hooks per year), and 6 % of the total national catch is taken by this fishery (approximately 85 tons per year).

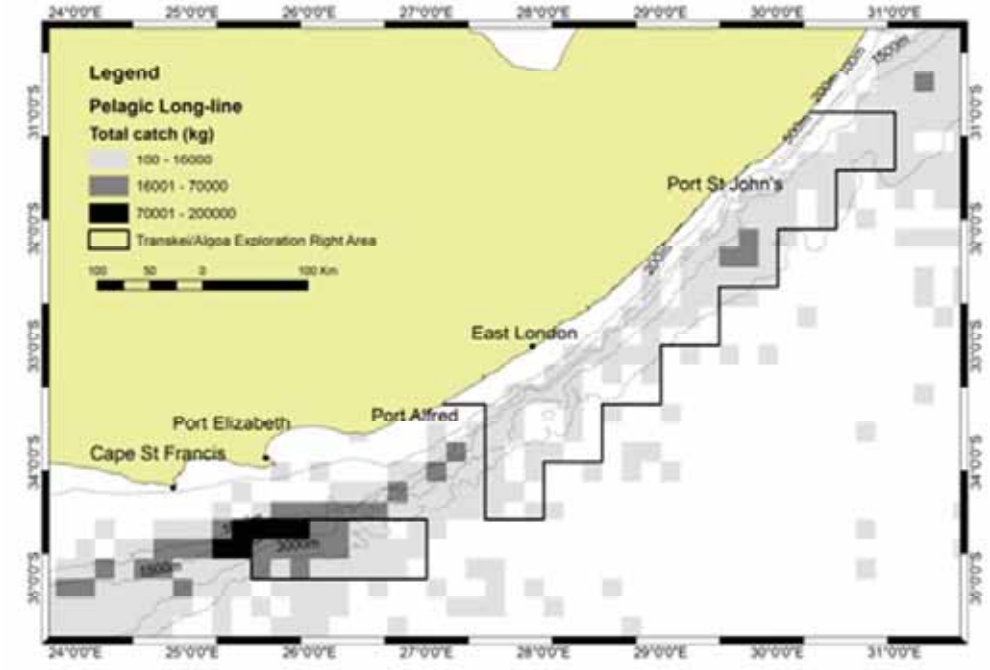



**Figure 13. Distribution of long-line fishing effort targeting large pelagic species (tuna, shark and swordfish) from 1997 to 2011 in relation to the proposed survey area**

The impact of the proposed survey operations on the large pelagic long-line sector is considered to be of regional extent and short-term duration. The status of the impact is assessed to be negative, of MEDIUM intensity and of overall LOW significance. It is highly probable that the impact would occur and the degree of confidence of the assessment for this fishery is high.

| *Environmental Impact Assessment of Fisheries: Pelagic Long-Line* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Regional | Regional |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Medium | Medium |
| **Significance** | Low | Low |
| **Status** | Negative | Negative |
| **Probability** | Highly Probable | Highly Probable |
| **Confidence** | High | High |

### 4.6 South Coast Rock Lobster

The South Coast rock lobster fishery is a deep-water long-line trap fishery. Barrel-shaped plastic traps are set for periods ranging from 24 hours to several days. Each vessel typically hauls and resets approximately 2 000 traps per day in sets of 100 to 200 traps per line. They will set between ten lines and 16 lines per day, each of which may be up to 2 km in length. Each line will be weighted to lie along the seafloor and will be connected at each end to a marker buoy at the sea surface. Vessels are large, ranging from 30 m to 60 m in length. Those that have on-board freezing capacity will remain at sea for up to 40 days per trip, while those retaining live catch will remain at sea between seven and 10 days before discharging at port. The fishery operates year-round with the month of October showing relatively low activity within the fishery. There were seven vessels operating within the fishery in 2012.

South Coast Rock Lobster (*Palinurus gilchristi*) occurs on the continental shelf of the South Coast between depths of 50 m and 200 m. Two areas are commercially viable to fish on the South Coast, the first is on the Agulhas Bank and the second is within 50 km of the shoreline between Mossel Bay and East London (see Figure 14). The fishery is restricted by the Agulhas Current from operating far offshore, but would be expected to operate within the proposed survey area on the Agulhas Bank and inshore of the 200 m isobath.

The proposed survey area coincides with approximately 5% (2600 $km^2$) of South Coast rock lobster fishing grounds on the Agulhas Bank. Within the proposed survey area approximately 21 400 traps were set between 2001 and 2011 which is 3% of the total effort conducted within South African waters by the South Coast rock lobster fishery. The catch of rock lobster taken from the area amounted to 3 % of the total catch taken by the fishery between the years 2001 - 2011.

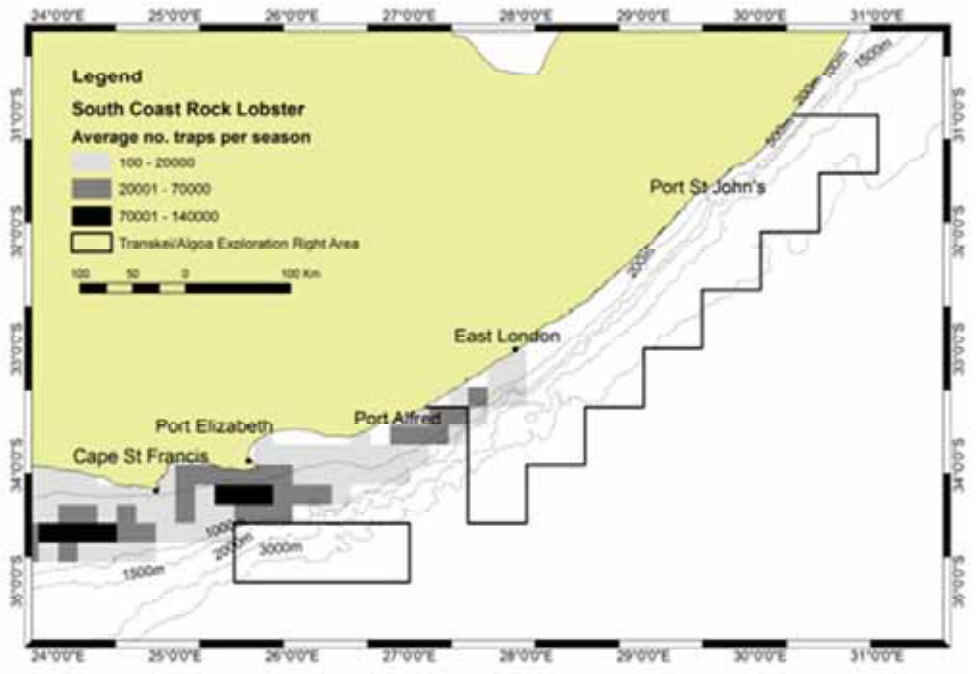



**Figure 14. Distribution of the South Coast rock lobster trap fishery in relation to the proposed survey area. Data are presented as the average annual number of traps hauled on a 10' by 10' grid basis for the period 2001 to 2011**

The impact of the proposed survey operations on the South Coast rock lobster fishery is considered to be of local extent and short-term duration. The status of the impact is assessed to be negative, of LOW intensity and of overall VERY LOW significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is high.

| ***Environmental Impact Assessment of Fisheries: South Coast Rock Lobster*** | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | High | High |

### 4.7 Traditional Line Fishery

The traditional line fishery is based on approximately 35 species. Different assemblages of species are targeted according to the region in which they are being fished and include tuna species and a diversity of species in the famillae (sparidae, serranidae, caragidae, scombridae and sciaenidae). On the West Coast the dominant species targeted is snoek (*Thyrsites atun*). This fishery is split between recreational, commercial and subsistence sectors, jointly landing approximately 14 100 tons per annum (2009). Historically, the sector incorporated the tuna pole fishery and was ranked third according to volume of landings and overall economic value. Currently, the volume of fish caught by the traditional line fishery is much lower than many other commercial sectors, but is one of the most important in terms of the number of active participants. Almost all of the traditional linefish catch is consumed locally.

The commercial fishery operates between Port Nolloth on the West Coast to Cape Vidal on the East Coast from the coast out to approximately the 100 m depth contour. Gear consists of hand line or rod-and-reel. Recreational permit-holders use skiboats (fast motor boats) or fish from the shore (anglers) whereas the commercial sector is purely boat-based. Subsistence permit-holders are shore-based and estuarine (purely based on the East Coast). It should be noted that the hake handline fishery (although currently not in operation) targets *M. capensis* on the south coast, in similar areas as the linefish sector. Line fishers are restricted to a maximum of ten hooks per line but a single fisherman may operate several lines at a time. Due to the diversity of the fishery there are many launch sites with an extensive operational range and is therefore managed on an effort rather than on a catch basis. There are currently about 450 commercial vessels operating extensively around the coast and many more skiboats used in the recreational sector which may be launched from a number of slipways and harbours.

Linefish and hake handline activity occurs in the vicinity of the proposed survey area, particularly in the inshore regions (< 100 m) where the survey vessel is likely to transit during inshore line changes. Of particular importance would be to relay information of the proposed survey operations and timing to all right's holders within the fishery. Linefish data are not available at present therefore known historical distribution of linefish effort is shown in Figure 15.

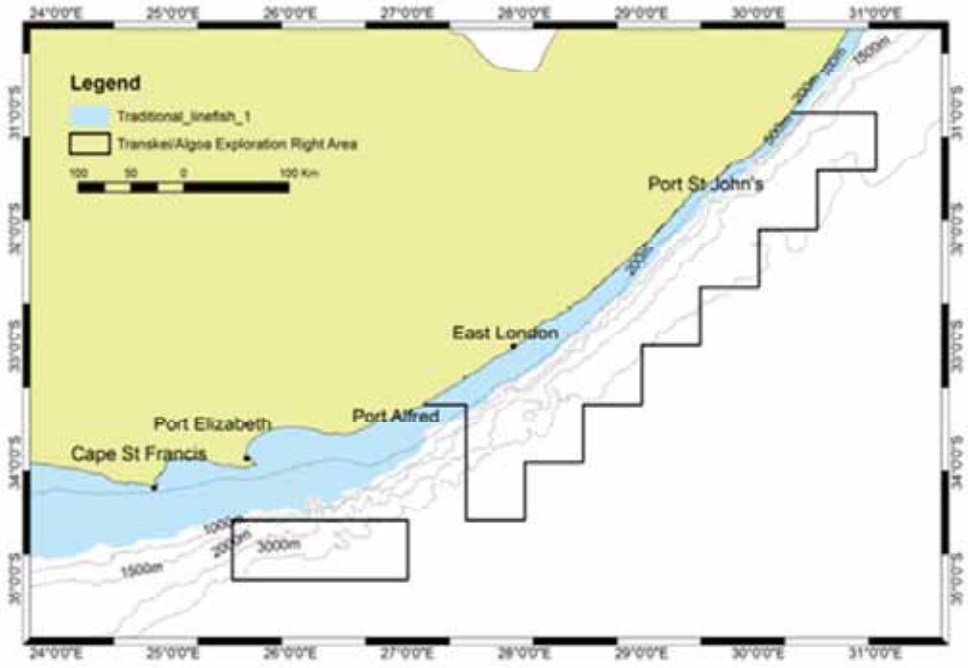



**Figure 15. Approximate range of traditional line and hake handline fisheries in relation to the proposed survey area**

The impact of the proposed survey operations on the traditional line-fish sector is considered to be of local extent and short-term duration. The status of the impact is assessed to be negative, of LOW intensity and of overall VERY LOW significance. It is improbable that the impact would occur and the degree of confidence of the assessment for this fishery is MEDIUM.

| ***Environmental Impact Assessment of Fisheries: Traditional Line-Fish and Hake Hand-Line*** | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Improbable | Improbable |
| **Confidence** | Medium | Medium |

### 4.8 Squid Jig

Chokka squid (*Loligo vulgaris reynaudii*) is distributed from the border of Namibia to the East Coast. Of South Africa. Along the South Coast adult squid is targeted in spawning aggregations on fishing grounds

extending from Plettenberg Bay to Port Alfred between 20 m and 120 m depths (see Figure 18). The fishery is seasonal, with most effort conducted between November and March. The method of fishing involves hand-held jigs and bright lights which are used to attract squid at night. The catch is frozen at sea or at land-based facilities at harbours between Plettenberg Bay and Port Alfred.

The squid fishery is managed in terms of the Total Allowable Effort (TAE) allowed within the fishery and also sees an annual four week closure between October and November during which time DAFF undertakes a survey on spawning aggregations in the bay areas. Fishing rights were issued to 121 companies for the period 2006 to 2013 with the number of crew and vessels active within the fishery listed as 2422 and 136 respectively. A maximum landed catch of 12 000 tons was recorded in 2003/4 with a leveling-off thereafter to 9 000 tons between 2005 and 2008. Currently the catch in the fishery approximates 6000 t and the annual average catch value is about R180 million.

The distribution of fishing effort is mostly concentrated in the bay areas around Cape St Francis and Port Elizabeth (See Figure 16, however the research survey conducted by DAFF has shown that squid also occurs near Cape Agulhas, False Bay and Saldahna). Approximately, 6 % (2565 km$^2$) of the squid jig fishing grounds coincide with the Transkei Algoa Exploration Area. The effort or number of fishing events that occur inside the proposed area amounts to 0.4 % (25 events) of the total effort.

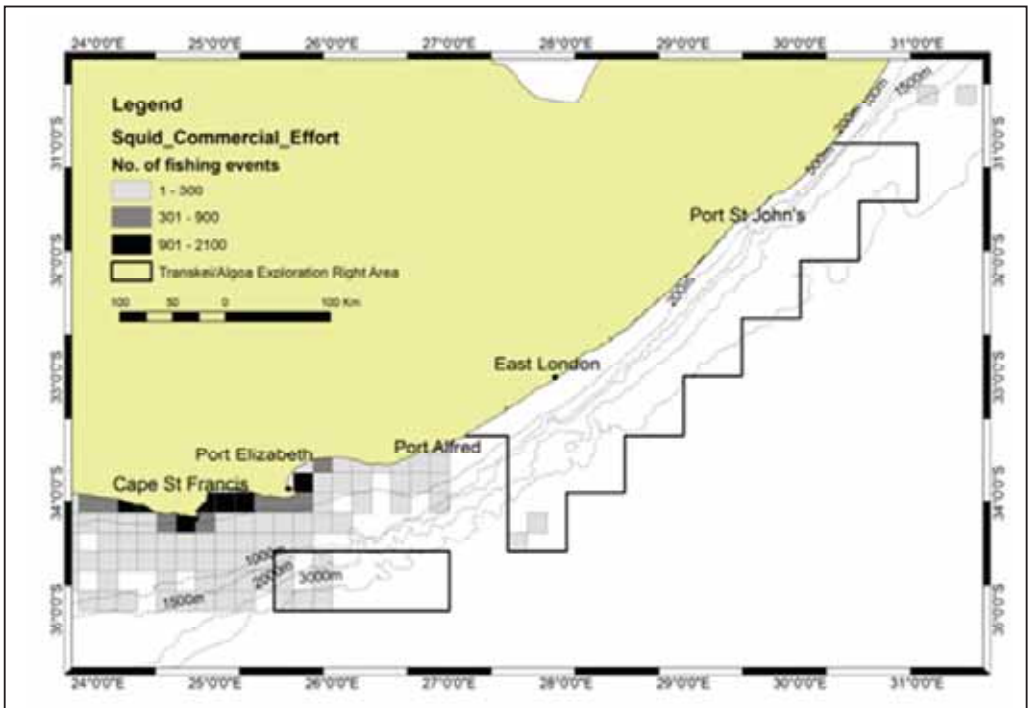



**Figure 16. Distribution of the squid jig fishery in relation to the proposed survey area**

The impact of the proposed survey operations on the squid jig sector is considered to be of local extent and short-term duration. The status of the impact is assessed to be negative, of LOW intensity and of overall VERY LOW significance. It is probable that the impact would occur and the degree of confidence of the assessment for this fishery is MEDIUM.

| *Environmental Impact Assessment of Fisheries: Squid Jig Fishery* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

## 5. SUMMARY AND RECOMMENDATIONS

Seven commercial fisheries have been identified as being active in the vicinity of the proposed survey area and could potentially be impacted by seismic operations (Table 2).

- The small pelagic purse seine fishery operates predominately on the West and South Coast inshore of 200 m. Although these fishing grounds fall inside the proposed survey area, the fishery is only likely to be impacted by the presence of the survey vessel during inshore line changes
- A small proportion of fishing activities for the hake-directed demersal trawl and long-line sectors takes place within the proposed survey area. Both fisheries are active all year round.
- Long-line vessels targeting pelagic tuna species, swordfish and shark operate extensively around the entire coast along the shelf-break and into deeper waters. As such vessel activity would be expected to be encountered within the survey area around the 200 m bathycontour. Since the gear used by this fishery consists of surface-set drifting lines of up to 100 km in length, this fishery would be highlighted as posing a potential hazard to the seismic operation in terms of gear entanglements. Note that the datasets for the tuna-directed and historical shark-directed fisheries have been combined in this assessment as similar gear types are used in both sectors. Shark-directed pelagic long-line vessels fish shallower than tuna-directed long-line vessels.

- The south coast rock lobster occurs on the Agulhas Bank and near Mossel Bay in depths between 50 m and 200 m - within the proposed survey area. Since the fishery operates year-round it is likely that the fishery would operate during the survey.

The following recommendations are proposed in order to minimize disruptions to both the survey and fishing operations:

1. Prior to the commencement of the survey, the fishing industry, DAFF (Branch: Fisheries) and other IAPs should be consulted and informed of the pending activity and the likely implications for the various fishing sectors in the area as well as research surveys planned to coincide with the proposed seismic operations. IAPs should include; South African Deepsea Trawling Industry Association (SADSTIA), South East Coast Inshore Fishery Association (SECIFA), Small Hake Quota Holders Association, South African Tuna Longline Association, Hake Longline Association, South Coast Rock Lobster Association, Shark Longline Association, South African Marine Linefish Management Association (SAMLMA) and Blue Continent Products.
2. It is recommended that the survey vessel be accompanied by at least one chase boat. An experienced Fisheries Liaison Officer (FLO) should be deployed on board either the survey vessel or chase boat to facilitate communication with maritime vessels. In the case where an FLO is not deployed, the on-board Marine Mammal Observer (MMO) should be familiar with fisheries operational in the area.
3. The MMO should report daily on vessel activity and respond and advise on action to be taken in the event of encountering fishing gear and the survey vessel's potential impacts on marine fauna. The MMO should have extensive experience as it is likely that large and small marine mammals will be encountered during the survey. This is also likely to include the use of Passive Acoustic Monitoring (PAM)
4. A daily electronic reporting routine should be set up to keep interested and affected parties informed of survey activity, fisheries interactions and environmental issues.

In terms of fishing sector-specific communications, the following mitigation measures are recommended (see appendix 2 for contact details):

1. .**Small pelagics:** Identify active vessels and set up ongoing communications with operators for the duration of the survey.

2. **Demersal Long-line**: Identify gear (marked at each end by a surface buoy) - demersal long-liners generally stay close to their lines when gear is deployed and communication with skippers on the position of set gear is essential.
3. **Demersal Trawl**: Identify vessels – due to proximity to trawl grounds, notification of survey areas of operation is essential. With good communication and reduced time in the area disruption of fishing activity can be minimised.
4. **Pelagic Long-line**: Establish communications with the known operators if drifting buoys (with radar responders) are sighted
5. **South Coast Rock Lobster Trap**: Establish a direct line of communication with operators and proposed trap areas – sectors of the fishing area will need to be closed when doing the seismic survey and will have a significant impact on both the seismic operator and the fishery if fouling occurs. This will require negotiation with the fishing companies.
6. **Squid jig**: Identify active vessels and set up ongoing communications with operators for the duration of the survey

**Table 2**. Summary table showing impact ratings of the proposed offshore seismic survey on the fishing industry and fisheries research cruise both with and without mitigation measures.

| | Extent | Duration | Intensity | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|
| ***Environmental Impact Assessment of Fisheries: Safety zone during proposed survey operations*** | | | | | | |
| ***Demersal Trawl*** | | | | | | |
| Without mitigation | Local | Short-term | Low | Very Low | Probable | High |
| With mitigation | Local | Short-term | Low | Very Low | Probable | High |
| ***Mid-Water Trawl*** | | | | | | |
| Without mitigation | Local | Short-term | Low | Very Low | Probable | High |
| With mitigation | Local | Short-term | Low | Very Low | Probable | High |
| ***Demersal Longline (Hake-directed)*** | | | | | | |
| Without mitigation | Local | Short-term | Low | Very Low | Probable | High |
| With mitigation | Local | Short-term | Low | Very Low | Probable | High |
| ***Pelagic Longline*** | | | | | | |
| Without mitigation | Regional | Short-term | Medium | Low | Highly Probable | High |
| With mitigation | Regional | Short-term | Medium | Low | Highly Probable | High |
| ***South Coast Rock Lobster*** | | | | | | |
| Without mitigation | Local | Short-term | Low | Very Low | Probable | High |
| With mitigation | Local | Short-term | Low | Very Low | Probable | High |
| ***Traditional Line Fishery*** | | | | | | |
| Without mitigation | Local | Short-term | Low | Very low | Improbable | Medium |
| With mitigation | Local | Short-term | Low | Very low | Improbable | Medium |
| ***Squid Jig Fishery*** | | | | | | |
| Without mitigation | Local | Short-term | Low | Very low | Probable | High |
| With mitigation | Local | Short-term | Low | Very low | Probable | High |

**APPENDIX 1.**
**CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS**

The following convention was used to determine significance ratings in the assessment:

| Rating | Definition of Rating |
|---|---|
| ***Extent – defines the physical extent or spatial scale of the impact*** | |
| LOCAL | Extending only as far as the activity, limited to the site and its immediate surroundings. Specialist studies to specify extent. |
| REGIONAL | e.g. South-East Coast |
| NATIONAL | South Africa |
| INTERNATIONAL | Extending beyond the borders of South Africa |
| ***Duration – the time frame over which the impact will be experienced*** | |
| SHORT TERM | 0 - 5 years |
| MEDIUM TERM | 6 - 15 years |
| LONG TERM | Where the impact would cease after the operational life of the activity, either because of natural processes or by human intervention. |
| PERMANENT | Where mitigation either by natural processes or by human intervention would not occur in such a way or in such time span that the impact can be considered transient. |
| ***Intensity – establishes whether the magnitude of the impact is destructive or benign in relation to the sensitivity of the receiving environment*** | |
| Zero to Very Low | Where fishing operations are not affected. |
| LOW | Where fishing operations continue, albeit in a slightly modified way. |
| MEDIUM | Where fishing operations continue, albeit in a modified way. |
| HIGH | Where fishing operations are altered to the extent that they temporarily or permanently cease. |
| ***Status – describes whether the impact would have a negative, positive or zero effect on the affected environment*** | |
| POSITIVE | The impact benefits fishing operations |
| NEGATIVE | The impact results in a cost to the fishing industry |
| NEUTRAL | The impact has no effect |
| ***Probability – the likelihood of the impact occurring*** | |
| IMPROBABLE | Where the possibility of the impact to materialise is very low either because of design or historic experience. |
| PROBABLE | Where there is a distinct possibility that the impact would occur. |
| HIGHLY PROBABLE | Where it is most likely that the impact would occur. |
| DEFINITE | Where the impact would occur regardless of any preventive measures. |

| *Degree of confidence in impact predictions – based on available information and specialist knowledge* | |
|---|---|
| LOW | Less than 35% sure of impact prediction. |
| MEDIUM | Between 35% and 70% sure of impact prediction. |
| HIGH | Greater than 70% sure of impact prediction. |

Using core criteria above, the significance of the impact is determined:

| Rating | Definition of Rating |
|---|---|
| ***Significance – attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity*** | |
| VERY HIGH | Impacts could be EITHER:<br>of ***high intensity*** at a ***regional level***and endure in the ***long term***;<br>OR of ***high intensity*** at a ***national level*** in the ***medium term***;<br>OR of ***medium intensity*** at a ***national level***in the ***long term.*** |
| HIGH | Impacts could be EITHER:<br>of ***high intensity*** at a ***regional level*** and endure in the ***medium term***;<br>OR of ***high intensity*** at a ***national level*** in the ***short term***;<br>OR of ***medium intensity*** at a ***national level*** in the ***medium term;***<br>OR of ***low intensity*** at a ***national level*** in the ***long term***;<br>OR of ***high intensity*** at a ***local level*** in the ***long term***;<br>OR of ***medium intensity*** at a ***regional level*** in the ***long term.*** |
| MEDIUM | Impacts could be EITHER:<br>of ***high intensity*** at a ***local level*** and endure in the ***medium term***;<br>OR of ***medium intensity*** at a ***regional level*** in the ***medium term***;<br>OR of ***high intensity*** at a ***regional level*** in the ***short term***;<br>OR of ***medium intensity*** at a ***national level*** in the ***short term***;<br>OR of ***medium intensity*** at a ***local level*** in the ***long term***;<br>OR of ***low intensity*** at a ***national level*** in the ***medium term;***<br>OR of ***low intensity*** at a ***regional level***in the ***long term.*** |
| LOW | Impacts could be EITHER<br>of ***low intensity*** at a ***regional level*** and endure in the ***medium term***;<br>OR of ***low intensity*** at a ***national level*** in the ***short term***;<br>OR of ***high intensity*** at a ***local level*** and endure in the ***short term***;<br>OR of ***medium intensity*** at a ***regional level*** in the ***short term***;<br>OR of ***low intensity*** at a ***local level*** in the ***long term***;<br>OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.*** |
| VERY LOW | Impacts could be EITHER<br>of ***low intensity*** at a ***local level*** and endure in the ***medium term***;<br>OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***;<br>OR of ***low to medium intensity*** at a ***local level*** and endure in the ***short term.*** |
| INSIGNIFICANT | Impacts with:<br>Zero or Very Low intensity with any combination of extent and duration. |
| UNKNOWN | In certain cases it may not be possible to determine the significance of an impact. |

Additional criteria to be considered, which could "increase" the significance rating are:

- Permanent / irreversible impacts (as distinct from long-term, reversible impacts);
- Potentially substantial cumulative effects; and
- High level of risk or uncertainty, with potentially substantial negative consequences.

Additional criteria to be considered, which could "decrease" the significance rating are:

- Improbable impact, where confidence level in prediction is high.

When assigning significance ratings to impacts *aftermitigation*, the specialist needs to:

- First, consider probable changes in intensity, extent and duration of the impact after mitigation, assuming effective implementation of mitigation measures, leading to a revised significance rating; and
- Then moderate the significance rating after taking into account the likelihood of proposed mitigation measures being effectively implemented. Consider:

    - Any potentially significant risks or uncertainties associated with the effectiveness of mitigation measures;
    - The technical and financial ability of the proponent to implement the measure; and
    - The commitment of the proponent to implementing the measure, or guarantee over time that the measures would be implemented.

The significance ratings are based on largely objective criteria and inform decision-making at a project level as opposed to a local community level. In some instances, therefore, whilst the significance rating of potential impacts might be "low" or "very low", the importance of these impacts to local communities or individuals might be extremely high. The importance which I&APs attach to impacts must be taken into consideration, and recommendations should be made as to ways of avoiding or minimising these negative impacts through project design, selection of appropriate alternatives and / or management.

The relationship between the significance ratings after mitigation and decision-making can be broadly defined as follows:

| ***Significance after mitigation – considering changes in intensity, extent and duration after mitigation and assuming effective implementation of mitigation measures, the effect on decision-making:*** | |
|---|---|
| Very Low; Low | Will not have an influence on the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented. |
| Medium | Should influence the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented. |
| High; Very High | Would strongly influence the decision to proceed with the proposed project. |

# ENVIRONMENTAL MANAGEMENT PROGRAMME FOR PROPOSED EXPLORATION ACTIVITIES IN THE TRANSKEI AND ALGOA BLOCKS, OFF THE EAST COAST OF SOUTH AFRICA

## Marine Faunal Assessment

**Prepared for:**

**On behalf of**

**April 2013**

PISCES Environmental Services (Pty) Ltd

# ENVIRONMENTAL MANAGEMENT PROGRAMME FOR PROPOSED EXPLORATION ACTIVITIES IN THE TRANSKEI AND ALGOA BLOCKS, OFF THE EAST COAST OF SOUTH AFRICA

## MARINE FAUNAL ASSESSMENT

Prepared for

Environmental Resources Management Southern Africa Pty Ltd

Prepared by

Andrea Pulfrich
Pisces Environmental Services (Pty) Ltd

April 2013

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**ABBREVIATIONS and UNITS**

| | |
|---|---|
| CCA | CCA Environmental (Pty) Ltd |
| cm | centimetres |
| CMS | Centre for Marine Studies |
| CSIR | Council for Scientific and Industrial Research |
| dB | decibells |
| EMP | Environmental Management Programme |
| GAENP | Greater Addo Elephant National Park |
| h | hour |
| Hz | Herz |
| IUCN | International Union for the Conservation of Nature |
| kHz | kiloHerz |
| km | kilometre |
| $km^2$ | square kilometre |
| KZN | KwaZulu-Natal |
| M&CM | Marine & Coastal Management: Department of Environment Affairs |
| MMO | Marine Mammal Observer |
| MPA | Marine Protected Area |
| m | metres |
| m/sec | metres per second |
| PAM | Passive Acoustic Monitoring |
| ppt | parts per thousand |
| PTS | permanent threshold shifts |
| rms | root mean squared |
| S | south |
| TTS | temporary threshold shifts |
| 2D | two-dimensional |
| 3D | three-dimensional |
| µg/l | micrograms per litre |
| µPa | micro Pascal |
| °C | degrees Centigrade |
| % | percent |
| ~ | approximately |
| < | less than |
| > | greater than |

PTS — Permanent threshold shift is a raising of the hearing threshold from over-exposure to high-level sound; but, in this case, permanent damage occurs to the inner ear sensory mechanisms and hence the shift is non-reversible.

TTS — Temporary threshold shift is the temporary raising of hearing threshold resulting from exposure to high-level sounds. This is the lowest end of the physical effects scale, which is a temporary, reversible form of hearing impairment. In TTS, the lower threshold of hearing in the relevant frequency band is increased (*i.e.* hearing becomes less sensitive) when exposed to a critical combination of sound intensity and duration.

## EXPERTISE AND DECLARATION OF INDEPENDENCE

This report was prepared by Dr Andrea Pulfrich of Pisces Environmental Services (Pty) Ltd. Andrea has a PhD in Fisheries Biology from the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany.

As Director of Pisces since 1998, Andrea has considerable experience in undertaking specialist environmental impact assessments, baseline and monitoring studies, and Environmental Management Programmes / Plans relating to marine diamond mining and dredging, hydrocarbon exploration and thermal/hypersaline effluents. She is a registered Environmental Assessment Practitioner and member of the South African Council for Natural Scientific Professions, South African Institute of Ecologists and Environmental Scientists, and International Association of Impact Assessment (South Africa).

This specialist report was compiled on behalf of Environmental Resources Management Southern Africa Pty Ltd (ERM) for their use in preparing an Environmental Management Plan for oil and gas exploration activities by Impact Africa Limited, off the East Coast of South Africa. I do hereby declare that Pisces Environmental Services (Pty) Ltd is financially and otherwise independent of the Applicant and ERM.



Dr Andrea Pulfrich

## 1. GENERAL INTRODUCTION

For this investigation Impact Africa Limited is proposing to undertake a three-year exploration programme in the Transkei and Algoa Exploration Areas, on the East Coast of South Africa (Figure 1), comprising:

- Airborne geophysics (gravity and magnetics) data will be acquired for identification of prospective areas of structural trap development and depth to basement/magnetic source
- 2D or 3D seismic data will be acquired and or licensed, processed, and interpreted.
- Surface heat flow measurements will be taken to determine thermal regime and calibrate thermal models.
- Seabottom bathymetry will be determined using a multibeam echosounder to look for hydrocarbon seepages and constrain boundary conditions.
- A seabed and water column sampling program will be carried out to identify seabed and near surface features indicative of natural hydrocarbon seepage.

Although a phased approach will be implemented to the proposed exploration programme, some of the phases might occur in parallel or the final order of activities may change.

In terms of the of Section 79(4)(b) of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA), a requirement for obtaining an Exploration Right is that an Environmental Management Programme report (EMPr) must be compiled in terms of Section 39 and submitted to the Petroleum Agency of South Africa (PASA) for consideration and for approval by the Minister of Mineral Resources. ERM has been appointed to compile the EMPr for the proposed survey. ERM in turn has approached Pisces Environmental Services (Pty) Ltd for a specialist report on potential impacts of the proposed operations on marine fauna in the area.

Hydrocarbon deposits occur in reservoirs in sedimentary rock layers. Being lighter than water they accumulate in traps where the sedimentary layers are arched or tilted by folding or faulting of the geological layers. Marine hydro-acoustic surveys are the primary methods for locating such deposits and are thus an indispensable component of offshore oil or gas exploration. In shallower water exploration approaches may include surface heat flow measurements and seabed drop-core sampling.

The nature of the sound impulses utilised during hydro-acoustic surveys have resulted in concern over their potential impact on marine fauna, particularly marine mammals, fish, and turtles (McCauley *et al*. 2000). Consequently, it has been proposed that environmental management be applied at the exploration stage of the a life cycle of a hydrocarbon field project (Duff *et al*. 1997, in Salter & Ford 2001).

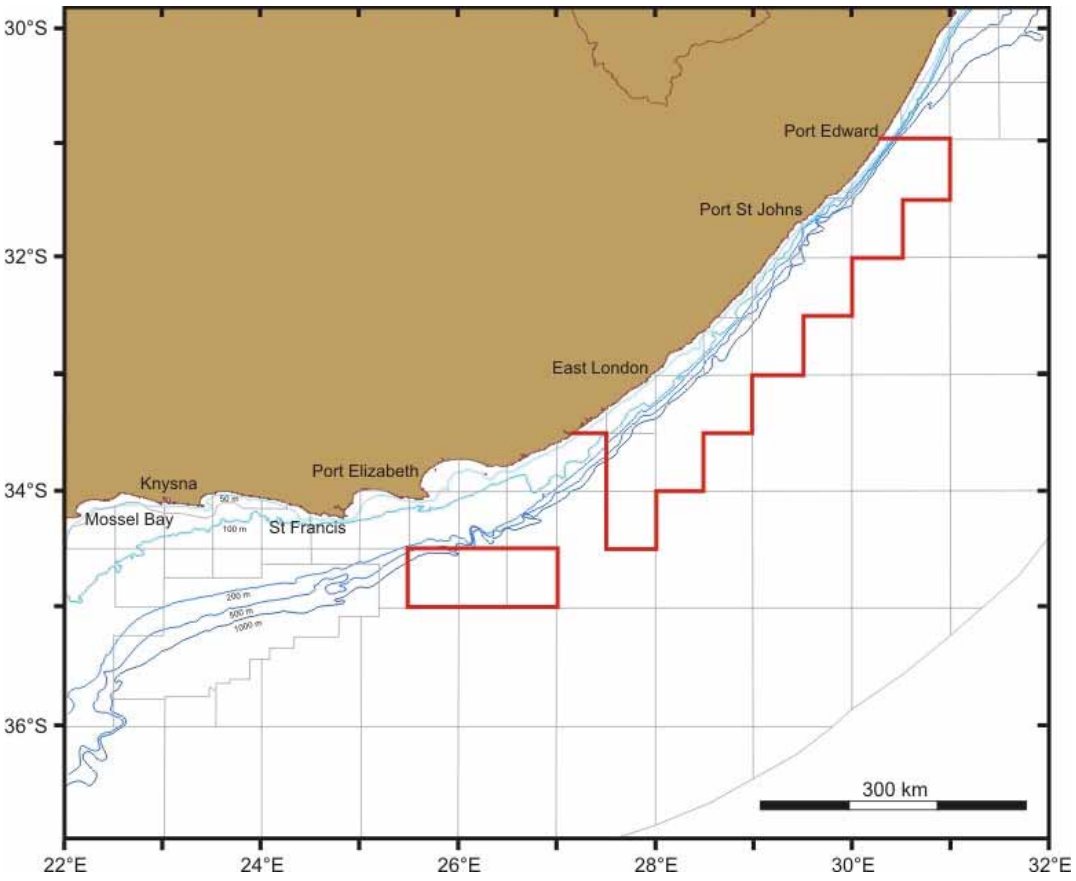



Figure 1: Location of Impact Africa's proposed exploration programme area off the East Coast of South Africa, in relation to neighbouring petroleum licence blocks.

## 1.1. Scope of Work

This specialist report was compiled as a desktop study on behalf of ERM, for their use in developing an EMPr for the proposed oil and gas exploration activities programme on the southeast coast of South Africa.

The terms of reference for this study are:

- Provide a general description of the local marine fauna in and around the proposed seismic area.
- Identify, describe and assess the significance of potential impacts of the proposed seismic survey on the local marine fauna, focussing particularly on marine mammals, fish and penguins, but including generic effects on fish eggs and larvae, and pelagic and benthic invertebrates.
- Identify practicable mitigation measures to reduce any negative impacts and indicate how these could be implemented in the implementation and management of the proposed project.

## 1.2. Approach to the Study

As determined by the terms of reference, this study has adopted a 'desktop' approach. Consequently, the description of the natural baseline environment in the study area is based on a review and collation of existing information and data from the scientific literature, internal reports and the Generic Environmental Management Programme Report (EMPr) compiled for oil and gas exploration in South Africa (CCA & CMS 2001). The information for the identification of potential impacts and the assessment thereof was drawn from various scientific publications, the Generic, information sourced from the Internet as well as Marine Mammal Observer close-out Reports. The sources consulted are listed in the Reference chapter.

All identified marine and coastal impacts are summarised, categorised and ranked in appropriate impact assessment tables, to be incorporated in the overall EMPr.

## 2. DESCRIPTION OF THE PROPOSED PROJECT

Impact Africa is applying for an exploration right to undertake a proposed exploration programme for oil and gas reserves within an area of approximately 145,838 $km^2$, off the Transkei Coast. Water depths in the proposed exploration area range from the shoreline to approximately 4,000 m depth (Figure 1).

The proposed exploration programme would commence with airborne geophysics acquisition over the entire Exploration Right area in 2014. Integration of the airborne geophysical data with well data, and other geologic and geophysical data sets, would provide support for future seismic acquisition planning programmes, and seismic interpretation efforts, exploration concepts and exploration strategies.

Thereafter target areas would be identified for potential 2D and / or 3D seismic surveys , followed by an integrated seabed sampling programme which would be undertaken in order to identify seabed features that are indicative of natural hydrocarbon seepage and to sample sediments and associated hydrocarbons at and just below the seabed. However, some of these phases might occur in parallel or the final order of activities may change.

### 2.1. Airborne Geophysical Acquisition (Phase 1)

Impact Africa proposes to acquire a minimum of 7,500 $km^2$ of airborne high-resolution gravity gradiometry data, as well as gravity and magnetic data, over a period of ~60 days. Acquisition of these data sets and integration of the airborne geophysical data with well data, and other geologic and geophysical data sets, would provide support for future seismic acquisition planning programmes, as well as support integrated seismic interpretation efforts, exploration concepts and exploration strategies.

Acquisition would be accomplished using a fixed wing aircraft. To obtain the highest quality data and resolution, the survey design usually includes relatively low flight altitudes (typically at a 120 m terrain or sea level clearance) and relatively close line spacing of generally no more than 1 km parallel spaced lines, typically oriented perpendicular to main structure orientation.

Although acquisition of such data is passive and the measurement equipment does not emit any inducing forces, low altitude overflights may have both acoustic and visual impacts on large marine mammals in the area. Should data be acquired over the entire Exploration Right area, this would take in the order of 180 productive days to complete.

### 2.2. Seismic Survey (Phase 2)

Seismic survey programmes comprise data acquisition in either two-dimensional (2D) and/or three-dimensional (3D) scales, depending on information requirements. 2D surveys are typically applied to obtain regional data from widely spaced survey grids and provide a vertical slice through the seafloor geology along the survey track-line. Infill surveys on closer grids subsequently provide more detail over specific areas of interest. In contrast, 3D seismic surveys are conducted on a very tight survey grid in specific target areas identified during 2D applications, and provide a cube image of the seafloor geology along each survey track-line.

During seismic surveys high-level, low frequency sound impulses are generated by an array of acoustic instrumentation towed behind a survey vessel, just below the sea surface. The sounds are directed towards the seabed and the seismic signal is reflected by the geological interfaces below the seafloor. The reflected signals are received by receivers or sets of hydrophones towed behind the vessel in a single streamer (2D) or in multiple streamers (3D) and are fed back to the recording instruments on board. The spacing between the hydrophone groups is commonly 25 m or shorter, depending on the purpose of the seismic survey. Each group contains many hydrophones, spaced less than 1 m apart. The hydrophone streamers must be towed at constant depth (6 - 10 m), with flotation usually achieved by filling the cables with kerosene, so that they are neutrally buoyant. To compensate for minor adjustments, Automatic Cable Levellers, or "birds" are used. The ends of the hydrophone streamers are marked with tail buoys, to warn shipping about the presence of the cable in the water. The tail buoys also act as a platform for surface positioning systems so that the cable locations can be accurately monitored (Figure 5).

While acquiring the seismic data, the survey vessel would travel along transects of a prescribed grid within the survey area that have been chosen to cross any known or suspected geological structure in the area. The vessel typically travels at a speed of between four and six knots (*i.e.* 2 to 3 metres per second) while surveying.

The seismic survey would involve a seismic sound source (airgun array) and a hydrophone streamer. The configuration of the airgun and hydrophone array would be dependent on whether a 2D or 3D seismic survey is undertaken. Typically the streamer(s) can be up to 12,000 m long and towed at variable depths between 6 – 30 m depth below the surface. The streamer(s) would therefore not be visible, except for the tail-buoy(s) at the terminal end(s) of the cable(s). The airgun array would be towed 80 - 150 m behind the vessel at a depth of between 5 - 25 m below the surface. As the survey vessel would be restricted in manoeuvrability (a turn radius of 4.5 km is expected), other vessels should remain clear of it. A supply/chase vessel usually assists in the operation of keeping other vessels at a safe distance.

Each triggering of a sound pulse is termed a seismic shot, and these are fired at intervals of 10 - 20 seconds and at an operating pressure of between 2,000 to 2,500 psi and a volume of 3,000 to 5,000 cubic inches. Each seismic shot is usually only between 5 and 30 milliseconds in duration, and despite peak levels within each shot being high, the total energy delivered into the water is low.

Airguns have most of their energy in the 5-300 Hz frequency range, with the optimal frequency required for deep penetration seismic work being 50-80 Hz. The maximum sound pressure levels at the source of airgun arrays in use today in the seismic industry are in the range 230-255 dB re 1µPa at 1 m, with the majority of their produced energy being low frequency of 10-100 Hz (McCauley 1994; NRC 2003). The location where this level of sound is attained is directly beneath the airgun array, generally near its centre, but the exact location and depth beneath the array are dependent on the detailed makeup of the array, the water depth, and the physical properties of the seafloor (Dragoset 2000). However, based on analogue sound sources, sound levels for the seismic survey can notionally be expected to attenuate below 160 dB less than 1,325 m from the source array.

For this investigation Impact Africa is proposing to undertake acquisition of a 2D seismic survey. However, if it is determined by subsequent analysis of existing data, that acquisition of a seismic dataset utilising 3D seismic techniques might be a more advantageous approach for data collection, then a 3D seismic survey might be substituted for the 2D survey or may be done in addition to the 2D seismic survey.

The proposed 2D seismic survey would be in the order of 5,000 km in total length. Most lines will be widely spaced over the Transkei Algoa Exploration Area with some areas where the lines will be closer together

The commencement of the surveys will depend on an Exploration Right award date. It is anticipated that the survey would be undertaken during the summer of 2014/2015 and would take in the order of 150 days to complete.

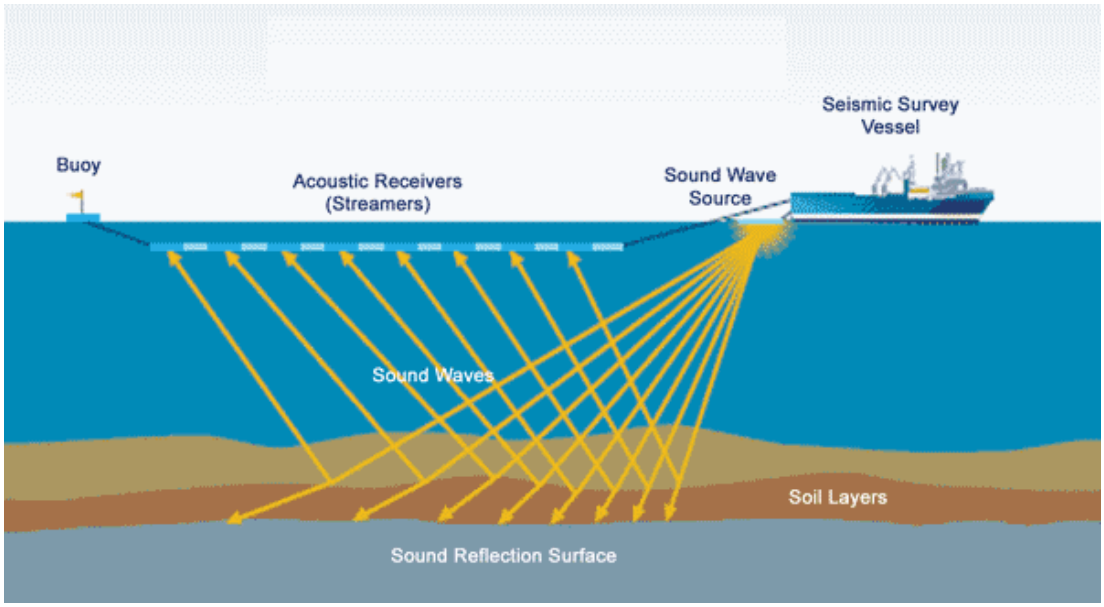



Figure 5: The principles of offshore seismic data acquisition (Source: www.fishsafe.eu).

## 2.3. Surface Heat Flow Measurements (Phase 3)

The heat flow measurements would be conducted using heat flow probes (Figure 2), which would measure both the temperature and thermal conductivity of sediments in situ up to 12 m below the seabed. The probe typically consists of a 6-cm diameter solid alloy steel bar, which extends from the wire termination at the top through the 500 kg lead-fill weight stand, down to the tip of the heat flow probe. The out-rigged thermistor string is attached parallel to the steel bar. Acquisition of these data would be used to determine the thermal regime and calibrate thermal models to understand hydrocarbon system potential.

The measurement device would be lowered from a vessel to near the seabed. It is then allowed to drop under its own weight, being driven into the sediments by gravity. The

instrument is allowed to equilibrate and is then recovered to the surface. No samples or other materials would be recovered with the heat flow probe. It is anticipated that up to 50 measurements would be collected across the Exploration Right area, which would take in the order of 60 productive days to complete.




Figure 2: Heatflow probe being lowered over the side of a survey vessel (Source: www.geo.uni-bremen.de)(Left) and schematic of heatflow probe in seabed (http://www.tdi-bi.com/field_services/hf_info/description.htm)..

## 2.4. Multi-beam Bathymetry Survey (Phase 4)

The multi-beam bathymetry survey would be undertaken over the majority of the Exploration Right area, in order to produce a digital terrain model of the seafloor (Figure 3).

The survey vessel would be equipped with a multi-beam echo sounder to obtain swath bathymetry, and a sub-bottom profiler to image the seabed and the near-surface geology. Multi-beam technology is a complex sonar array that allows surveying of the seafloor at a resolution and accuracy sufficient to image the typical scale of active seafloor seeps. The multi-beam system provides depth-sounding information on either side of the vessel's track across a swath width of approximately two times the water depth, thereby allowing for highly accurate imaging and mapping of seafloor topography in the form of digital terrain models. The multi-beam echo sounder emits a fan of acoustic beams from a transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1 µPa at 1 m. The sub-bottom profiler emits an acoustic pulse from a transducer at frequencies ranging from 3 kHz to 40 kHz and typically produces sound levels in the order of 206 db re 1 µPa at 1 m. The operating frequencies of the acoustic equipment used in sonar surveys typically fall into the high frequency kHz range, and are thus beyond the hearing abilities of most marine fauna.

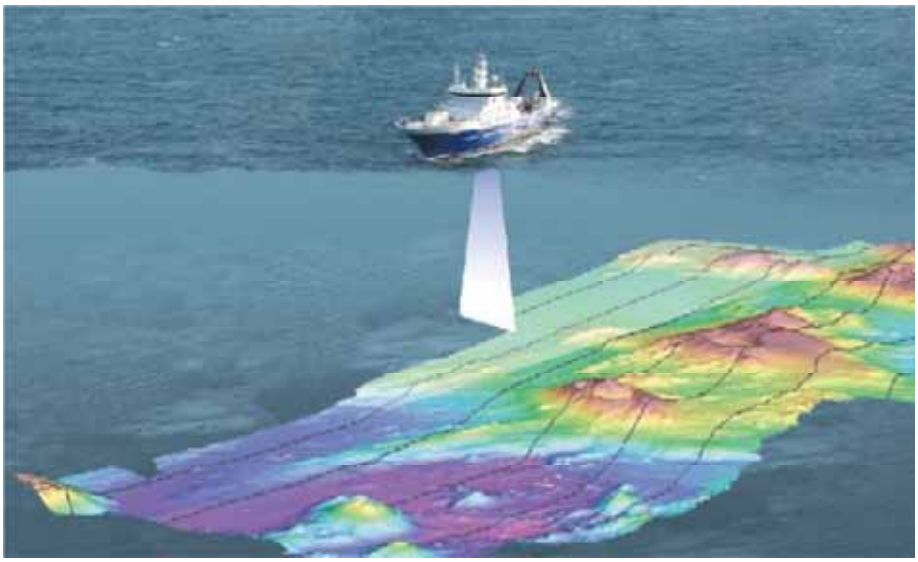


Figure 3: Schematic of a vessel using multi-beam depth/echo sounders (http://www.gns.cri.nz/).

These bathymetric data alone are not sufficient to identify all possible hydrocarbon seeps, as many seeps have no bathymetric expression. Backscatter data is typically collected concurrently by multi-beam echosounders as it can measure several properties of the seafloor associated with hydrocarbon seeps including; hardness; roughness; and volumetric heterogeneity. One or more of these three properties can result in an increase in backscatter intensity recorded by the multi-beam system and aid in the identification of potential natural hydrocarbon seeps on the seafloor in the survey area.

It is anticipated that data acquisition would take in the order of 150 productive days to complete at a vessel speed of 5 knots.

The data acquired by these sonar techniques would be used to identify, prioritize, and target potential piston coring and heat-flow measurement locations. Selected sites will then be sampled with navigated piston cores. The number of cores sampled and their exact location within the licence area can only be evaluated once the multi-beam bathymetric survey results are available.

## 2.5. Sea and Seabed Sampling Programme (Phase 5)

Having identified possible locations of natural hydrocarbon seeps on the seafloor using multi-beam bathymetry, backscatter and sub-bottom profiles, targeted piston coring would be undertaken. Piston coring is one of the more common methods used to collect seabed geochemical samples, with the sequence of operation illustrated in Figure 4. The piston coring operation is carried out by winching the tool over the side of the vessel and lowering the corer to just above the seabed (A). As the trigger weight hits the bottom (B), it releases the weight on the trigger arm and the trigger arm begins to rise. Once the trigger arm has risen through its full 1.2 m of travel (C), the corer is released to "free-fall" the 3 m distance to the bottom, forcing the core barrel to travel down over the piston into the sediment. When the corer hits

the end of its 3 m slack loop, the piston starts up the core barrel (D) creating suction below the piston, and expelling the water out the top of the corer. When forward momentum of the core has stopped, a slow pullout on the winch is begun. The suction created by the core sample in the liner prevents movement of the piston to the top of the core barrel in response to tension on the core wire. This suction triggers the separation of the top and bottom sections of the piston (E). The bottom half of the piston remains in place over the sediment to maintain integrity of the sample, while the top half (attached to the coring wire) "fetches up" against the stop in the core head, allowing the corer to be pulled out of the sediment and the sample to be hauled onboard. The recovered cores are visually examine at the surface for indications of hydrocarbons (gas hydrate, gas parting, or oil staining) and three sets of sub-samples retained for further geochemical analysis. Any material having geologic or environmental interest would be preserved for further study. The remaining sediment would be returned to the seabed.

Typically core barrels are 6 – 9 m in length, with a diameter of 100 mm. It is proposed to take in the order of 50 cores collected across the Exploration Right are. It is anticipated that the initial seabed sampling programme would take on the order of 120 productive days to complete.

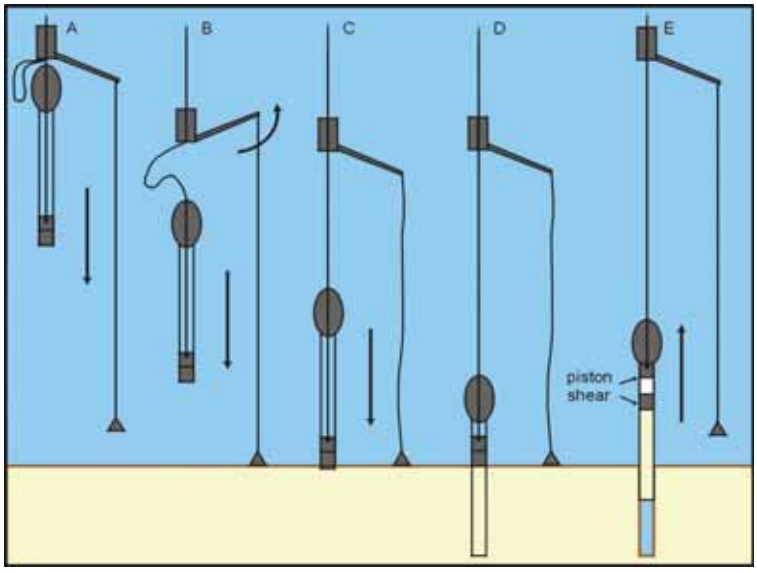



Figure 4: Schematic of the piston core operation at the seabed (Source: TDI-Brooks).

Water column samples may be taken and analysed for hydrocarbons, heavy metals and trace metals. At each station, water samples will be taken from three depths, namely near surface (~1 m below surface), mid-water, and near bottom. In addition, a Conductivity, Temperature, Depth (CTD) profiler may be deployed to measure salinity, temperature, dissolved oxygen and turbidity. The number of water sample stations has yet to be determined,

# 3. DESCRIPTION OF THE BASELINE MARINE ENVIRONMENT

The proposed survey area is located on the southeast coast, stretching between Cape St Francis in the Eastern Cape and Port Edward on the KwaZulu-Natal South Coast. Descriptions of the physical and biological environments are summarised primarily from information provided in the Generic EMPR for Oil and Gas Prospecting off the Coast of South Africa (CCA & CMS 2001).

## 3.1. The Physical Environment

### 3.1.1 Bathymetry and Sediments

The majority of the southeast coast region has a narrow continental shelf and a steep continental slope. The bathymetry drops steeply at the coast to approximately 50 m. In the region of Algoa Bay, the narrow shelf widens, with depth increasing gradually to the shelf break at a depth of 140 m off Port Elizabeth, 130 m off Cape St Francis, and 300 m south of Cape Agulhas (Birch & Rogers 1973). Between 22 and 26° E, the shelf break indents towards the coast forming the Agulhas 'bight' (Schumann 1998). At the apex of the Agulhas Bank the shelf widens to 130 nautical miles (250 km). Outside the shelf break, depth increases rapidly to more than 1,000 m (Hutchings 1994).

Whereas the East Coast is primarily linear, the coastline of the South Coast is characterised by a number of capes separated by sheltered sandy embayments. Sand dominates both the inshore and offshore surficial sediments south of Durban, although a substantial gravel component is present on the middle and outer shelf to as far as Port St Johns, occurring as coarse lag deposits in areas of erosion or non-deposition. Traces of mud are present on most areas of the shelf, although significant mud depo-centres are absent. The outer shelf is dominated by gravels of shell-fragment and algal-nodule origin (Heydorn *et al*. 1978).

### 3.1.2 Water Masses and Circulation

The oceanography of this coast is almost totally dominated by the warm Agulhas Current. The current forms between 25° and 30° S, flowing southwards along the shelf edge of the East Coast (Schumann 1998) of southern Africa as part of the anticyclonic Indian Ocean gyre, before retroflecting between 16° and 20° E. It is a well-defined and intense jet some 100 km wide and 1,000 m deep (Schumann 1998), flowing in a south-west direction at a rapid rate, with current speeds of 2.5 m/sec or more, and water transport rates of over $60 \times 10^6$ $m^3$/sec have being recorded (Pearce *et al*. 1978; Gründlingh 1980). Following its divergence into deep water off the Tugela Bank, the Agulhas Current re-attaches itself to the coast, south of Durban where the continental shelf again narrows, until off Port Edward it is so close inshore that the inshore edge (signified by a temperature front) is rarely discernible (Pearce 1977). On the eastern half of the South Coast, the Agulhas Current flows along the shelf break at speeds of up to 3 m/sec, diverging inshore of the shelf break south of Still Bay (34° 28'S, 21° 26'E) before realigning to the shelf break off Cape Agulhas (Heydorn & Tinley 1980). The Agulhas Current may produce large meanders with cross shelf dimensions of approximately 130 km, which move downstream at approximately 20 km per day. It may also shed eddies, which travel at around 20 cm/sec and advect onto the Agulhas Bank (Swart & Largier 1987). After detaching from the

shelf edge at 15° E, the Agulhas Current retroflects and flows eastwards (Schumann 1998)(Figure 6).

Currents over the inner and mid-shelf (to depths of 160 m) are weak and variable, with velocities along the eastern half of the South Coast ranging from 25 - 75 cm/sec midshelf and 10 - 40 cm/sec nearshore. Eastward flow may occur close inshore (Boyd *et al*. 1992; Boyd & Shillington 1994), being particularly strong off Port Elizabeth. Bottom water shows a persistent westward movement, although short-term current reversals may occur (Swart & Largier 1987; Boyd & Shillington 1994; CCA & CSIR 1998).

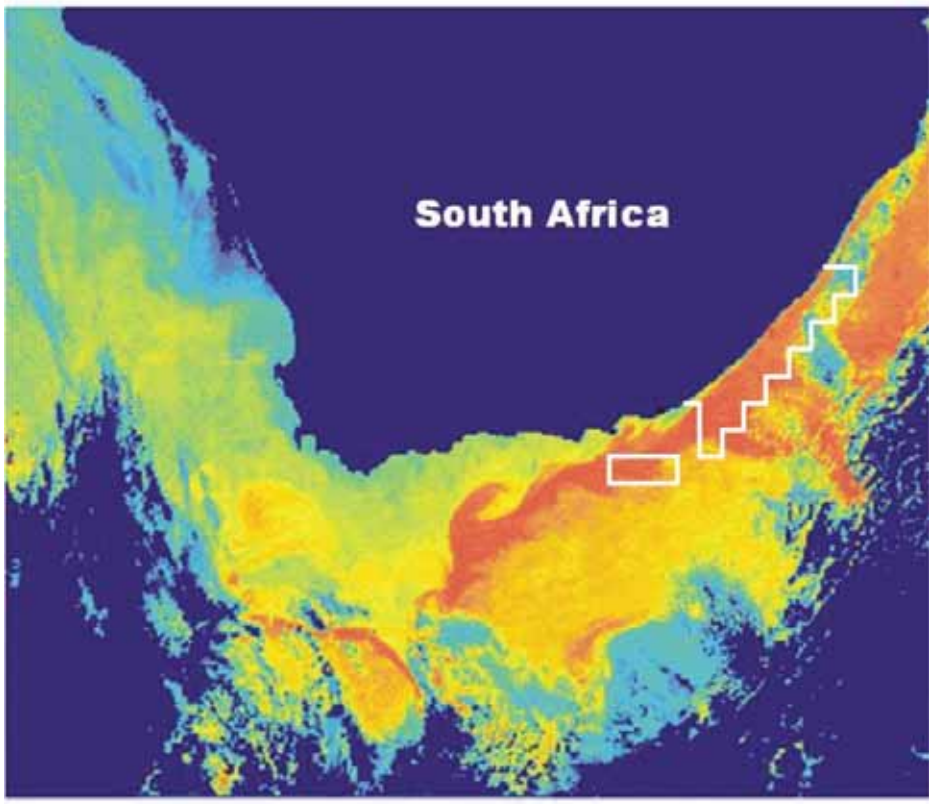



Figure 6: The predominance of the Agulhas current in the oceanography of the proposed reconnaissance permit area (white outline).

As the Agulhas Current originates in the equatorial region of the western Indian Ocean its waters are typically blue and clear, with low nutrient levels. The surface waters are a mix of Tropical Surface Water (originating in the South Equatorial Current) and Subtropical Surface Water (originating from the mid-latitude Indian Ocean). The surface waters of the Agulhas Current may be over 25° C in summer and 21° C in winter and have lower salinities than the Equatorial Indian Ocean, South Indian Ocean Central water masses found below. Surface water characteristics, however, vary due to insolation and mixing (Schumann 1998). South Indian Ocean Central Water of 14° C and a salinity of 35.3 ppt occurs below the surface water layers at between 150 - 800 m depth. The deeper waters comprise, from shallowest to deepest, Antarctic Intermediate Water, North Indian Deep Water, North Atlantic Deep Water and

Antarctic Bottom Water. Sub-tropical Surface Water of between 15 and 20° C often intrudes into the Agulhas Current at depths of 150 - 200 m from the east (Schumann 1998).

Seasonal variation in temperatures is limited to the upper 50 m of the water column (Gründlingh 1987), increasing offshore towards the core waters of the Agulhas Current. South of Mbashe and East London, a persistent wedge of cooler water is present over the continental shelf during summer (Beckley & Van Ballegooyen 1992), extending northwards to the southern KwaZulu-Natal coast in winter. This wedge is typically cooler than 19° C, but may be cooler than 16° C between East London and Port Alfred, and south of Mbashe. Inshore, waters are warmest during autumn, with warm water tongues found off Cape Recife (near Port Elizabeth) from January to March, and Knysna from October to January and during August. Warm water also tends to bulge towards Knysna between April and July and during September (Christensen 1980).

Strong and persistent thermoclines are common over the shelf, extending inshore during the summer, but breaking down during the cooler and windier winter conditions (Schumann & Beekman 1984; Boyd & Shillington 1994). Thermoclines at the eastern edge of the South Coast are located at 20-40 m depth, whereas they are deeper at the western edge (40-60 m) (Largier & Swart 1987).

### 3.1.3 Winds and Swells

The main wind axis off the East coast is parallel to the coastline, with north-north-easterly and south-south-westerly winds predominating for most of the year (Schumann & Martin 1991) and with average wind speeds around 2.5 m/s (Schumann 1989).

In the sea areas off KwaZulu-Natal, the majority of swells are from the South and South-southwest, with the largest attaining >7 m. During summer and autumn, some swells also arrive from the east. The less regular weather patterns affecting the East Coast (e.g. low pressure cells present NE of Durban, cut-off low pressure cells and tropical cyclones) strongly influence the wave climate, resulting in swells in excess of 10 m (Hunter 1988; Schumann 1998). The giant waves (>20 m high) that are at times encountered within the Agulhas Current (Heydorn & Tinley 1980), arise from the meeting of the south-westerly swells and the southerly flowing Agulhas Current, and may be a navigation hazard at times.

Westerly winds predominate along the South Coast in winter, frequently reaching gale force strengths. During summer, easterly wind directions increase markedly resulting in roughly similar strength/frequency of east and west winds during that season (Jury 1994). The strongest winds are observed at capes, including Agulhas, Infanta, Cape Seal, Robberg and Cape Recife (Jury & Diab 1989). Calm periods are most common in autumn (CSIR & CCA, 1998).

Wind-driven upwelling occurs inshore along the South Coast, especially during summer when easterly winds prevail (Schumann *et al*. 1982; Walker 1986; Schumann 1998). Such upwelling usually begins at the prominent capes and progresses westwards (Schumann *et al*. 1982; Schumann 1988), and can result in temperature changes of up to 8° C within a few hours (Hutchings 1994).

Intensive upwelling of Indian Ocean Central Water occurs periodically over the shelf and shelf edge, along the inner boundary of the Agulhas Current (Schumann 1998). This process is

primarily due to frictional interactions between the Agulhas Current and bottom topography (Hutchings 1994), and is most intense at the eastern boundary of the South Coast, where the cold bottom layer breaks the surface. Such shelf-edge upwelling largely defines the strong thermocline and halocline topography of the Agulhas Bank region, particularly in summer. A cool ridge of upwelled water that extends in a north-east (NE) – south-west (SW) direction over the mid-shelf regions between the shelf-edge upwelling and inshore waters close to the coast. (Swart & Largier 1987; Boyd & Shillington 1994; Schumann 1998), dividing the waters of the Agulhas Bank into the two-layered structure in the inshore region and a partially mixed structure in the eastern offshore region.

On the South Coast, the majority of waves arrive from the south-west quadrant (Whitefield *et al*. 1983), dominating wave patterns during winter and spring (Carter & Brownlie 1990). Waves from this direction frequently exceed 6 m (Swart & Serdyn 1981, 1982) and can reach up to 10 m (Heydorn 1989). During summer, easterly wind-generated 'seas' occur (Heydorn & Tinley 1980; Heydorn 1989; Carter & Brownlie 1990).

## 3.2. The Biological Environment

The majority of the proposed survey area is located beyond the 50 m depth contour. Communities within the offshore marine habitat are comparatively homogenous, largely as a result of the greater consistency in water temperature at depths around the South African coastline, than in the shallower coastal waters. Nonetheless, due to the extent of the proposed survey area, it falls within a number of inshore and offshore bioregions (Lombard *et al*. 2004) (Figure 7).

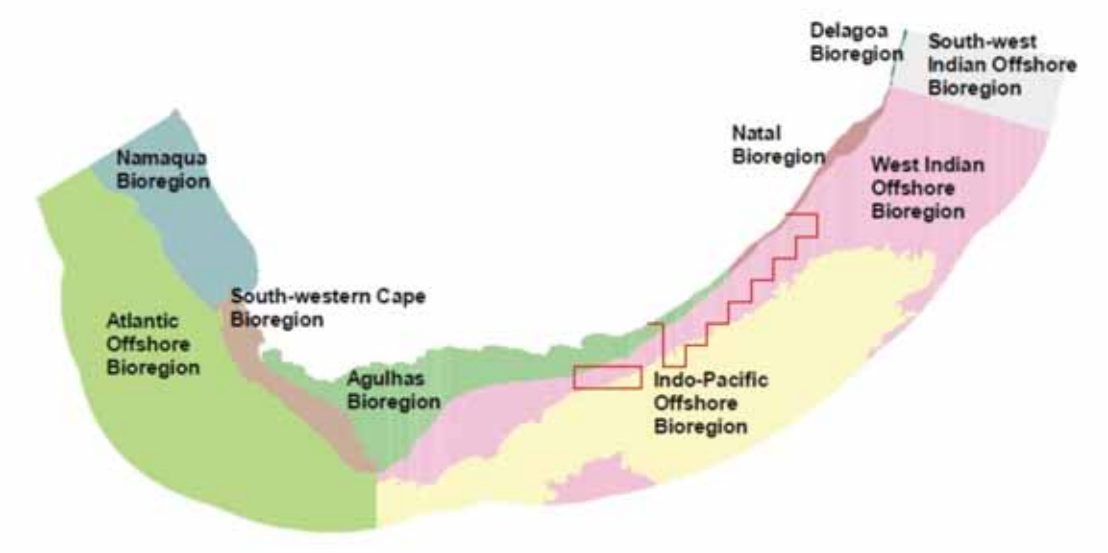



Figure 7: The inshore and offshore bioregions occurring in the proposed reconnaissance permit area (red outline) (adapted from Lombard *et al*. 2004).

The biological communities occurring in the survey area consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The nearshore and offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments, deep-water reefs 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 species.

### 3.2.1 Phytoplankton

The nutrient-poor characteristics of the Agulhas Current water are reflected in comparatively low primary productivity in the southern portion of the proposed survey area, with mean *chlorophyll a* concentrations averaging between 1-2 mg/m$^3$ over the whole year in the top 30 m of the water column. *Chlorophyll a* concentrations vary seasonally, being minimal in winter and summer (<1 – 2 mg/m$^3$), and maximal (2 - 4 mg/m$^3$) in spring and autumn (Brown 1992). Along the eastern half of the South Coast phytoplankton concentrations are usually higher than further west, comprising predominantly large cells (Hutchings 1994). Along the KwaZulu-Natal coast, primary productivity in inshore areas are low, with *chlorophyll a* concentrations ranging between 0.03 and 3.88 µg/l (Carter & Schleyer 1988).

### 3.2.2 Zooplankton

On the South Coast , the biomass of mesozooplankton increases from west (~0.5-~1.0 g C/m$^2$) to east (~1.0-~2.0 g C/m$^2$), mirroring the eastward increase in *chlorophyll a* concentrations. Dense swarms of euphausiids dominate this zooplankton component, and form an important food source for pelagic fishes (Cornew *et al*. 1992; Verheye *et al*. 1994).

On the East Coast, continental shelf waters support greater and more variable concentrations of zooplankton biomass than offshore waters (Beckley & Van Ballegooyen 1992), with species composition varying seasonally (Carter & Schleyer 1988). Copepods represent the dominant species group (Carter & Schleyer 1988), but chaetognaths are also abundant (Schleyer 1985).

### 3.2.3 Ichthyoplankton

A variety of pelagic species, including anchovy, pilchard, and horse mackerel, are reported to spawn east of Cape Agulhas, and to the west of the proposed survey areas (Crawford 1980; Hutchings 1994; Roel & Armstrong 1991) (Figure 8). In the case of pilchards (*Sardinops sagax*), adults move eastwards and northwards after spawning. After the "sardine run" in June and July, pilchard eggs occur in inshore waters along the Eastern Cape and the southern KwaZulu-Natal coast (Anders 1975; Connell 1996). Anchovy (*Engraulis japonicus*) eggs were reported in the water column during December as far north as St Lucia (Anders 1975). There is thus overlap of egg and larval distributions of these species with the proposed survey area. Of the demersal species, kingklip spawn off the shelf edge to the south of St Francis and Algoa Bays, coincident with the Algoa Block (Hutchings 1994). Squid (*Loligo* spp.) larvae are widely distributed in inshore waters (<50 m) (Augustyn *et al*. 1994).

The inshore area of the Agulhas Bank, especially between the cool water ridge and the shore, serve as an important nursery area for numerous linefish species (e.g. elf *Pomatomus saltatrix*, leervis *Lichia amia*, geelbek *Atractoscion aequidens*) (Wallace *et al*. 1984; Smale *et al*. 1994). Adults undertake spawning migrations along the coast into KwaZulu-Natal waters (Van der Elst 1976, 1981; Griffiths 1987; Garret 1988; Beckley & van Ballegooyen 1992). The eggs and larvae are subsequently dispersed southwards by the Agulhas Current, with juveniles occurring on the inshore Agulhas Bank (Van der Elst 1976, 1981; Garret 1988). Along the East Coast, ichthyoplankton is confined primarily to inshore waters, with larval concentrations varying between 0.005 and 4.576 larvae/$m^3$. Concentrations, however, decrease rapidly with distance offshore (Beckley & Van Ballegooyen 1992).

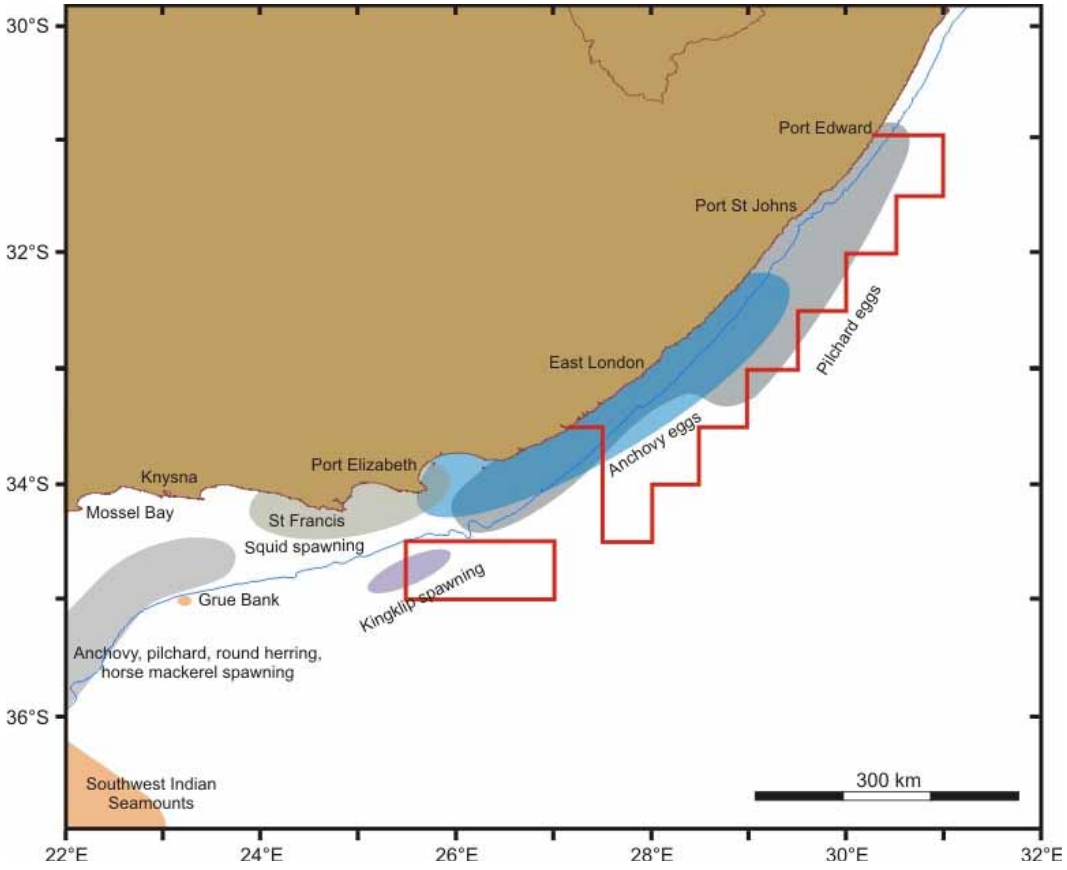



Figure 8: Important fishing banks, seamounts, pelagic and demersal fish and squid spawning areas in relation to the proposed reconnaissance permit area (red outline) (after Anders 1975, Crawford *et al*. 1987, Hutchings 1994). The 200 m depth contour is also shown.

### 3.2.4 Invertebrates

The intertidal and shallow subtidal reefs along the East Coast of South Africa support a wide diversity of marine flora and fauna and a relatively high percentage of endemic species (Turpie *et al*. 2000, Awad *et al*. 2002). However, information about benthic reef communities and

hard grounds in the project area is limited to descriptions of reef ecosystems in the Pondoland area (Celliers *et al*. 2007), and the Goukamma area on the south coast (Götz *et al*. 2009). The following description is summarised from these studies and from descriptions of South Africa's reef types provided in SANBI's Reef Atlas Project.

The nearshore reefs of the Pondoland coast shelter a mix of subtropical and warm-temperate fauna that manifest both a latitudinal and longitudinal shift in benthic composition over a relatively short distance. There is a change from low-diversity macroalgae dominated communities on the shallow high-profile reefs in the north to high-diversity (and comparatively high total living cover and high biomass) communities dominated by sponges, ascidians and bryozoans, on low-profile deeper reefs and reefs to the south. The shallow-water algae-dominated habitats also harbour hard corals (*Stylophora pistillata*), with wave action strongly influencing the community structure. This shift is concomitant with a reduction in available light associated with increased water turbidity. The shift from a habitat defined primarily by phototropism to a benthic community dominated by suspension-feeders is probably driven by higher sediment loads and the greater availability of nutrients coming from the numerous rivers along this portion of the coast. The reduction in available light with depth similarly allows non-phototrophic species — such as sponges and ascidians — to compete with algae for space on the reef.

Further south in the Port Elizabeth area, inshore reefs to -30 m depth also show relatively distinct changes in community structure, being characterised by diverse reef assemblages dominated by cauliflower soft coral (Sink *et al*. 2011) (Figure 9). Further south off Goukamma, the reefs are characterised by equally distributed high and low profile areas. The benthic taxa were dominated by bryozoans and sponges (22.9% and 21.1% respectively), followed by gorgonians (16.4%), ascidians (13.7%) and algae (10.1%). Crinoids (8.4%) and hydrozoans (7.5%) constituted <10% of the overall occurrence. Community composition in this area was found to be strongly affected by linefishing, with higher abundance of algae and crinoids at fished sites, and higher sponge cover on reefs within the Goukamma Marine Protected Area (MPA).



Figure 9: Diverse and unique reef assemblages, dominated by cauliflower soft coral occur on the inshore reefs to -30 m depth off Port Elizabeth (Source: Sink *et al*. 2011).

Information on invertebrates occurring beyond -30 m depth along the South Coast is sparse. The squid (*Loligo vulgaris reynaudii*) (Figure 10, left) occurs extensively on the Agulhas Bank out to the shelf edge (500 m depth contour) increasing in abundance towards the eastern boundary of the South Coast, especially between Plettenberg Bay and Algoa Bay (Augustyn 1990; Sauer *et al*. 1992; Augustyn *et al*. 1994). Adults are normally distributed in waters >100 m, except along the eastern half of the South Coast where they also occur inshore, forming dense spawning aggregations at depths between 20 - 130 m. These spawning aggregations are a seasonal occurrence reaching a peak in November and December.

The deep-water rock lobster (*Palinurus gilchristi*) (Figure 10, right) occurs on rocky substrate in depths of 90 - 170 m between Cape Agulhas and southern KwaZulu-Natal. Larvae drift southwards in the Agulhas Current, settling in the south of the Agulhas Bank before migrating northwards again against the current to the adult grounds (Branch *et al*. 2010). The species is fished commercially along the southern Cape Coast between the Agulhas Bank and East London, with the main fishing grounds being in the 100 – 200 m depth range south of Cape Agulhas on the Agulhas Bank, and off Cape St Francis, Cape Recife and Bird Island.



Figure 10: Squid spawn in nearshore areas off the South Coast (left) and South Coast rock lobster occur in deep water (right) (photos: www.mpa.wwf.org.za; Steve Kirkman).

Other deep-water crustaceans that may occur in the proposed survey area are the shovel-nosed crayfish (*Scyllarides elisabethae*) and the Natal deep-sea rock lobster (*Palinurus delagoae*). The shovel-nosed crayfish occurs primarily on gravelly seabed at depths of around 150 m, although it is sometimes found in shallower water. Its distribution range extends from Cape Point to Maputo. The Natal rock lobster similarly occurs on open areas of mud and rubble at depths of 180-300 m. Larvae settle offshore with juveniles and adults migrating inshore as they age. This species primarily occurs north of Durban. Other rock lobster species occurring in shallower waters on the south and east coasts include the West Coast rock lobster (*Jasus lalandii*), East Coast rock lobster (*Panulirus homarus*), Longlegged spiny lobster (*Panulirus longipes*), the ornate spiny lobster (*Panulirus ornatus*) and the painted spiny lobster (*Panulirus versicolor*), all of which are typically associated with shallow-water reefs, although the West Coast lobster has been recorded at depths of 120 m (Branch *et al*. 2010).

The benthic biota of offshore soft bottom substrates constitutes invertebrates that live on (epifauna), or burrow within (infauna), the sediments, and are generally divided into

megafauna (animals >10 mm), macrofauna (>1 mm) and meiofauna (<1 mm). The structure and composition of benthic soft-bottom communities is primarily a function of abiotic factors such as water depth and sediment grain size, but others such as current velocity and organic content abundance also play a role (Snelgrove & Butman 1994; Flach & Thomsen 1998; Ellingsen 2002). Further shaping is derived from biotic factors such as predation, food availability, larval recruitment and reproductive success. The high spatial and temporal variability for these factors results in seabed communities being both patchy and variable. In nearshore waters where sediment composition is naturally patchy, and significant sediment movement may be induced by the dynamic wave and current regimes (Fleming & Hay 1988), the benthic macrofauna are typically adapted to frequent disturbance. In contrast, further offshore where near-bottom conditions are more stable, the macrofaunal communities will primarily be determined by sediment characteristics and depth.

There is insufficient information available on benthic invertebrates in the proposed survey area to allow for a description of the zoogeographic distribution of benthic macrofaunal communities (McClurg 1988). However, from studies conducted off the West Coast (Christie & Moldan 1977; Moldan 1978; Jackson & McGibbon 1991; Environmental Evaluation Unit 1996; Parkins & Field 1997; 1998; Pulfrich & Penney 1999; Goosen *et al*. 2000; Savage *et al*. 2001; Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b; Atkinson 2009) and off Richards Bay in northern KwaZulu-Natal (Connell *et al*. 1985, 1989; McClurg *et al*. 1999, 2000, 2001, 2002, 2003, 2004; McClurg & Blair 2005, 2006, 2007, 2008; CSIR 2007, 2009) it can be deduced that in general species diversity, abundance and biomass is relatively low on inshore substrates, but increasing from the shore to ~80 m depth. Communities are characterised equally by polychaetes, crustaceans (of which amphipods, copepods and ostracods are the dominant types), echinoderms and molluscs. Further offshore to 120 m depth, the midshelf is a particularly rich benthic habitat where biomass can attain 60 g/m$^2$ dry weight (Christie 1974; see also Steffani 2007b). The comparatively high benthic biomass in this midshelf region represents an important food source to carnivores such as the mantis shrimp, cephalopods and demersal fish species. Outside of this rich zone biomass declines to 4.9 g/m$^2$ at 200 m depth and then is consistently low (<3 g/m$^2$) on the outer shelf (Christie 1974). The meiobenthos includes the smaller species such as nematode worms, flat worms, harpacticoid copepods, ostracods and gastrotriches. Some of the meiofauna are adept at burrowing while others live in the interstitial spaces between the sand grains.

The benthic fauna of the continental slope beyond ~450 m depth are poorly known, largely due to limited opportunities for sampling, and to date very few areas of the continental slope off the South and East Coasts have been biologically surveyed. With little sea floor topography and hard substrate, such areas are likely to offer minimal habitat diversity or niches for animals to occupy. Detritus-feeding crustaceans, holothurians and echinoderms tend to be the dominant epi-benthic organisms of such habitats. Also associated with soft-bottom substrates are demersal communities that comprise bottom-dwelling invertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source. Atkinson (2009) reported numerous species of urchins and burrowing anemones beyond 300 m depth off the West Coast.

In recent years there has also been increasing interest in deep-water corals and sponges because of their likely sensitivity to disturbance and their long generation times. These benthic filter-feeders generally occur at depths exceeding 150 m. Some coral species form reefs while others are smaller and remain solitary. Corals and sponges add structural

complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze *et al*. 1997; MacIssac *et al*. 2001). Their frameworks offer refugia for a great variety of invertebrates and fish (including commercially important species) within, or in association with, the living and dead frameworks. The Agulhas Bank hosts a diversity of deep-water corals and sponges (Figure 11), that have establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current. Substantial shelf areas should thus potentially be capable of supporting rich, deep-water benthic, filter-feeding communities.

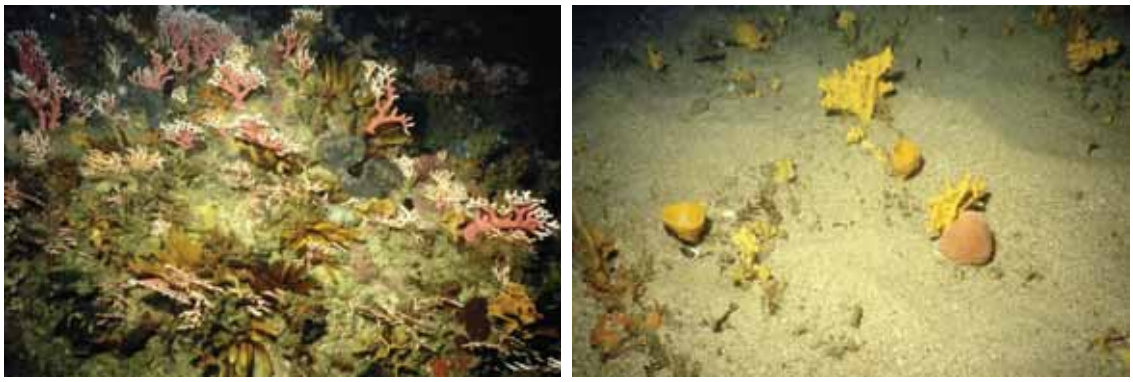


Figure 11: Offshore benthic communities occurring on reefs on the central Agulhas Bank include protected cold water porcelain coral *Allopora nobilis*, sponges, crinoids and bryozoans (Left; Photo: Andrew Penney), whereas a variety of habitat-forming sponges, colonial ascidians and hydroids occur on sandy seabed (Right; Photo: Andrew Penney).

### 3.2.5 Seamount Communities

Geological features of note in the proposed survey area include various banks, knolls and seamounts (referred to collectively here as "seamounts"). These seabed features protrude into the water column, and are subject to, and interact with, the water currents surrounding them. The effects of such seabed features on the surrounding water masses can include the up-welling of relatively cool, nutrient-rich water into nutrient-poor surface water thereby resulting in higher productivity (Clark *et al*. 1999), which can in turn strongly influences the distribution of organisms on and around seamounts. Evidence of enrichment of bottom-associated communities and high abundances of demersal fishes has been regularly reported over such seabed features.

The enhanced fluxes of detritus and plankton that develop in response to the complex current regimes around such seabed features lead to the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Seamounts provide an important habitat for commercial deepwater fish stocks such as orange roughy, oreos, alfonsino and Patagonian toothfish, which aggregate around these features for either spawning or feeding (Koslow 1996).

Such complex benthic ecosystems in turn enhance foraging opportunities for many other predators, serving as mid-ocean focal points for a variety of pelagic species with large ranges (turtles, tunas and billfish, pelagic sharks, cetaceans and pelagic seabirds) that may migrate large distances in search of food or may only congregate on seamounts at certain times (Hui

1985; Haney *et al*. 1995). Seamounts thus serve as feeding grounds, spawning and nursery grounds and possibly navigational markers for a large number of species (SPRFMA 2007).

Enhanced currents, steep slopes and volcanic rocky substrata, in combination with locally generated detritus, favour the development of suspension feeders in the benthic communities characterising seamounts (Rogers 1994). Deep- and cold-water corals (including stony corals, black corals and soft corals) (Figure 12, left) are a prominent component of the suspension-feeding fauna of many seamounts, accompanied by barnacles, bryozoans, polychaetes, molluscs, sponges, sea squirts, basket stars, brittle stars and crinoids (reviewed in Rogers 2004). There is also associated mobile benthic fauna that includes echinoderms (sea urchins and sea cucumbers) and crustaceans (crabs and lobsters) (reviewed by Rogers 1994). (Figure 12, right). Compared to the surrounding deep-sea environment, seamounts typically form biological hotspots with a distinct, abundant and diverse fauna, many species of which remain unidentified. Consequently, the fauna of seamounts is usually highly unique and may have a limited distribution restricted to a single geographic region, a seamount chain or even a single seamount location (Rogers *et al*. 2008). Levels of endemism on seamounts are also relatively high compared to the deep sea. As a result of conservative life histories (*i.e*. very slow growing, slow to mature, high longevity, low levels of recruitment) and sensitivity to changes in environmental conditions, such biological communities have been identified as Vulnerable Marine Ecosystems (VMEs). They are recognised as being particularly sensitive to anthropogenic disturbance (primarily deep-water trawl fisheries and mining), and once damaged are very slow to recover, or may never recover (FAO 2008).

It is not always the case that seamount habitats are VMEs, as some seamounts may not host communities of fragile animals or be associated with high levels of endemism. South Africa's seamounts and their associated benthic communities have not been sampled by either geologists or biologists (Sink & Samaai 2009). While numerous deep-water banks occur within the reconnaissance permit area, none fall within the proposed 2D survey area.



Figure 12: Seamounts are characterised by a diversity of deep-water corals that add structural complexity to seabed habitats and offer refugia for a variety of invertebrates and fish (Photos: www.dfo-mpo.gc.ca/science/Publications/article/2007/21-05-2007-eng.htm, Ifremer & AWI 2003).

### 3.2.6 Pelagic and Demersal Fish

The South and East Coast ichthyofauna is diverse, comprising a mixture of temperate and tropical species. As a transition zone between the Agulhas and Benguela current systems, the South Coast ichthyofauna includes many species occurring also along the West and/or East Coasts. The seabed of the Agulhas Bank substrate is also diverse comprising areas of sand, mud and coral thereby contributing to increased benthic fauna and fish species.

Small pelagic shoaling species occurring along the South Coast include anchovy (*Engraulis encrasicolus*), pilchard (*Sardinops sagax*) (Figure 13, left), round herring (*Etrumeus japonicas*), chub mackerel (*Scomber japonicas*) and horse mackerel (*Trachurus trachurus capensis*) (Figure 13, right). Anchovies are usually located between the cool upwelling ridge and the Agulhas Current (Hutchings 1994), and are larger than those of the West Coast. Having spawned spawn intensively in an area around the 200 m depth contour between Mossel Bay and Plettenberg Bay between October and January, most adults move inshore and eastwards ahead of warm Agulhas Current water. The Agulhas Bank area is, however, is not considered an important anchovy recruitment ground (Hampton 1992). Round herring juveniles similarly occur inshore along the South Coast, but move offshore with age (Roel *et al*. 1994; Hutchings 1994).




Figure 13: Cape fur seal preying on a shoal of pilchards (left). School of horse mackerel (right) (photos: www.underwatervideo.co.za; www.delivery.superstock.com).

Pilchards are typically found in water between 14 °C and 20 °C. Spawning occurs on the Agulhas Bank during spring and summer (Crawford 1980), with recruits being found inshore along the South Coast (Hutchings 1994). It is thought that the Agulhas Bank may be a refuge for pilchard under low population levels, and therefore vital for the persistence of the species (CCA & CSIR 1998). During the winter months of June to August, the penetration of northerly-flowing cooler water along the Eastern Cape coast and up to southern KwaZulu-Natal effectively expands the suitable habitat available for this species, resulting in a 'leakage' of large shoals northwards along the coast in what has traditionally been known as the 'sardine run'. The cool band of inshore water is critical to the 'run' as the sardines will either remain in the south or only move northwards further offshore if the inshore waters are above 20 °C. The shoals can attain lengths of 20-30 km and are typically pursued by Great White Sharks, Copper Sharks, Common Dolphins, Cape Gannets and various other large pelagic predators (www.sardinerun.co.za). Catch rates of several important species in the recreational shoreline

fishery of KwaZulu-Natal have been shown to be associated with the timing of the sardine run (Fennessey *et al*. 2010). Other pelagic species that migrate along the coast include elf (*Pomatomus saltatrix*), geelbek (*Atractoscion aequidens*), yellowtail (*Seriola lalandi*), kob (*Argyrosomus* sp) seventy-four (*Cymatoceps nasutus*), strepie (*Sarpa salpa*), Cape stumpnose (*Rhabdosargus holubi*) and mackerel (*Scomber japonicus*), which are all regular spawners within KwaZulu-Natal waters (Van der Elst 1988).

Large migratory pelagic species that occur in offshore waters and beyond the shelf break include dorado (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*) (Figure 14, left) and black, blue and striped marlin (*Makaira indica, M. nigricans, Tetrapturus audax*), frigate tuna (*Auxis thazard*), skipjack (*Katsuwonus pelamis*), longfin tuna/albacore (*Thunnus alalunga*) (Figure 14, right), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), Southern Bluefin tuna and Bluefin tuna (*Thunnus maccoyii* and *T. thynnus thynnus*, respectively) (Van der Elst 1988; Smale *et al*. 1994).




Figure 14: Large migratory pelagic fish such as sailfish (left) and longfin tuna (right) occur in offshore waters (photos: www.arkive.org; www.osfimages.com).

There is a high diversity of Teleosts (bony fish) and Chondrichthyans (cartilaginous fish) associated with the inshore and shelf waters of the South and East Coasts, many of which are endemic to the Southern African coastline and form an important component of the demersal trawl and long-line fisheries. The Cape hake (*Merluccius capensis*), is distributed widely on the Agulhas Bank, while the deep-water hake (*Merluccius paradoxus*) is found further offshore in deeper water (Boyd *et al*. 1992; Hutchings 1994). Juveniles of both species occur throughout the water column in shallower water than the adults. Kingklip (*Genypterus capensis*) is also an important demersal species, with adults distributed in deeper waters along the whole of the South Coast, especially on rocky substrate (Japp *et al*. 1994). They are reported to spawn in an isolated area beyond the 200 m isobaths between Cape St Francis and Port Elizabeth during spring (see Figure 8). Juveniles occur further inshore. The Agulhas or East Coast sole (*Austroglossus pectoralis*) inhabits inshore muddy seabed (<125 m) on the shelf between Cape Agulhas and Algoa Bay (Boyd *et al*. 1992). Apart from the above-mentioned target species, numerous other by-catch species are landed by the South Coast demersal trawling fishery including panga (*Pterogymnus laniarius)*, kob (*Argyrosomus hololepidotus*), gurnard (*Chelidonichthyes* spp.), monkfish (*Lophius* sp.), John Dory (*Zeus capensis*) and angel fish (*Brama brama*).

The shallower inshore areas (<100 m) along the South and East Coasts comprise a varied habitat of rocky reefs and soft-bottom substrates, which support a high diversity of endemic sparid and other teleost species (Smale *et al*. 1994) (Figure 15), some of which move into inshore protected bays to spawn (Buxton 1990) or undertake spawning migrations up the coast to KwaZulu-Natal. Those species that undertake migrations along the South and East Coasts include Red Steenbras, White Steenbras (summer), Kob, Geelbek and Elf (winter). Spawning of the majority of species endemic to the area occurs in spring and summer. Many of these species form an important component of the commercial and recreational linefishery (Table 1). Furthermore, there are numerous pelagic species that frequent nearshore waters and are targeted by line-fishermen (Table 1).



Figure 15: The South Coast reefs support a wide diversity of teleost species including musselcracker (left) and red stumpnose (right) (photos: http://spearfishingsa.co.za, www.easterncapescubadiving.co.za).

Table 1: Some of the more important demersal and pelagic linefish species landed by commercial and recreational boat fishers and shore anglers along the South and East Coasts (adapted from CCA & CMS 2001).

| Name | Species Name |
|---|---|
| **Demersal teleosts** | |
| Bank steenbras | Chirodactylus grandis |
| Belman | *Umbrina canariensis* |
| Blacktail | *Diplodus sargus* |
| Blue hottentot | *Pachymetopon aeneum* |
| Bronze bream | *Pachymetopon grande* |
| Cape bank steenbras | *Chirodactylus grandis* |
| Cape stumpnose | *Rhabdosargus holubi* |
| Carpenter | *Argyrozona argyrozona* |
| Dageraad | *Chrysoblephus christiceps* |
| Englishman | *Chrysoblephus anglicus* |
| Fransmadam | *Boopsoidea inornata* |
| Galjoen | *Dichistius capensis* |
| Grey chub | *Kyphosus biggibus* |
| Kob | *Argyrosomus hololepidotus* |

| Name | Species Name |
|---|---|
| Mini kob | *Johnius dussumieri* |
| Musselcracker | *Sparodon durbanensis* |
| Natal stumpnose | *Rhabdosargus sarba* |
| Poenskop | *Cymatoceps nasutus* |
| Pompano | *Trachinotus africanus* |
| Red roman | *Chrysoblephus laticeps* |
| Red steenbras | *Petrus rupestris* |
| Red stumpnose | *Chrysoblephus gibbiceps* |
| River bream | *Acanthopagrus berda* |
| Rockcod | *Epinephalus* spp. |
| Sand steenbras | *Lithognathus mormyrus* |
| Santer | *Cheimerius nufar* |
| Scotsman | *Polysteganus praeorbitalis* |
| Seventyfour | *Polysteganus undulosus* |
| Slinger | *Chrysoblephus puniceus* |
| Snapper salmon | *Otolithes ruber* |
| Spotted grunter | *Pomadasys commersonnii* |
| Squaretail kob | *Argyrosomus thorpei* |
| Steentjie | *Spondyliosoma emarginatum* |
| Strepie | *Sarpa salpa* |
| White steenbras | *Lithognathus lithognathus* |
| White stumpnose | *Rhabdosargus globiceps* |
| Wreckfish | *Polyprion americanus* |
| Zebra | *Diplodus cervinus* |
| **Pelagic teleosts** | |
| Elf | *Pomatomus saltatrix* |
| Garrick/leerfish | *Lichia amia* |
| Geelbek | *Atractoscion aequidens* |
| Green jobfish | *Aprion virescens* |
| King mackerel | *Scomberomorus commerson* |
| Kingfish species | *Caranx* spp. |
| Queenfish | *Scomberoides commersonianus* |
| Queen mackerel | *Scomberomorus plurilineatus* |
| Tenpounder | *Elops machnata* |
| Wahoo | *Acanthocybium solandri* |
| Yellowtail | *Seriola lalandi* |

A wide variety of chondrichthyans occur in nearshore waters of the South Coast (Table 2), some of which, such as St Joseph shark (*Callorhincus capensis*), Soupfin shark (*Galeorhinus galeus*) and Biscuit skate (*Raja straeleni*), are also landed by the trawl and line fishery.

Table 2: Some of the chondrichthyan species occurring along the South and East Coasts (adapted from CCA & CMS 2001).

| Name | Species Name |
|---|---|
| Great white shark | *Carcharodon carcharias* |
| Ragged-tooth shark | *Odontaspis taurus* |
| Bronze whaler shark | *Carcharhinus brachyurus* |
| Dusky shark | *Carcharhinus obscures* |
| Blacktip shark | *Carcharhinus limbatus* |
| Hammerhead shark | *Sphyrna* spp. |
| Lesser Sandshark | *Rhinobatus annulatus* |
| Milkshark | *Rhizoprionodon acutus* |
| Gully shark | *Triakis megalopterus* |
| Skates | Rajiformes |
| Stingrays | Dasyatidae |
| St Joseph shark | *Callorhincus capensis* |
| Soupfin shark | *Galeorhinus galeus* |
| Diamond ray | *Gymnura natalensis* |
| Tiger catshark | *Halaelurus natalensis* |
| Izak | *Halohalaelurus regani* |
| Puffadder shyshark | *Haploblepharus edwardsii* |
| Houndsharks | *Mustelus* spp. |
| Bullray | *Myliobatis aquilla* |
| Yellowspotted catshark | *Scyliorhinus capensis* |
| Spiny dogfish | *Squalus* spp. |
| Electric ray | *Torpedo fuscomaculata* |

### 3.2.7 Turtles

Three species of turtle occur along the South Coast, namely the leatherback (*Dermochelys coriacea*), and occasionally the loggerhead (*Caretta caretta*) and the green (*Chelonia mydas*) turtle. Along the East coast the Olive Ridley (*Lepidochelys olivacea*) and hawksbill turtle (*Eretmochelys imbricata*) may also be encountered. In the IUCN Red listing, the leatherback and hawksbill are described as "critically endangered", the loggerhead and green turtles are "endangered"and the Olive Ridley is "Vulnerable" on a global scale. Leatherback Turtles are thus 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). As a signatory of CMS, South Africa has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles. South Africa is thus committed to conserve these species at an international level.

Leatherback turtles (Figure 16, left) inhabit the deeper waters of the Atlantic Ocean and are considered a pelagic species. They travel the ocean currents in search of their prey (primarily jellyfish) and may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al*. 2004; Lambardi *et al*. 2008), thus making them difficult to observe from the surface and susceptible to seismic operations. They come into coastal bays and estuaries to mate, and lay their eggs on the adjacent beaches. Leatherback turtles from the east South African 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).

Loggerheads (Figure 16, right) tend to keep more inshore, hunting around reefs, bays and rocky estuaries along the African East Coast, where they feed on a variety of benthic fauna including crabs, shrimp, sponges, and fish. In the open sea their diet includes jellyfish, flying fish, and squid (www.oceansafrica.com/turtles.htm).

The green turtle is a non-breeding resident along the east coast of South Africa, and together with loggerhead turtles are expected to occur only as occasional visitors along the South Coast. The hawksbill turtle occurs only as a visitor to our coast as it breeds in Madagascar and Mauritius. The Olive Ridley turtle is rare in our waters occurring as occasional strays.

Both the leatherback and the loggerhead turtle nest on the beaches of the northern KwaZulu-Natal coastline between October and February, extending into March. The southern extremity of the nesting area is thus located over 400 km to the north of the proposed seismic area. Hatchlings are born from late January through to March when the Agulhas Current is warmest. Once hatchlings enter the sea, they move southward in the Agulhas Current and are thought to remain in the southern Indian Ocean gyre for the first five years of their lives, as there is an absence of turtles between 10 - 60 cm from the southern African East Coast. Beach strandings of juvenile loggerhead and leatherback turtles along the South African coast suggest juvenile turtles in the Agulhas Current between Algoa Bay and Mossel Bay (Hughes 1974).

Since concerted turtle conservation efforts began in KwaZulu-Natal in the early 1960, the average number of nesting leatherback females has risen from only five in 1966 to over 90 in the early 2000s. The number of loggerhead turtles has also risen from less than 100 in the early 1960s to ~2,000 currently nesting annually within the Maputaland Marine Reserve (Mann-Lang 2000; www.southafricablog.co.za/archives/loggerhead-turtle/).




Figure 16: Leatherback (left) and loggerhead turtles (right) occur along the East Coast of South Africa (Photos: Ketos Ecology 2009; www.aquaworld-crete.com).

### 3.2.8 Seabirds

Thirteen of the 60 species of seabirds known to, or thought likely to occur, along the South Coast, breed within the region (Table 3), including Cape Gannets (Algoa Bay islands), African Penguins (Algoa Bay islands), Cape Cormorants (a small population at Algoa Bay islands and mainland sites), Whitebreasted Cormorant, Roseate Tern (Bird and St Croix Islands), Swift Term (Stag Island) and Kelp Gulls. Although the Algoa Bay Islands do not fall directly within the

proposed survey areas, they are in close enough proximity for the seabird species to be encountered during survey operations.

Table 3: Breeding resident seabirds present along the South Coast (adapted from CCA & CMS 2001).

| Species name | Common name | Global IUCN Status |
|---|---|---|
| *Spheniscus demersus* | African Penguin | Endangered |
| *Phalacrocorax carbo* | Great Cormorant | Least Concern |
| *Phalacrocorax capensis* | Cape Cormorant | Near Threatened |
| *Phalacrocorax neglectus* | Bank Cormorant | Endangered |
| *Phalacrocorax coronatus* | Crowned Cormorant | Least Concern |
| *Morus capensis* | Cape Gannet | Vulnerable |
| *Larus dominicanus* | Kelp Gull | Least Concern |
| *Larus cirrocephalus* | Greyheaded Gull | Least Concern |
| *Larus hartlaubii* | Hartlaub's Gull | Least Concern |
| *Hydroprogne caspia* | Caspian Tern | Vulnerable |
| *Sterna bergii* | Swift Tern | Least Concern |
| *Sterna dougallii* | Roseate Tern | Least Concern |
| *Sterna balaenarum* | Damara Tern | Near Threatened |

In the vicinity of the proposed survey areas sea-birds at times intensively target shoals of pelagic fish, particularly during the 'sardine run'. Small pelagic species such as anchovy and pilchard form important prey items for seabirds, particularly the Cape Gannet (Figure 17, left), the African Penguin (Figure 17, right) and the various cormorant species. Most of the breeding resident seabird species feed on pelagic shoaling fish species (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). Feeding strategies include surface plunging (gannets and terns), pursuit diving (cormorants and penguins), and scavenging and surface seizing (gulls). All these species feed relatively close inshore, although gannets and kelp gulls may feed further offshore.




Figure 17: Typical diving seabirds on the South Coast are the Cape Gannets (left) (Photo: NACOMA) and the flightless African Penguin (right) (Photo: Klaus Jost).

In particular, African Penguins forage at sea with most birds being found within 20 km of the coast and to the south of Cape Recife, and thus inshore of the Algoa Block.

Forty-six seabird species occur commonly along the East coast (Table 4). As the East Coast provides few suitable breeding sites for coastal and seabirds, only three species (Grey-headed gull, Caspian tern and Swift tern breed regularly along the coast (CSIR 1998). Many of the river mouths and estuaries along the East Coast, however, serve as important roosting and foraging sites for coastal and seabirds birds (Underhill & Cooper 1982; Turpie 1995).

Table 4: Resident and fairly-common to common visiting seabirds present along the KwaZulu-Natal coast (from CSIR 1998).

| Species name | Common name | Status |
|---|---|---|
| *Diomedea exulans* | Wandering albatross | Non-breeding winter visitor |
| *Diomedea cauta* | Shy albatross | Non-breeding winter visitor |
| *Diomedea melanophris* | Blackbrowed albatros | Non-breeding winter visitor |
| *Diomedea chlororhynchos* | Yellownosed albatross | Non-breeding winter visitor |
| *Macronectes giganteus* | Southern giant petrel | Non-breeding winter visitor |
| *Macronectes halli* | Northern giant petrel | Non-breeding winter visitor |
| *Daption capense* | Pintado petrel | Non-breeding visitor, mainly in winter |
| *Pterodroma macroptera* | Greatwinged petrel | Non-breeding winter visitor |
| *Pterodroma mollis* | Softplumaged petrel | Non-breeding visitor, mainly in winter |
| *Pachyptila vittata* | Broadbilled prion | Non-breeding visitor, mainly in winter |
| *Procellaria aequinoctialis* | Whitechinned petrel | Non-breeding visitor, mainly in winter |
| *Calonectris diomedea* | Cory's shearwater | Summer visitor |
| *Puffinus gravis* | Great shearwater | Summer vagrant |
| *Puffinus griseus* | Sooty shearwater | Non-breeding visitor, mainly in winter |
| *Hydrobates pelagicus* | European storm petrel | Non-breeding visitor, mainly in summer |
| *Oceanodroma leucorhoa* | Leach's storm petrel | Summer vagrant |
| *Oceanites oceanicus* | Wilson's storm petrel | Non-breeding visitor, common year round |
| *Morus capensis* | Cape gannet | Common, follows 'sardine run' |
| *Stercorarius parasiticus* | Arctic skua | Summer visitor from Palaearctic |
| *Catharacta skua* | Antarctic skua | Present all year, more abundant in winter |
| *Larus dominicanus* | Kelp gull | Year-round visitor from South & West Coast |
| *Larus cirrocephalus* | Greyheaded gull | Coastal breeding resident |
| *Hydroprogne caspia* | Caspian tern | Coastal breeding resident |
| *Sterna bergii* | Swift tern | Coastal breeding resident |
| *Sterna paradisaea* | Arctic tern | Summer visitor from Palaearctic |
| *Sterna sandvicensis* | Sandwich tern | Summer visitor from Palaearctic |
| *Sterna bengalensis* | Lesser crested tern | Visitor to the coast, mainly in summer |
| *Sterna albifrons* | Little tern | Palaearctic migrant, common in summer |
| *Sterna hirundo* | Common tern | Summer visitor from Palaearctic |

### 3.2.9 Marine Mammals

The marine mammal fauna of the South and East Coasts comprises between 28 and 38 species of cetaceans (whales and dolphins) known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur here (Table 5) and one seal species, the Cape fur seal (*Arctocephalus pusillus*) (Findlay 1989; Findlay *et al*. 1992; Ross 1984; Peddemors 1999). The offshore areas have been particularly poorly studied with almost all available information from deeper waters (>200 m) arising from historic whaling records. Information on smaller cetaceans in deeper waters is particularly poor. Of the migratory cetaceans listed in Table 5, the blue, sei and humpback whales are listed as "Endangered" and the Southern Right and fin whale as "Vulnerable" in the IUCN Red Data book.

The distribution of whales and dolphins on the South and East Coasts can largely be split into those associated with the continental shelf and those that occur in deep, oceanic waters. Species from both environments may, however, be found associated with the shelf (200 – 1,000 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 kilometres. The most common species within the proposed survey area (in terms of likely encounter rate not total population sizes) are likely to be the common bottlenose dolphin, long finned pilot whale, southern right whale and humpback whale.

Cetaceans comprised two basic taxonomic groups: the mysticetes (filter-feeding baleen whales) and the odontocetes (toothed predatory whales and dolphins). Due to large differences in their size, sociality, communication abilities, ranging behaviour and acoustic behaviour, these two groups are considered separately.

The majority of baleen whales fall into the family Balaenidae. Those occurring in the proposed survey area include the blue, fin, sei, minke, dwarf minke and two populations of Bryde's whale. Most of these species occur in pelagic waters, with only occasional visits into shelf waters. All of these species show some degree of migration either to, or through, the proposed survey area when *en route* between higher-latitude feeding grounds (Antarctic or Subantarctic) and lower-latitude breeding grounds. Depending on the ultimate location of these feeding and breeding grounds, seasonality off South Africa can be either unimodal (usually in June-August, e.g. minke and blue whales) or bimodal (usually May-July and October-November, e.g. fin whales), reflecting a northward and southward migration through the area. As whales follow geographic or oceanographic features, the northward and southward migrations may take place at difference distances from the coast, thereby influencing the seasonality of occurrence at different locations. Due to the complexities of the migration patterns, each species is discussed in further detail below.

Two types of Bryde's whales are recorded from South African waters - a smaller neritic form (of which the taxonomic status is uncertain) and a larger pelagic form described as *Balaenoptera brydei*. The migration patterns of Bryde's whales differ from those of all other baleen whales in the region as they are not linked to seasonal feeding patterns. The inshore population is unique in that it is resident year round on the Agulhas Bank, only undertaking occasional small seasonal excursions up the east coast during winter. Sightings over the last two decades suggest that the distribution of this population has shifted eastwards, with sightings on the West Coast very rare compared to pre-1980s whaling records (Best 2001, 2007;

Table 5: Cetaceans occurrence off the South and East Coasts of South Africa, their seasonality and likely encounter frequency with proposed seismic survey operations (adapted from S. Elwen, Mammal Research Institute, pers. comm., Best 2007).

| Common Name | Species | Shelf | Offshore | Seasonality | Likely encounter freq. |
|---|---|---|---|---|---|
| ***Delphinids*** | | | | | |
| Common bottlenose dolphin | *Tursiops truncatus* | Yes | Yes | Year round | Monthly |
| Indo-Pacific bottlenose dolphin | *Tursiops aduncus* | Yes | | Year round | Monthly |
| Common (short beaked) dolphin | *Delphinus delphis* | Yes | Yes | Year round | Monthly |
| Common (long beaked) dolphin | *Delphinus capensis* | Yes | | Year round | Monthly |
| Fraser's dolphin | *Lagenodelphis hosei* | | Yes | Year round | Occasional |
| Spotted dolphin | *Stenella attenuata* | Yes | Yes | Year round | Occasional |
| Striped dolphin | *Stenella coeruleoalba* | | Yes | Year round | Occasional |
| Indo-Pacific humpback dolphin | *Sousa chinensis* | Yes | | Year round | Monthly |
| Long-finned pilot whale | *Globicephala melas* | | Yes | Year round | <Weekly |
| Short-finned pilot whale | *Globicephala macrorhynchus* | | Yes | Year round | <Weekly |
| Killer whale | *Orcinus orca* | Occasional | Yes | Year round | Occasional |
| False killer whale | *Pseudorca crassidens* | Occasional | Yes | Year round | Monthly |
| Risso's dolphin | *Grampus griseus* | Yes (edge) | Yes | Year round | Occasional |
| Pygmy killer whale | *Feresa attenuata* | | Yes | Year round | Occasional |
| ***Sperm whales*** | | | | | |
| Pygmy sperm whale | *Kogia breviceps* | | Yes | Year round | Occasional |
| Dwarf sperm whale | *Kogia sima* | | Yes | Year round | Occasional |
| Sperm whale | *Physeter macrocephalus* | | Yes | Year round | Occasional |

| Common Name | Species | Shelf | Offshore | Seasonality | Likely encounter freq. |
|---|---|---|---|---|---|
| ***Beaked whales*** | | | | | |
| Cuvier's | *Ziphius cavirostris* | | Yes | Year round | Occasional |
| Arnoux's | *Beradius arnouxii* | | Yes | Year round | Occasional |
| Southern bottlenose | *Hyperoodon planifrons* | | Yes | Year round | Occasional |
| Hector's | *Mesoplodon hectori* | | Yes | Year round | Occasional |
| Layard's | *Mesoplodon layardii* | | Yes | Year round | Occasional |
| Longman's | *Mesoplodon pacificus* | | Yes | Year round | Occasional |
| True's | *Mesoplodon mirus* | | Yes | Year round | Occasional |
| Gray's | *Mesoplodon grayi* | | Yes | Year round | Occasional |
| Blainville's | *Mesoplodon densirostris* | | Yes | Year round | Occasional |
| ***Baleen whales*** | | | | | |
| Minke | *Balaenoptera bonaerensis* | Yes | Yes | >Winter | Monthly |
| Dwarf minke | *B. acutorostrata* | Yes | | Year round | Occasional |
| Fin whale | *B. physalus* | | Yes | MJJ & ON, rarely in summer | Occasional |
| Blue whale | *B. musculus* | | Yes | MJJ | Occasional |
| Sei whale | *B. borealis* | | Yes | MJ & ASO | Occasional |
| Bryde's (inshore) | *B brydei (subspp)* | | Yes | Year round | Occasional |
| Pygmy right | *Caperea marginata* | Yes | | Year round | Occasional |
| Humpback | *Megaptera novaeangliae* | Yes | Yes | AMJJASOND | Daily |
| Southern right | *Eubalaena australis* | Yes | | JJASON | Daily |

Best *et al*. 1984). Although this is a very small population, which is possibly decreasing in size (Penry 2010), its current distribution implies that it is likely to be encountered in the proposed survey area.

The offshore population of Bryde's whale lives off the continental shelf (>200 m depth), and migrates between wintering grounds off equatorial West Africa (Gabon) and summering grounds off the South African West Coast (Best 2001). Its seasonality within South African waters is thus opposite to the majority of the balaenopterids, with abundance on the West Coast highest in January-February. This population of Bryde's whales is unlikely to be encountered in the proposed survey area.

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 on the east coast highest in June (on the northward migration), and with a second larger peak in September. All whales were caught in waters deeper than 200 m with most 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.

Fin whales were historically caught off the South African East Coast, with a unimodal winter (June-July) peak in catches off Durban. However, as northward moving whales were still observed as late as August/September, the return migration may occur further offshore. 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 Southern Africa.

Blue whales were historically caught in high numbers off Durban, showing a single peak in catches in June/July. Sightings of the species in the area between 1968-1975 were rare and concentrated in March to May (Branch *et al*. 2007). However, scientific search effort (and thus information) in pelagic waters is very low. The chance of encountering the species in the proposed survey area is considered low.

Minke whales are present year-round with a large portion of this population consisting of small, sexually immature animals that primarily occur beyond 30 nautical miles from the coast during summer and autumn. Off Durban Minke whales are reported to increase in numbers in April and May, remaining at high levels through June to August and peaking in September (Best 2007).

The most abundant baleen whales off the coast of South Africa are southern right and humpback whales (Figure 18). Southern rights migrate to the southern Africa subcontinent to breed and calve, where they tend to have an extremely coastal distribution mainly in sheltered bays (90% <2 km from shore; Best 1990, Elwen & Best 2004). Winter concentrations have been recorded all along the southern and eastern coasts of South Africa as far north as Maputo Bay, with the most significant concentration currently on the South Coast between Cape Town and Port Elizabeth. They typically arrive in coastal waters off the South Coast between June and November each year, although animals may be sighted as early as April and as late as January. While in local waters, southern rights are found in groups of 1-10 individuals, with cow-calf pairs predominating in inshore nursery areas. From July to October, animals aggregate and become involved in surface-active groups, which can persist for several hours.

Best (2000) estimated that southern right population was increasing at approximately 7% per annum. The most recent abundance estimate for the South African Southern right whale population (2008) puts the population at approximately 4,600 individuals of all age and sex classes, which is thought to be at least 23% of the original population size (Brandão *et al*. 2011).



Figure 18: The humpback whale (left) and the southern right whale (right) migrate along the South and East Coasts during winter (Photos: www.divephotoguide.com; www.aad.gov.au).

The majority of humpback whales on the south and east coasts of South Africa are migrating past the southern African continent. The main winter concentration areas for Humpback whales on the east coast include Mozambique, Madagascar, Kenya and Tanzania. Three principal migration routes for Humpbacks in the south-west Indian Ocean have been proposed. On the first route up the East Coast, the northern migration reaches the coast in the vicinity of Knysna continuing as far north as central Mozambique. The second route approaches the coast of Madagascar directly from the south, possibly via the Mozambique Ridge. The third, less well established route, is thought to travel up the centre of the Mozambique Channel to Aldabra and the Comore Islands (Findlay *et al*. 1994; Best *et al*. 1998). Humpbacks have a bimodal distribution off the East coast, most reaching southern African waters around April, continuing through to September/October when the southern migration begins and continues through to December. The calving season for Humpbacks extends from July to October, peaking in early August (Best 2007). Cow-calf pairs are typically the last to leave southern African waters on the return southward migration, although considerable variation in the departure time from breeding areas has been recorded (Barendse *et al*. 2010). Off Cape Vidal whale abundances peak around June/July on their northward migration, although some have been observed still moving north as late as October. Southward moving animals on their return migration were first seen in July, peaking in August and continuing to late October (Findlay & Best 1996a, b).

All information about sperm whales in the southern African subregion 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, well-structured social system with adult males behaving differently from younger males and female groups. They live in deep ocean waters, occasionally coming into depths of 500-200 m on the shelf (Best 2007). Seasonality of catches off the East Coast suggest that medium- and large-sized males are more abundant during winter, while female groups are more abundant in summer, although animals occur year

round (Best 2007). Although considered relatively abundant worldwide (Whitehead 2002), no current data are available on density or abundance of sperm whales in African waters. Sperm whales feed at great depth, during dives in excess of 30 minutes, making them difficult to detect visually. The regular echolocation clicks made by the species when diving, however, 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 off the shelf of south and east South Africa. Beaked whales are all considered to be true deep water species usually being seen in waters in excess of 1,000 - 2,000 m depth (see various species accounts in Best 2007). Their presence in the area may fluctuate seasonally, but insufficient data exist to define this clearly. Of the smaller odontocetes, the common bottlenose dolphin (Figure 19, left) and humpback dolphins (Figure 19, right) are known to be resident on the shelf and offshore and are likely to be frequently encountered in the survey area. Similarly, the long-finned pilot whale, which is usually associated with the shelf edge and is regularly reported by MMOs, fishermen and other observers (S. Elwen pers commn), is likely to be commonly encountered. False killer whales, killer whales, and the offshore form of the bottlenose dolphin are also likely to be encountered with some regularity in deeper waters (Findlay *et al*. 1992, Best 2007).




Figure 19: Toothed whales that occur on the South and East Coasts include the Bottlenose dolphin (left) and the Indo-pacific humpback dolphin (right) (Photos: www.fish-wallpapers.com; www.shutterstock.com).

In summary, the majority of data available on the seasonality and distribution of large whales in the proposed survey area is largely the result of commercial whaling activities mostly dating from the 1960s. 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 with almost all data being limited to the continental shelf. Whaling data indicates that several other large whale species are also abundant on the South and East Coasts for much of the year: fin whales peak in May-July and October-November and sei whale numbers peak in May-June and again in August-October.

Of the migratory cetaceans, the Blue, Sei and Humpback whales are listed as "Endangered" and the Southern Right and Fin whale as "Vulnerable" in the IUCN Red Data book. All whales and dolphins are given protection under the South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed[1], killed or fished. No vessel or aircraft may approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.

The Cape fur seal (*Arctocephalus pusillus pusillus*) is the only seal species that has breeding colonies along the South Coast (Figure 20), namely at Seal Island in Mossel Bay, on the northern shore of the Robberg Peninsula in Plettenberg Bay and at Black Rocks (Bird Island group) in Algoa Bay. The timing of the annual breeding cycle is very regular occurring between November and January, after which the breeding colonies break up and disperse. 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. The movement of seals from the three South Coast colonies are poorly known, however, although limited tracking of Algoa Bay animals has suggested these seals to be feeding in the inshore region south of Cape Recife. The diet varies with season and availability and includes pelagic species such as horse mackerel, pilchard, and hake, as well as squid and cuttlefish.

Historically the Cape fur seal was heavily exploited for its luxurious pelt. Sealing restrictions were first introduced to southern Africa in 1893, and harvesting was controlled until 1990 when it was finally prohibited. The protection of the species has resulted in the recovery of the populations, and numbers continue to increase. Consequently, their conservation status in not regarded as threatened.



Figure 20: Colony of Cape fur seals (Photo: Dirk Heinrich).

1 In the Regulations for the management of boat-based whale watching and protection of turtles as part of the Marine Living Resources Act of 1998 the definition of "harassment" is given as "behaviour or conduct that threatens, disturbs or torments cetaceans".

### 3.2.10 Marine Protected Areas

Numerous marine protected areas (MPAs) exist along the South and East coasts (Figure 21). There are four MPAs on the Western Cape coast east of Cape Agulhas namely De Hoop, Goukama, Robberg, and Tsitsikama. MPAs of the Eastern Cape include Sardinia Bay and the Bird Island Group, the Amathole MPA in the vicinity of East London, and the Dwesa-Cwebe, Hluleka and Pondoland MPAs located on the Wild Coast. Although these MPAs extend offshore only a few nautical miles, those that fall within the proposed Exploration Right area are the newly proclaimed Amathole (Gxulu Gonubie, and Kei), Dwesa-Cwebe, Hluleka and Pondoland MPAs. The Amathole MPA comprised the three former closed areas, namely from Christmas Rock to the Gxulu River mouth, from Nahoon Point to Gonubie Point, and from the Nyara River mouth to the Kei River mouth.

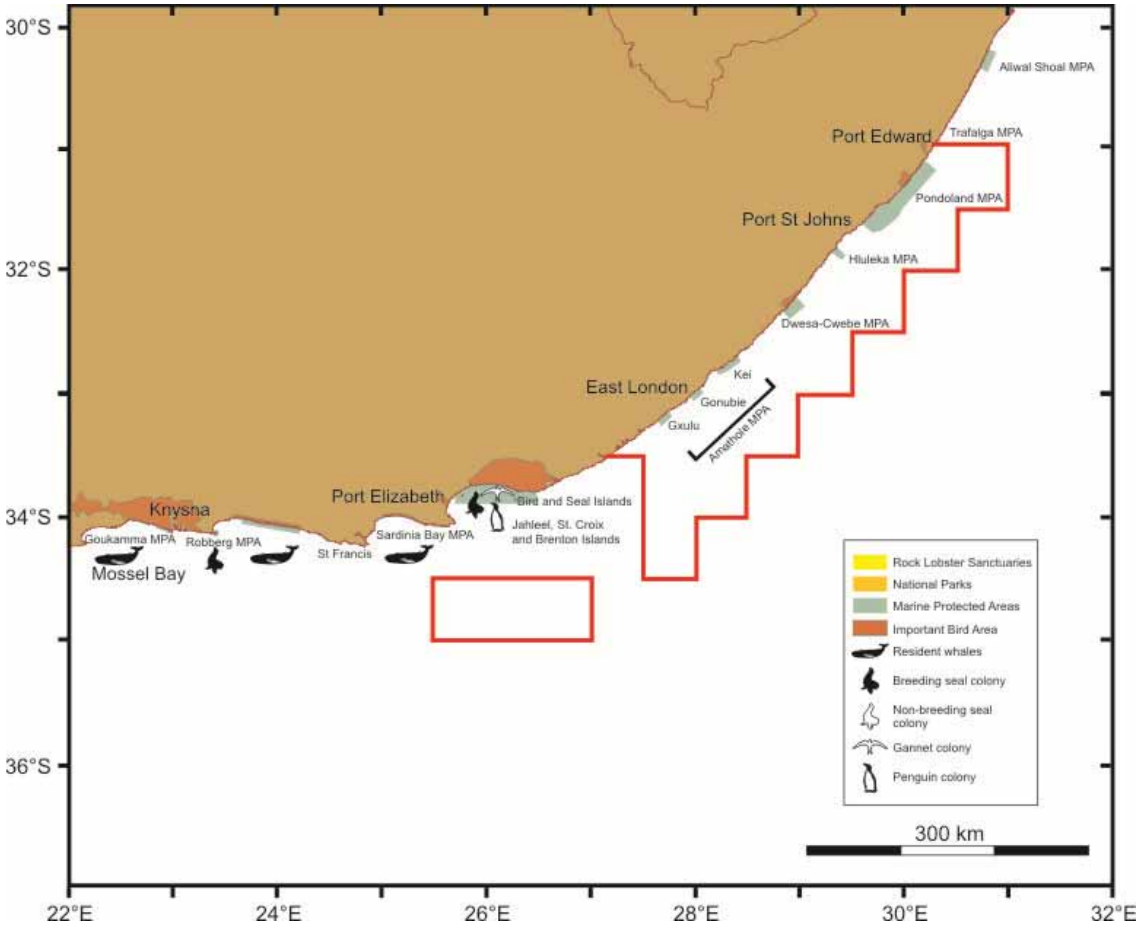



Figure 21: Project - environment interaction points on the southeast coast, illustrating the location of seabird and seal colonies, seasonal whale populations, and marine protected areas in relation to the proposed reconnaissance permit area (red outline).

# 4. ACOUSTIC IMPACTS ON MARINE FAUNA

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation (see references in McCauley 1994). Such acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean can thus be expected to interfere directly or indirectly with such activities thereby affecting the physiology and behaviour of marine organisms (NRC 2003). Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 dB re 1 µPa at 1 m (NRC 2003). Especially at low frequencies between 5 to 100 Hz, vessel traffic is a major contributor to noise in the world's oceans, and under the right conditions, these sounds can propagate 100s of kilometres thereby affecting very large geographic areas (Coley 1994, 1995; NRC 2003; Pidcock *et al*. 2003). Other forms of anthropogenic noise include 1) aircraft flyovers, 2) multi-beam sonar systems, 3) seismic acquisition, 4) hydrocarbon and mineral exploration and recovery, and 5) noise associated with underwater blasting, pile driving, and construction. Below follows a detailed review of the effects of seismics on marine fauna and brief summaries of the effects of aircraft noise and multi-beam sonars.

## 4.1. Seismics

The airguns used in modern seismic surveys produce some of the most intense non-explosive sound sources used by humans in the marine environment (Gordon *et al*. 2004). However, the transmission and attenuation of seismic sound is probably of equal or greater importance in the assessment of environmental impacts than the produced source levels themselves, as transmission losses and attenuation are very site specific, and are affected by propagation conditions, distance or range, water and receiver depth and bathymetrical aspect with respect to the source array. In water depths of 25 - 50 m airgun arrays are often audible to ranges of 50 -75 km, and with efficient propagation conditions such as experienced on the continental shelf or in deep oceanic water, detection ranges can exceed 100 km and 1,000 km, respectively (Bowles *et al*. 1991; Richardson *et al*. 1995; see also references in McCauley 1994). The signal character of seismic shots also changes considerably with propagation effects. Reflective boundaries include the sea surface, the sea floor and boundaries between water masses of different temperatures or salinities, with each of these preferentially scattering or absorbing different frequencies of the source signal. This results in the received signal having a different spectral makeup from the initial source signal. In shallow water (<50 m) at ranges exceeding 4 km from the source, signals tend to increase in length from <30 milliseconds, with a frequency peak between 10-100 Hz and a short rise time, to a longer signal of 0.25-0.75 seconds, with a downward frequency sweep of between 200 - 500 Hz and a longer rise time (McCauley 1994; McCauley *et al*. 2000).

In contrast, in deep water received levels vary widely with range and depth of the exposed animals, and exposure levels cannot be adequately estimated using simple geometric spreading laws (Madsen *et al*. 2006). These authors found that the received levels fell to a minimum

between 5 - 9 km from the source and then started increasing again at ranges between 9 – 13 km, so that absolute received levels were as high at 12 km as they were at 2 km, with the complex sound reception fields arising from multi-path sound transmission.

Acoustic pressure variation is usually considered the major physical stimulus in animal hearing, but certain taxa are capable of detecting either or both the pressure and particle velocity components of a sound (Turl 1993). An important component of hearing is the ability to detect sounds over and above the ambient background noise. Auditory masking of a sound occurs when its' received level is at a similar level to background noise within the same frequencies. The signal to noise ratio required to detect a pure tone signal in the presence of background noise is referred to as the critical ratio.

The auditory thresholds of many species are affected by the ratio of the sound stimulus duration to the total time (duty cycle) of impulsive sounds of <200 millisecond duration. The lower the duty cycle the higher the hearing threshold usually is. Although seismic sound impulses are extremely short and have a low duty cycle at the source, received levels may be longer due to the transmission and attenuation of the sound (as discussed above).

Below follows a brief review of the impacts of seismic surveys on marine faunal communities. This information is largely drawn from McCauley (1994), McCauley *et al*. (2000), the Generic EMPr for Oil and Gas Prospecting off the Coast of South Africa (CCA & CMS 2001) and the very comprehensive review by Cetus Projects (2007), compiled as part of the Environmental Impact Assessment for the Ibhubesi Gas Field. While the effects on pelagic and benthic invertebrates, fish and seabirds is covered briefly, the discussion and assessments focus primarily on marine mammals and turtles.

#### 4.1.1 Impacts on Plankton

As the movement of phytoplankton and zooplankton is largely limited by currents, they are not able to actively avoid the seismic vessel and thus are likely to come into close contact with the sound sources. Phytoplankton are not known to be affected by seismic surveys and are unlikely to show any significant effects of exposure to airgun impulses outside of a 1 m distance (Kosheleva 1992; McCauley 1994).

Zooplankton comprises meroplankton (organisms which spend a portion of their life cycle as plankton, such as fish and invertebrate larvae and eggs) and holoplankton (organisms that remain planktonic for their entire life cycle, such as siphonophores, nudibranchs and barnacles). The abundance and spatial distribution of zooplankton is highly variable and dependent on factors such as fecundity, seasonality in production, tolerances to temperature, length of time spent in the water column, hydrodynamic processes and natural mortality. Zooplankton densities are generally low and patchily distributed. The amount of exposure to the influence of seismic airgun arrays is thus dependent on a wide range of variables. Invertebrate members of the plankton that have a gas-filled flotation aid, may be more receptive to the sounds produced by seismic airgun arrays, and the range of effects may extend further for these species than for other plankton. However, for a large seismic array, a physiological effect out to 10 m from the array is considered a generous value with known effects demonstrated to 5 m only (Kostyuchenko 1971).

McCauley (1994) concludes that when compared with total population sizes or natural mortality rates of planktonic organisms, the relative influence of seismic sound sources on these populations can be considered insignificant. The wash from ships propellers and bow waves can be expected to have a similar, if not greater, volumetric effect on plankton than the sounds generated by airgun arrays.

Due to their importance in commercial fisheries, numerous studies have been undertaken experimentally exposing the eggs and larvae of various ichthyoplankton species to airgun sources (reviewed in McCauley 1994). These are discussed further in Section 4.1.3.

### 4.1.2 Impacts on Marine Invertebrates

Many marine invertebrates have tactile organs or hairs (termed mechanoreceptors), which are sensitive to hydro-acoustic near-field disturbances, and some have highly sophisticated statocysts, which have some resemblance to the ears of fishes (Offutt 1970; Hawkins & Myrberg 1983; Budelmann 1988, 1992; Packard *et al*. 1990; Popper *et al*. 2001) and are thought to be sensitive to the particle acceleration component of a sound wave in the far-field. However, information on hearing by invertebrates, and noise impacts on them is sparse. Although many invertebrates cannot sense the pressure of a sound wave or the lower amplitude component of high frequency sounds, low frequency high amplitude sounds may be detected *via* the mechanoreceptors, particularly in the near-field of such sound sources (McCauley 1994). Sensitivity to near-field low-frequency sounds or hydroacoustic disturbances has been recorded for the lobster *Homarus americanus* (Offut 1970), and various other invertebrate species (Horridge 1965, 1966; Horridge & Boulton 1967; Moore & Cobb 1986; Packard *et al*. 1990; Turnpenney & Nedwell 1994).

Despite no quantitative records of invertebrate mortality from seismic sound exposure under field operating conditions, lethal and sub-lethal effects have been observed under experimental conditions where invertebrates were exposed to airguns up to five metres away. These include reduced growth and reproduction rates and behavioural changes in crustaceans (DFO 2004; McCauley 1994; McCauley *et al*. 2000). The effects of seismic survey energy on snow crab (*Chionoecetes opilo*) on the Atlantic coast of Canada, for example ranged from no physiological damage but effects on developing fertilized eggs at 2 m range (Christian *et al*. 2003) to possible bruising of the heptopancreas and ovaries, delayed embryo development, smaller larvae, and indications of greater leg loss but no acute or longer term mortality and no changes in embryo survival or post hatch larval mobility (DFO 2004). The ecological significance of sub-lethal or physiological effects could thus range from trivial to important depending on their nature.

Giant squid strandings coincident with seismic surveys have been reported (Guerra *et al*. 2004). Although animals showed no external damage, all had severe internal injuries (including disintegrated muscles and unrecognisable organs) indicative of having ascended from depth too quickly. The causative link to seismic surveys has, however, not been established with certainty.

Behavioural responses of invertebrates to particle motion of low frequency stimulation has been measured by numerous researchers (reviewed in McCauley 1994). Again a wide range of responses are reported ranging from no avoidance by free ranging invertebrates (crustaceans,

echinoderms and molluscs) of reef areas subjected to pneumatic airgun fire (Wardle *et al*. 2001), and no reduction in catch rates of brown shrimp (Webb & Kempf 1998), prawns (Steffe & Murphy 1992, in McCauley, 1994) or rock lobsters (Parry & Gasson 2006) in the near-field during or after seismic surveys.

Cephalopods, in contrast, may be receptive to the far-field sounds of seismic airguns, although responses are unknown. Behavioural response range from attraction at 600 Hz pure tone (Maniwa 1976), through startle responses at received levels of 174 dB re 1 µPa, to increase levels of alarm responses once levels had reached 156 – 161 dB re 1 µPa (McCauley *et al*. 2000). Based on the results of caged experiments, McCauley *et al*. (2000) therefore suggest that squid would significantly alter their behaviour at an estimated 2 - 5 km from an approaching large seismic source.

### 4.1.3 Impacts on Fish

Fish hearing has been reviewed by numerous authors including Popper and Fay (1973), Hawkins (1973), Tavolga *et al*. (1981), Lewis (1983), Atema *et al*. (1988), and Fay (1988). Fish have two different systems to detect sounds namely 1) the ear (and the otolith organ of their inner ear) that is sensitive to sound pressure and 2) the lateral line organ that is sensitive to particle motion. Certain species utilise separate inner ear and lateral line mechanisms for detecting sound; each system having its own hearing threshold (Tavolga & Wodinsky 1963), and it has been suggested that fish can shift from particle velocity sensitivity to pressure sensitivity as frequency increases (Cahn *et al*. 1970, in Turl 1993).

In fish, the proximity of the swim-bladder to the inner ear is an important component in the hearing as it acts as the pressure receiver and vibrates in phase with the sound wave. Vibrations of the otoliths, however, result from both the particle velocity component of the sound as well as stimulus from the swim-bladder. The resonant frequency of the swim-bladder is important in the assessment of impacts of sounds as species with swim-bladders of a resonant frequency similar to the sound frequency would be expected to be most susceptible to injury. Although the higher frequency energy of received seismic impulses needs to be taken into consideration, the low frequency sounds of seismic surveys would be most damaging to swim-bladders of larger fish. The lateral line is sensitive to low frequency (between 20 and 500 Hz) stimuli through the particle velocity component of sound.

Most species of fish and elasmobranchs are able to detect sounds from well below 50 Hz (some as low as 10 or 15 Hz) to upward of 500 - 1,000 Hz (Popper & Fay 1999; Popper 2003; Popper *et al*. 2003), and consequently can detect sounds within the frequency range of most widely occurring anthropogenic noises. Within the frequency range of 100 - 1,000 Hz at which most fish hear best, hearing thresholds vary considerably (50 and 110 dB re 1 µPa). They are able to discriminate between sounds, determine the direction of a sound, and detect biologically relevant sounds in the presence of noise. In addition, some clupeid fish can detect ultrasonic sounds to over 200 kHz (Popper & Fay 1999; Mann *et al*. 2001; Popper *et al*. 2004). Fish that possess a coupling between the ear and swim-bladder have probably the best hearing of fish species (McCauley 1994). Consequently, there is a wide range of susceptibility among fish to seismic sounds, with those with a swim-bladder will be more susceptible to anthropogenic sounds than those without this organ.

Studies have shown that fish can be exposed directly to the sound of seismic survey without lethal effects, outside of a very localised range of physiological effects. Physiological effects of impulsive airgun sounds on fish species include swim-bladder damage (Falk & Lawrence 1973), transient stunning (Hastings 1990, in Turnpenney & Nedwell 1994), short-term biochemical variations in different tissues typical of primary and secondary stress response (Santulli *et al*. 1999; Smith *et al*. 2004), and temporary hearing loss due to destruction of the hair cells in the hearing maculae (Enger 1981; Lombarte *et al*. 1993; Hastings *et al*. 1996; McCauley *et al*. 2000; Scholik & Yan 2001, 2002; McCauley *et al*. 2003; Popper *et al*. 2005; Smith *et al*. 2006). Popper (2008) concludes that as the vast majority of fish exposed to seismic sounds will in all likelihood be some distance from the source, where the sound level has attenuated considerably, only a very small number of animals in a large population will ever be directly killed or damaged by sounds from seismic airgun arrays.

Behavioural responses to impulsive sounds are varied and include leaving the area of the noise source (Suzuki *et al*. 1980; Dalen & Rakness 1985; Dalen & Knutsen 1987; Løkkeborg 1991; Skalski *et al*. 1992; Løkkeborg & Soldal 1993; Engås *et al*. 1996; Wardle *et al*. 2001; Engås & Løkkeborg 2002; Hassel *et al*. 2004), changes in depth distribution (Chapman & Hawkins 1969; Dalen 1973; Pearson *et al*. 1992; Slotte *et al*. 2004), spatial changes in schooling behaviour (Slotte *et al*. 2004), and startle response to short range start up or high level sounds (Pearson *et al*. 1992; Wardle *et al*. 2001). In some cases behavioural responses were observed at up to 5 km distance from the firing airgun array (Santulli *et al*. 1999; Hassel *et al*. 2004). Behavioural effects are generally short-term, however, 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 (McCauley *et al*. 2000). In some cases behaviour patterns returned to normal within minutes of commencement of surveying indicating habituation to the noise. Disturbance of fish is believed to cease at noise levels below 160 dB re 1µPa. The ecological significance of such effects is therefore expected to be low, except in cases where they influence reproductive activity.

Although the effects of airgun noise on spawning behaviour of fish have not been quantified to date, it is predicted that if fish are exposed to powerful external forces on their migration paths or spawning grounds, they may be disturbed or even cease spawning altogether. The deflection from migration paths may be sufficient to disperse spawning aggregations and displace spawning geographically and temporally, thereby affecting recruitment to fish stocks. The magnitude of effect in these cases will depend on the biology of the species and the extent of the dispersion or deflection. Dalen *et al*. (1996), however, recommended that in areas with concentrated spawning or spawning migration seismic shooting be avoided at a distance of ~50 km from these areas.

Indirect effects of seismic shooting on fish include reduced catches resulting from changes in feeding behaviour or vertical distribution (Skalski *et al*. 1992), but information on feeding success of fish (or larger predators) in association with seismic survey noise is lacking.

The physiological effects of seismic sounds from airgun arrays will mainly affect the younger life stages of fish such as eggs, larvae and fry, many of which form a component of the meroplankton and thus have limited ability to escape from their original areas in the event of various influences. Numerous studies have been undertaken experimentally exposing the eggs and larvae of various fish species to airgun sources (Kostyuchenko 1971; Dalen & Knutsen 1987;

Holliday *et al*. 1987; Booman *et al*. 1992; Kosheleva 1992; Popper *et al*. 2005, amongst others). These studies generally identified mortalities and physiological injuries at very close range (<5 m) only. For example, increased mortality rates for fish eggs were proven out to ~5 m distance from the air guns. A mortality rate of 40-50% was recorded for yolk sac larvae (particularly for turbot) at a distance of 2-3 m (Booman *et al*. 1996), although mortality figures for yolk sac larvae of anchovies at the same distances were lower (Holliday *et al*. 1987). Yolk sac larvae of cod experienced significant eye injuries (retinal stratification) at a distance of 1 m from an air gun array (Matishov 1992), and Booman *et al*. (1996) report damage to brain cells and lateral line organs at <2 m distance from an airgun array. Increased mortality rates (10-20%) at later stages (larvae, post-larvae and fry) were proven for several species at distances of 1-2 m. Changes have also been observed in the buoyancy of the organisms, in their ability to avoid predators and effects that affect the general condition of larvae, their growth rate and thus their ability to survive. Temporary disorientation juvenile fry was recorded for some species (McCauley 1994). Fish larvae with swim-bladders may be more receptive to the sounds produced by seismic airgun arrays, and the range of effects may extend further for these species than for others.

From a fish resource perspective, these effects may potentially contribute to a certain diminished net production in fish populations. However, Sætre & Ona (1996) calculated that under the "worst case" scenario, the number of larvae killed during a typical seismic survey was 0.45% of the total larvae population. When more realistic "expected values" were applied to each parameter of the calculation model, the estimated value for killed larvae during one run was equal to 0.03% of the larvae population. If the same larval population was exposed to multiple seismic runs, the effect would add up for each run. For species such as cod, herring and capelin, the natural mortality is estimated at 5-15% per day of the total population for eggs and larvae. This declines to 1-3% per day once the species reach the 0 group stage *i.e*. at approximately 6 months (Sætre & Ona 1996). Consequently, Dalen *et al*. (1996) concluded that seismic-created mortality is so low that it can be considered to have an inconsequential impact on recruitment to the populations.

#### 4.1.4 Impacts on Seabirds

Among the marine avifauna of South African waters, it is only the diving birds, or birds which rest on the water surface, that may be affected by the underwater noise of seismic surveys. The African penguin (*Spheniscus demersus*), which is flightless and occurs along the South Coast, would be particularly susceptible to impacts from underwater seismic noise. In African penguins the best hearing is in the 600 Hz to 4 kHz range with the upper limit of hearing at 15 kHz and the lower limit at 100 Hz (Wever *et al*. 1969). No critical ratios have, however, been measured. Principal energy of vocalisation of African penguins was found at <2 kHz, although some energy was measured at up to 6 kHz (Wever *et al*. 1969).

The continuous nature of the intermittent seismic survey pulses suggest that African penguins and other diving birds would hear the sound sources at distances where levels would not induce mortality or injury, and consequently be able to flee an approaching sound source. Consequently, the potential for injury to seabirds from seismic surveys in the open ocean is deemed to be low (see also Stemp 1985, in Turnpenny & Nedwell 1994), particularly given the extensive feeding range of the potentially affected seabird species.

### 4.1.5 Impacts on Turtles

The potential effects of seismic surveys on turtles include:

- Physiological injury (including disorientation), mortality from seismic noise or collision with or entanglement in towed seismic apparatus;
- Behavioural avoidance of seismic survey areas;
- Masking of environmental sounds and communication; and
- Indirect effects due to effects on prey.

Available data on marine turtle hearing is limited, but suggest highest auditory sensitivity at frequencies of 250 – 700 Hz, and some sensitivity to frequencies at least as low as 60 Hz (Ridgway *et al*. 1969; Wever *et al*. 1978, in McCauley 1994; O'Hara & Wilcox, 1990; Moein-Bartol *et al*. 1999). The overlap of this hearing sensitivity with the higher frequencies produced by airguns, suggest that turtles may be considerably affected by seismic noise.

No information on physiological injury to turtle hearing could be sourced in the literature. If subjected to seismic sounds at close range, temporary or permanent hearing impairment may result, but it is unlikely to cause death or life-threatening injury. As with other large mobile marine vertebrates, it is assumed that sea turtles will avoid seismic noise at levels/distances where the noise is a discomfort. Juvenile turtles may be unable to avoid seismic sounds in the open ocean, and consequently may be more susceptible to seismic noise.

Behavioural changes in response to anthropogenic sounds have been reported for some sea turtles and include startle response (Lenhardt *et al*. 1983), an increase in swim speed and erratic behaviour indicative of avoidance (O'Hara & Wilcox 1990; McCauley *et al*. 2000). Further trials carried out on caged loggerhead and green turtles indicated that significant avoidance response occurred at received levels ranging between 172 and 176 dB re 1 µPa at 24 m, and repeated trails several days later suggest either temporary reduction in hearing capability or habituation with repeated exposure. Hearing however returned after two weeks (Moein *et al*. 1994; McCauley *et al*. 2000).

Observations of marine turtles during a ten-month seismic survey in deep water (1,000-3,000 m) off Angola found that turtle sighting rate during guns-off was double that of full-array seismic activity, although these results should be treated with caution since a large proportion of the sightings occurred during unusually calm conditions and during peak diurnal abundance of turtles when the airguns were inactive (Weir 2007). In contrast, Parente *et al*. (2006), working off Brazil found no significant differences in turtle sightings with airgun state. It is possible that during deep water surveys turtles only detect airguns at close range or are not sufficiently mobile to move away from approaching airgun arrays (particularly if basking for metabolic purposes when they may be slow to react) (Weir 2007). This is in marked contrast to previous assessments that assumed that the impact of seismic noise on behaviour of adult turtles in the open ocean environment is of low significance given the mobility of the animals (CSIR 1998; CCA & CMS 2001). In the study by Weir (2007) a confident assessment of turtle behaviour in relation to seismic status was hindered, however, by the apparent reaction of individual animals to the survey vessel and towed equipment rather than specifically to airgun sound. As these reactions occurred at close range (usually <10 m) to approaching objects, they appeared to be based principally on visual detection.

Although collisions between turtles and vessels are not limited to seismic ships, the large amount of equipment towed astern of survey vessels does increase the potential for collision, or entrapped within seismic equipment and towed surface floats. Basking turtles are particularly slow to react to approaching objects may not be able to move rapidly away from approaching airguns. In the past, almost all reported turtle entrapments were associated with the subsurface structures ('undercarriage') of the tail buoys attached to the end of each seismic cable. Towing points are located on the leading edge of each side of the undercarriage, and these are attached by chains to a swivel leading to the end of the seismic cable (Ketos Ecology 2009). Entrapment occurs either as a result of 'startle diving' in front of towed equipment or following foraging on barnacles and other organisms growing along seismic cables and surfacing to breathe immediately in front of the tail buoy (primarily loggerhead and Olive Ridley turtles). In the first case the turtle becomes stuck within the angled gap between the chains and the underside of the buoy, lying on their sides across the top of the chains and underneath the float with their ventral surface facing the oncoming water thereby causing the turtle to be held firmly in position (Figure 22, left). Depending on the size of the turtle, they can also become stuck within the gap below a tail buoy, which extends to 0.8 m below water level and is ~0.6 m wide. The animal would need to be small enough to enter the gap, but too big to pass all the way through the undercarriage. Furthermore, the presence of the propeller in the undercarriage of some buoy-designs prohibits turtles that have entered the undercarriage from travelling out of the trailing end of the buoy (Figure 22, right). Once stuck inside or in front of a tail buoy, the water pressure generated by the 4–6 knot towing speed, would hold the animal against/inside the buoy with little chance of escape due to the angle of its body in relation to the forward movement of the buoy. For a trapped turtle this situation will be fatal, as it will be unable to reach the surface to breathe (Ketos Ecology 2009). To prevent entrapment, the seismic industry has implemented the use of “turtle guards” on all tailbuoys.

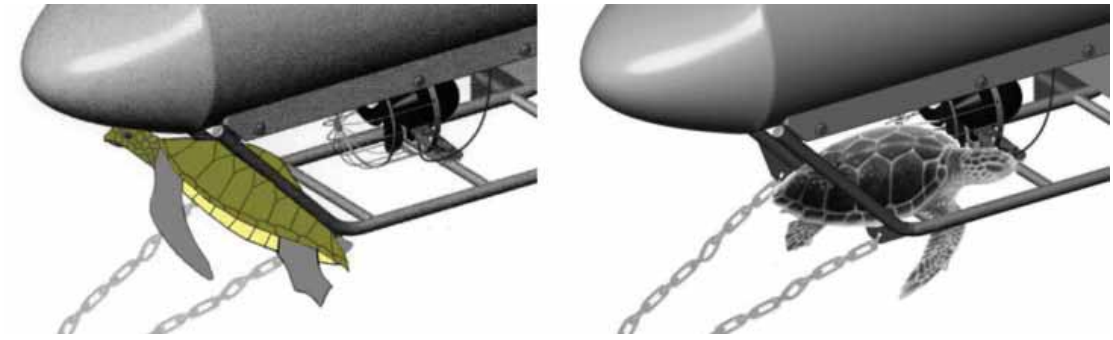


Figure 22: Turtles commonly become trapped in front of the undercarriage of the tail buoy in the area between the buoy and the towing chains (left), and inside the 'twin-fin' undercarriage structure (right) (Ketos Ecology 2009).

Breeding adults of sea turtles undertake large migrations between distant foraging areas and their nesting sites (within the summer months October to March, with peak nesting during December and January). Although Lenhardt *et al.* (1983) speculated that turtles may use acoustic cues for navigation during migrations, information on turtle communication is lacking. The effect of seismic noise in masking environmental cues such as surf noise (150-500 Hz), which overlaps the frequencies of optimal hearing in turtles (McCauley 1994), is unknown and speculative.

### 4.1.6 Impacts on Seals

The Cape fur seal forages over the continental shelf to depths of over 200 m and would consequently be expected to occur within the proposed seismic survey area.

Underwater behavioural audiograms have been obtained for two species of Otariidae (sea lions and fur seals), but no audiograms have been measured for Cape fur seals. Extrapolation of these audiograms to below 100 Hz would result in hearing thresholds of approximately 140-150 dB re 1 µPa for the California sea lion and well above 150 dB re 1 µPa for the Northern fur seal. The range of greatest sensitivity in fur seals lies between the frequencies of 2-32 kHz (McCauley 1994). Underwater critical ratios have been measured for two northern fur seals and averaged ranged from 19 dB at 4 kHz to 27 dB at 32 kHz. The audiograms available for otariid pinnipeds suggest they are less sensitive to low frequency sounds (<1 kHz) than to higher frequency sounds (>1 kHz). The range of low frequency sounds (30-100 Hz) typical of seismic airgun arrays thus falls below the range of greatest hearing sensitivity in fur seals. This generalisation should, however, be treated with caution as no critical ratios have been measured for Cape fur seals.

Seals produce underwater sounds over a wide frequency range, including low frequency components. Although no measurement of the underwater sounds have been made for the Cape fur seal, such measurements have been made for a con-generic species *Arctocephalus philippii*, which produced narrow-band underwater calls at 150 Hz. Aerial calls of seals range up to 6 Hz, with the dominant energy in the 2-4 kHz band. However, these calls have strong tonal components below 1 kHz, suggesting some low frequency hearing capability and therefore some susceptibility to disturbance from the higher frequency components of seismic airgun sources (Goold & Fish 1998; Madsen *et al*. 2006).

The potential impact of seismic survey noise on seals could include physiological injury to individuals, behavioural avoidance of individuals (and subsequent displacement from key habitat), masking of important environmental or biological sounds and indirect effects due to effects on predators or prey.

The physiological effects of loud low frequency sounds on seals are not well documented, but include cochlear lesions following rapid rise time explosive blasts (Bohne *et al*. 1985; 1986), temporary threshold shifts (TTS) following exposure to octave-band noise (frequencies ranged from 100 Hz to 2000 Hz, octave-band exposure levels were approximately 60–75 dB, while noise-exposure periods lasted a total of 20–22 min) (Kastak *et al*. 1999), with recovery to baseline threshold levels within 24 h of noise exposure.

Using measured discomfort and injury thresholds for humans, Greenlaw (1987) modelled the pain threshold for seals and sea lions and speculated that this pain threshold was in the region of 185 – 200 dB re 1 µPa. The impact of physiological injury to seals from seismic noise is deemed 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. However, noise of moderate intensity and duration may be sufficient to induce TTS under water in pinniped species (Kastak *et al*. 1999). Reports of seals swimming within close proximity of firing airguns should thus be interpreted with caution in terms of the impacts on individuals as such individuals may well be experiencing hearing threshold shifts.

Information on the behavioural response of fur seals to seismic exploration noise is lacking (Richardson *et al*. 1995; Gordon *et al*. 2004). Reports of studies conducted with Harbour and Grey seals include initial startle reaction to airgun arrays, and range from partial avoidance of the area close to the vessel (within 150 m) (Harris *et al*. 2001) to fright response (dramatic reduction in heart rate), followed by a clear change in behaviour, with shorter erratic dives, rapid movement away from the noise source and a complete disruption of foraging behaviour (Gordon *et al*. 2004). In most cases, however, individuals quickly reverted back to normal behaviour once the seismic shooting ceased and did not appear to avoid the survey area. Seals seem to show adaptive responses by moving away from airguns and reducing the risk of sustaining hearing damage. Potential for long-term habitat exclusion and foraging disruption over longer periods of exposure (*i.e*. during full-scale surveys conducted over extended periods) is however a concern.

Cape fur seals generally appear to be relatively tolerant to noise pulses from underwater explosives, which are probably more invasive than the slower rise-time seismic sound pulses. There are also reports of Cape fur seals approaching seismic survey operations and individuals biting hydrophone streamers (CSIR 1998). This may be related to their relative insensitivity to sound below 1 kHz and their tendency to swim at or near the surface, exposing them to reduced sound levels. It has also been suggested that this attraction is a learned response to towed fishing gear being an available food supply.

### 4.1.7 Impacts on Whales and Dolphins

The cetaceans comprise baleen whales (mysticetes) and toothed whales and dolphins (odontocetes). The potential impact of seismic survey noise on cetaceans includes a) physiological injury to individuals, b) behavioural disturbance (and subsequent displacement from key habitat), c) masking of important environmental or biological sounds, or d) effects due to indirect effects on prey. Reactions of cetaceans to anthropogenic sounds have been reviewed by McCauley (1994), Richardson *et al*. (1995), Gordon & Moscrop (1996) and Perry (1998). More recently reviews have focused specifically on the effects of sounds from seismic surveys on marine mammals (DFO 2004; NRC 2005; Nowacek *et al*. 2007; Southall *et al*. 2007; Abgrall *et al*. 2008, amongst others).

#### *Cetacean vocalisations*

Cetacean are highly reliant on acoustic channels for orientation in their environment, feeding and social communication (Tyack & Clark 2000). Baleen whales produce a wide repertoire of sounds ranging in frequencies from 12 Hz to 8 kHz (Richardson *et al*. 1995). Vocalisations may be produced throughout the year (Dunlop *et al*. 2007; Mussoline *et al*. 2012; Vu *et al*. 2012), with peaks in call rates during breeding seasons in some species, most notably humpback whales (Winn & Winn 1978).

Odontocetes produce a spectrum of vocalizations including whistles, pulsed sounds and echolocation clicks (Popper 1980). Whistles play a key role in social communication, they are concentrated in the 1-30 kHz frequency range but may extend up to 75 kHz (Samarra *et al*. 2010) and contain high frequency harmonics *(*Lammers *et al*. 2003). The characteristics of burst pulsed sounds are highly variable, concentrated in the mid frequency for killer whales

(Richardson *et al*. 1995), but extending well into the ultrasonic frequency range for other dolphin species (Lammers *et al*. 2003). Although most odontocete vocalizations are predominantly in mid and high frequency bands, there are recent descriptions of dolphins producing low frequency moans (150-240 Hz) and low frequency modulated tonal calls (990 Hz) (van der Woude 2009; Simrad *et al*. 2012), the function of which remains unclear but may be related to social behaviours.

Clicks are high intensity, short sounds associated with orientation and feeding. The frequency composition of echolocation clicks varies with species. Most delphinids produce broad band echolocation clicks with frequencies which extend well up into the ultra-sonic range > 100 kHz (Richardson *et al*. 1995). Sperm whales produce broadband echolocation clicks reaching up to 40 kHz in frequency (Backus & Schevill 1966; Madsen *et al*. 2002). Neonatal sperm whales produce lower frequency sounds at 300-1700 Hz (Madsen *et al*. 2003). Porpoise, Kogiids and dolphins in the genus *Cephalorhynchus* (including the Heaviside's dolphin) produce characteristic narrow band, high frequency (NBHF) echolocation clicks with a central frequency around 125 kHz (Madsen *et al*. 2005a; Morisaka *et al*. 2011). Beaked whales produce low frequency sounds (Richardson *et al*., 1995) and mid frequency echolocation clicks, burst pulse vocalisations and frequency modulated pulses with energy concentrated at 10 kHz and above (Madsen *et al*. 2005b; Rankin *et al*. 2011).

***Cetacean hearing***

Cetacean hearing has received considerable attention in the international literature, and available information has been reviewed by several authors including Popper (1980), Fobes & Smock (1981), Schusterman (1981), Ridgway (1983), Watkins & Wartzok (1985), Johnson (1986), Moore & Schusterman (1987) and Au (1993).

Marine mammals as a group have wide variations in ear anatomy, frequency range and amplitude sensitivity. The hearing threshold is the amplitude necessary for detection of a sound and varies with frequency across the hearing range (Nowacek *et al*. 2007). Considerable differences also exist between the hearing sensitivities of baleen and toothed whales and dolphins and between individuals, resulting in different levels of sensitivity to sounds at varying frequencies.

The factors that affect the response of marine mammals to sounds in their environment include the sound level and other properties of the sound, the physical and behavioural state of the animal and its prevailing acoustic characteristics, and the ecological features of the environment in which the animal encounters the sound. The responses of cetaceans to noise sources are often also dependent on the perceived motion of the sound source, as well as the nature of the sound itself. For example, many whales are more likely to tolerate a stationary source than they are one that is approaching them (Watkins 1986; Leung-Ng & Leung 2003), or are more likely to respond to a stimulus with a sudden onset than to one that is continuously present (Malme *et al*. 1985).

For most species the best frequency sensitivity corresponds closely to the frequencies at which they vocalise. Consequently, baleen whale hearing is centred at below 1 kHz (Fleischer 1976, 1978; Norris & Leatherwood 1981), while toothed whale and dolphin hearing is centred at frequencies of between 10 and 100 kHz (Richardson *et al*.1995). The combined information

strongly suggests that baleen whales are likely to be most sensitive to sounds from 10's of Hz to around 10 kHz (Southall *et al.,* 2007), while toothed whale and dolphin hearing is centred at frequencies of between 10 and 100 kHz (Richardson *et al.*1995). However, no psycho-acoustical or electrophysical work on the sensitivity of baleen whales to sound has been conducted (Richardson *et al.*, 1995) and hypotheses regarding the effects of sound in baleen whales are extrapolations from what is known to affect odontocetes or other marine mammals and from observations of behavioural responses. A partial response "audiogram" exists for the gray whale based on the avoidance of migrating whales to a pure tone source (Dahlheim & Ljungblad 1990). Frankel *et al.* (1995), in Perry 1998) found humpback whales in the wild to detect sounds ranging from 10 Hz to 10 kHz at levels of 102 to 106 dB re 1 µPa. Blue whales reduce calling in the presence of mid-frequency sonar (1-8 kHz) providing evidence that they are receptive to sound in this range (Melcón *et al.* 2012). Based on the low frequency calls produced by larger toothed whales, and anatomical and paleaontological evidence for baleen whales, it is predicted that these whales hear best in the low frequencies (Fleischer 1976, 1978; McCauley 1994), with hearing likely to be most acute below 1 kHz (Fleischer 1976, 1978; Norris & Leatherwood 1981). The available information demonstrates that the larger toothed whales and baleen whales will be very receptive to the sound produced by seismic airgun arrays and consequently this group may be more affected by this type of disturbance than toothed whales (Nowacek *et al.*, 2007).

Behavioural and electrophysical audiograms are available for several species of small- to medium-sized toothed whales (killer whale: Hall & Johnson 1972; Bain *et al.* 1993, false killer whale: Thomas *et al.* 1988, bottlenose dolphins: Johnson 1967, beluga: White *et al.* 1978; Awbrey *et al.* 1988, Harbour porpoise: Andersen 1970, Chinese river dolphin: Ding Wang *et al.* 1992 and Amazon river dolphin: Jacobs & Hall 1972; Risso's dolphin: Nachtigall *et al.* 1995, 1996, Harbour porpoise: Luke *et al.* 2009). In these species, hearing is centered at frequencies between 10 and 100 kHz (Richardson *et al.*1995). The high hearing thresholds at low frequency for those species tested implies that the low frequency component of seismic shots (10 - 300 Hz) will not be audible to the small to medium odontocetes at any great distance. However, the higher frequency of an airgun array shot, which can extend to 15 kHz and above (Madsen *et al.* 2006) may be audible from tens of kilometres away, due to the very low sensitivity thresholds of many toothed whales at frequencies exceeding 1 kHz. Although the match is poor, overlap nonetheless exists between the frequency spectra of seismic shots and the hearing threshold curve with frequency for some toothed whale species, suggesting that these may react to seismic shots at long ranges, but that hearing damage from seismic shots is only likely to occur at close range. They will thus not be affected as severely as many fish, and possibly sea turtles and baleen whales that have their greatest hearing sensitivity at low frequencies (McCauley 1994).

***Physiological injury***

Exposure to high sound levels can result in physiological injury to cetaceans through a number of avenues, including shifts of hearing thresholds (as either permanent (PTS) or temporary threshold shifts (TTS)) (Richardson *et al.* 1995; Au *et al.* 1999; Schlundt *et al.* 2000; Finneran *et al.* 2000, 2001, 2003), tissue damage (Lien *et al.* 1993; Ketten *et al.* 1993), acoustically induced decompression sickness particularly in beaked whales (Crum & Mao 1996; Cox *et al.*

2006), and non-auditory physiological effects including elevated blood pressures, increased heart and respiration rates, and temporary increases in blood catecholamines and glucocorticoids (Bowles & Thompson 1996), which may have secondary impacts on reproduction. Most studies conducted on sound-related injuries in cetaceans, however, investigated the effects of explosive pulses (Bohne *et al*. 1985, 1986; Lien *et al*. 1993; Ketten *et al*. 1993) and mid-frequency sonar pulses (Simmonds & Lopez-Jurado 1991; Crum & Mao 1996; Frantzis 1998; Balcomb & Claridge 2001; Evans & England 2001; Jepson *et al*. 2003; Cox *et al*. 2006), and the results are thus not directly applicable to non-explosive seismic sources such as those from airgun arrays.

Noise induced stress resulting from exposure to sources of marine sound can cause detrimental changes in blood hormones, including cortisol (Romano *et al*. 2004). However, quantifying stress caused by noise in wild populations is difficult as it is not possible to determine the physiological responses of an animal to a noise stressor based on behavioural observations alone (Wright *et al*. 2007). The timing of the stressor relative to seasonal feeding and breeding cycles (such as those observed in migrating baleen whales) may also influence the degree of stress induced by noise exposure (Tyack 2008)

There are no data on received levels that would induce permanent threshold shifts (PTS) in cetaceans, although Richardson *et al*. (1995) speculated that very prolonged exposure to noise levels of about 120 dB re 1µPa may induce PTS in beluga whales. Gradual PTS in marine mammals is highly unlikely to occur from seismic surveys. However, permanent hearing damage does not always develop gradually, but may result from brief exposure to high sound levels.

Experiments to induce threshold shifts have only recently been conducted on captive marine mammals (Au *et al*. 1999; Schlundt *et al*. 2000, Finneran *et al*. 2000, 2001, 2002, 2003). Temporary threshold shifts (TTS) became evident at received levels of 194 - 201 dB re 1 µPa at 3 kHz, 193-196 dB at 20 kHz and 192-194 dB at 75 kHz in a bottlenose dolphin exposed to 1-second pulses underwater. However, the relatively long 1-second pulse that elicited the TTS response supplies considerably more energy to the water column than a very much shorter seismic pulse. Finneran *et al*. (2003) found a 226 dB re 1 µPa (peak) was required to create TTS in a beluga, and no TTS was observed in a dolphin at up to 230 dB (peak) using a water gun. Airgun stimuli played back to harbor porpoise (a NBHF species with similar vocal characteristics and body size to Heaviside's dolphin) generated a TTS in the 4 kHz band at a received sound pressure level of 199.7 $db_{pk-pk}$ re 1 µPa and a sound exposure level of of 164.3 dB re 1 _$Pa^2$ s. Avoidance of the sound source was also observed (Luke *et al*. 2009). Based on statistical simulations accounting for uncertainty in the available data and variability in individual hearing thresholds, Gedamke *et al*. (2011) conclude that the possibility of seismic activity leading to TTS in baleen whales must be considered at distances up to several kilometers. As cetaceans are highly reliant on sound, hearing damage leading to TTS and PTS are likely to result in a reduction in foraging efficiency, reproductive potential, social cohesion and ability to detect predators (Weilgart 2007).

Overlap between the frequency spectra of seismic shots and the hearing threshold curve with frequency for some toothed whale species, suggests that these may react to seismic shots at long ranges, but that hearing damage from seismic shots is only likely to occur at close range. They will thus not be affected as severely as many fish, and possibly sea turtles and baleen

whales that have their greatest hearing sensitivity at low frequencies (McCauley 1994). Richardson *et al*. (1995) speculated that the Damage Risk Criteria (DRC) (*i.e*. the tolerable limits for noise exposure) for a marine mammal exposed to 100 seismic pulses might be in the order of 178 – 208 dB re 1µPa. They note, however, that as the duration of peak pressure is less than 200 ms, hearing damage is unlikely unless peak to peak pressure is several dB above these.

***Behavioural disturbance***

Typical behavioural response in cetaceans to seismic airgun noise include initial startle responses (Malme *et al*. 1985; Ljungblad *et al*. 1988; McCauley *et al*. 2000), changes in surfacing behaviour (Ljungblad *et al*. 1988; Richardson *et al*. 1985a; McCauley *et al*. 1996, 2000), shorter dives (Ljungblad *et al*. 1988), changes in respiration rate (Ljungblad *et al*. 1988; Richardson *et al*. 1985a, 1985b, 1986; Malme *et al*. 1983, 1985,1986), slowing of travel (Malme *et al*. 1983, 1984), and changes in vocalisations (McDonald *et al*. 1993, 1995) and call rate (Di lorio & Clarke 2010). These subtle changes in behavioural measures are often the only observable reaction of whales to reception of anthropogenic stimuli, and there is no evidence that these changes are biologically significant for the animals (see for example McCauley 1994). Possible exceptions are impacts at individual (through reproductive success) and population level through disruption of feeding within preferred areas (as reported by Weller *et al*. (2002) for Western gray whales). For continuous noise, whales begin to avoid sounds at exposure levels of 110 dB, and more than 80% of species observed show avoidance to sounds of 130 dB. For seismic noise, most whales show avoidance behaviour above 160 dB (Malme *et al*. 1983, 1984; Ljungblad *et al*. 1988; Pidcock *et al*. 2003). Behavioural responses are often evident beyond 5 km from the sound source (Ljungblad *et al*. 1988; Richardson *et al*. 1986, 1995), with the most marked avoidance response recorded by Kolski and Johnson (1987) who reported bowhead whales swimming rapidly away from an approaching seismic vessel at a 24 km distance.

In an analysis of marine mammals sightings recorded from seismic survey vessels in United Kingdom waters, Stone (2003) reported that responses to large gun seismic activity varied between species, with small odontocetes showing the strongest avoidance response. Responses of medium and large odontocetes (killer whales, pilot whales and sperm whales) were less marked, with sperm whales showing no observable avoidance effects (see also Rankin & Evans 1998; Davis *et al*. 2000; Madsen *et al*. 2006). Baleen whales showed fewer responses to seismic survey activity than small odontocetes, and although there were no effects observed for individual baleen whale species, fin and sei whales were less likely to remain submerged during firing activity. All baleen whales showed changes in behavioural responses further from the survey vessel (see also Ljungblad *et al*. 1988; McCauley 2000; Abgrall *et al*. 2008), and both orientated away from the vessel and altered course more often during shooting activity. The author suggests that different species adopt different strategies in response to seismic survey disturbance, with faster smaller odontocetes fleeing the survey area (e.g. Weir 2008), while larger slower moving baleen whales orientate away from and move slowly from the firing guns, possibly remaining on the surface as they do so (see also Richardson *et al*. 1985a, 1985b, 1986, 1995). Responses to small airguns were less, and although no difference in distance to firing and non-firing small airguns were recorded, there were fewer sightings of small odontocetes in

association with firing airguns. Other reports suggest that there is little effect of seismic surveys on small odontocetes such as dolphins, as these have been reported swimming near operating seismic vessels (Duncan 1985; Evans & Nice 1996; Abgrall *et al*. 2008; but see also Schlundt *et al*. 2000).

McCauley *et al*. (1996, 2000) found no obvious evidence that humpback whales were displaced by 2D and 3D seismic surveys and no apparent gross changes in the whale's migratory path could be linked to the seismic survey. Localised avoidance of the survey vessel during airgun operation was however noted. Whales which are not migrating but using the area as a calving or nursery ground may be more seriously affected through disturbance of suckling or resting. Potential avoidance ranges of 7-12 km by nursing animals have been suggested, although these might differ in different sound propagation conditions (McCauley *et al*. 2000). Disturbance of mating behaviour (which could involve a high degree of acoustic selection) by seismic noise could be of consequence to breeding animals.

The speed of sound increases with increasing temperature, salinity and pressure (Richardson *et al*. 1995) and stratification in the water column affects the rate of propagation loss of sounds produced by an airgun array. As sound travels, acoustic shadow and convergence zones may be generated as sound is refracted towards areas of slower sound speed. These can lead to areas of high and low noise intensity (shadow zones) so that exposure to different pulse components at distances of 1-13 km from the seismic source does not necessarily lessen (attenuate) with increasing range. In some cases this can lead to received levels at 12 km being as high as those at 2 km (Madsen *et al*. 2006). Depending on the propagation conditions of the water column, animals may need to move closer to the sound source or apply vertical rather than horizontal displacement to reduce their exposure. Although such movement may reduce received levels in the short-term it may prolong the overall exposure time and accumulated sound exposure level (SEL) (Madsen *et al*. 2006).

***Masking of important environmental or biological sounds***

Potential interference of seismic emissions with acoustic communication in cetaceans includes direct masking of the communication signal, temporary or permanent reduction in the hearing capability of the animal through exposure to high sound levels or limited communication due to behavioural changes in response to the seismic sound source. Baleen whales generally appear to vocalise almost exclusively within the frequency range of the maximum energy of seismic sounds, while toothed whales vocalise at much higher frequencies, and it is likely that clicks are not masked by seismic survey noise (Goold & Fish 1998). However, due to multi-path propagation, receivers (cetaceans) can be subject to several versions of each airgun pulse, which have very different temporal and spectral properties (Madsen *et al*. 2006). High frequency sound is released as a by-product of airgun firing and this can extend into the mid- and high-frequency range (up to and exceeding 15 kHz) so that the potential for masking of these sound sources should be also considered (Madsen *et al*. 2006).

***Indirect effects on prey species***

The majority of baleen whales will undertake little feeding within breeding ground waters on the South Coast and rely on blubber reserves during their migrations. 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.

## 4.2. Aircraft Noise

The dominant low-frequency components of aircraft engine noise (10-550 Hz) penetrate the water only in a narrow (26° for a smooth water surface) sound cone directly beneath the aircraft, with the angle of the cone increasing in Beaufort wind force >2 (Richardson *et al*. 1995). The peak sound level received underwater is inversely related to the altitude of the aircraft.

Available data indicate that the expected frequency range and dominant tones of sound produced by fixed-wing aircraft and helicopters overlap with the hearing capabilities of most odontocetes and mysticetes (Richardson *et al*. 1995; Ketten 1998). Determining the reactions of cetaceans to overflights is difficult, however, since most observations are made from either the disturbing aircraft itself (Richardson & Würsig 1997), or from a small nearby vessel. Reactions to aircraft flyovers vary both within and between species, and range from no or minimal observable behavioural response (Belugas: Stewart *et al*. 1982, Richardson *et al*. 1991; Sperm: Clarke 1956, Gambell 1968, Green *et al*. 1992), to avoidance by diving, changes in direction or increased speed of movement away from the noise source (Gray: Withrow 1983; Belugas: Richardson *et al*. 1991, Patenaude *et al*. 2002; Sperm: Clarke 1956; Fritts *et al*. 1983, Mullin *et al*. 1991, Würsig *et al*. 1998; Minke: Leatherwood *et al*. 1982; Bowhead: Patenaude *et al*. 2002; Humpbacks: Smultea *et al*. 1995), separation of cow-calf pairs (Gray: Withrow 1983), increased surface intervals (Belugas: Awbrey & Stewart 1983; Stewart *et al*. 1982; Patenaude *et al*. 2002), changes in vocalisation (Sperm whales: Watkins & Schevill 1977, Richter *et al*. 2003, 2006) and dramatic behavioural changes including breaching and lobtailing (Minke: Leatherwood *et al*. 1982; Sperm: Fritts *et al*. 1983; Bowhead: Patenaude *et al*. 2002; Beluga: Patenaude *et al*. 2002), and active and tight clustering behaviour at the surface (Sperm: Smultea *et al*. 2007).

Most authors established that the reactions resulted from the animals presumably receiving both acoustic and visual cues (the aircraft and/or its shadow). As would be expected, sensitivity of whales to disturbance by an aircraft generally lessened with increasing distance, or if the flight path was off to the side and downwind, and if its shadow did not pass directly over the animals (Watkins 1981; Smultea *et al*. 2007). Smultea *et al*. (2007) concluded that the observed reactions of whales to brief overflights were short-term and isolated occurrences were probably of no long-term biological significance and Stewart *et al*. (1982) suggested that disturbance could be largely eliminated or minimised by avoiding flying directly over whales and by maintaining a flight altitude of at least 300 m. However, repeated or prolonged exposures to aircraft overflights have the potential to result in significant disturbance of biological functions, especially in important nursery, breeding or feeding areas (Richardson *et al*. 1995). Aircraft activities that might result in harassment of whales and longer-term effects include military training exercises, helicopter overflights associated with offshore oil and gas exploration and development, regular recreational/ecotourism flights and research surveys (Smultea *et al*. 2007).

The reactions of pinnipeds to aircraft noise was reviewed by Richardson *et al*. (1995). As the frequency of aircraft engine noise overlaps with the hearing ranges of seals, these will likely

similarly receive both acoustic and visual cues from aircraft flyovers. Richardson *et al*. (1995), however, point out that in very few cases was it determined that responses were specifically to aircraft noise as opposed to visual cues. Furthermore, most reported observations relate to pinnipeds on land or ice, with few data specifically on the reactions of pinnipeds in water to either airborne or waterborne sounds from aircraft. Reactions to flyovers vary between species, ranging from stampeding into the water, through temporary abandonment of pupping beaches to alertness at passing aircraft. When in the water, seals have been observed diving when the aircraft passes overhead. Pinnipeds thus exhibit varying intensities of a startle response to airborne noise, most appearing moderately tolerant to flyovers and habituating over time (Richardson *et al*. 1995; Laws 2009). The rates of habituation also varies with species, populations, and demographics (age, sex). Any reactions to overflights would thus be short-term and isolated occurrences would unlikely be of any long-term biological significance.

The hazards of aircraft activity to birds include direct strikes as well as disturbance, the degree of which, relative to other sources of disturbance (e.g. vehicle-, pedestrian- and aquatic traffic), varies greatly. The negative effects of disturbance of birds by aircraft were reviewed by Drewitt (1999) and include loss of usable habitat, increased energy expenditure, reduced food intake and resting time and consequently impaired body condition, decreased breeding success and physiological changes. Nesting birds may also take flight and leave eggs and chicks unattended, thus affecting hatching success and recruitment success (Zonfrillo 1992). Differences in response to different types of aircraft have also been identified, with the disturbance effect of helicopters typically being higher than for fixed-wing aeroplanes. Results from a study of small aircraft flying over wader roosts in the German Wadden Sea showed that helicopters disturbed most often (in 100% of all potentially disturbing situations), followed by jets (84%), small civil aircraft (56%) and motor-gliders (50%) (Heinen 1986; Watson 1993, cited in Drewitt 1999).

As in the case of whales above, sensitivity of birds to aircraft disturbance are not only species specific, but generally lessened with increasing distance, or if the flight path was off to the side and downwind. However, the vertical and lateral distances that invoke a disturbance response vary widely, with habituation to the frequent loud noises of landing and departing aircraft without ill effects being reported for species such as gulls, lapwings, ospreys and starlings, amongst others (reviewed in Drewitt 1999). Further work is needed to examine the combined effects of visual and acoustic stimuli, as evidence suggests that in situations where background noise from natural sources (e.g. wind and surf) is continually high, the visual stimulus may have the greater effect.

## 4.3. Multi-beam Sonars

There are significant differences in the effects of seismic and multi-beam/side-scan surveys. Despite having similar sound levels to seismic surveys, the higher frequency emissions utilised in normal multi-beam and sub-bottom profiling operations tend to be dissipated to safe levels over a relatively short distance. The anticipated radius of influence of multi-beam sonar would thus be significantly less than that for an airgun array. Hence the most likely scenario for injury to an animal by acoustic equipment would be if the equipment were turned on full power while the animal was close to it (Anon 2007). Active sonar systems operate at frequency ranges >10 kHz, producing levels of sound pressure ranging from about 200 dB re 1µPa to 240

dB re 1µPa. Although these higher frequency sounds attenuate more rapidly in seawater than do lower frequency sounds, they do have the potential to impact marine fauna. Available information on cetacean hearing suggests that baleen whales are most sensitive to sounds from 10's of Hz to around 10 kHz (Southall *et al.*, 2007), while toothed whale and dolphin hearing is centred at frequencies of between 10 and 100 kHz (Richardson *et al*.1995). Both baleen whales and toothed whales would thus be expected to hear sonar signals from most types of oceanographic sonars at frequencies within their functional hearing range if the whales are within the sonar beam. Similarly, pinnipeds are also expected to hear sonar signals at frequencies within their functional hearing range if the animals are within the sonar beam, and phocids (true seals) and otariids (fur seals) would hear sonars operating at frequencies up to about 75 kHz and 35 kHz, respectively (Richardson *et al*.1995). Marine turtles, however, appear to have their highest auditory sensitivity at frequencies of 250 – 700 Hz, and thus well below the frequency ranges typically used by oceanographic sonars.

In 2003, the German Federal Environmental Agency (UBA) decreed restrictions on the use of multi-beam systems in Antarctic waters, with the arguement that marine mammals could theoretically be ensonified by the fan-shaped sonar beam, potentially resulting in a TTS or PTS, and leading to disorientation. However, the statistical probability of crossing a cetacean with a narrow multi-beam fan several times, or even once, is very small. In contrast, the US National Marine Fisheries Service (NMFS), believed that marine mammals were unlikely to be harassed or injured from the multi-beam sonar or the sub-bottom profiler as the multi-beam sonar had an anticipated radius of influence significantly less than that for an airgun array.

It is thus generally understood that in open coastal waters the effects of multi-beam sonars on marine fauna are negligible.

# 5. ASSESSMENT OF ACOUSTIC IMPACTS ON MARINE FAUNA

## 5.1. Assessment Procedure

The following convention was used to determine significance ratings in the assessment:

| Rating | Definition of Rating |
|---|---|
| ***Extent*** *- defines the physical extent or spatial scale of the impact* | |
| Local | Extending only as far as the activity, limited to the site and its immediate surroundings |
| Regional | Limited to the South and / or East Coast |
| National | Limited to the coastline of South Africa |
| International | Extending beyond the borders of South Africa |
| ***Duration*** *- the time frame over which the impact will be experienced* | |
| Short-term | 0 – 5 years |
| Medium-term | 6 – 15 years |
| Long-term | Where the impact would cease after the operational life of the activity, either because of natural processes or by human intervention |
| Permanent | Where mitigation either by natural processes or by human intervention would not occur in such a way or in such time span that the impact can be considered transient |
| ***Intensity*** *- establishes whether the magnitude of the impact is destructive or benign in relation to the sensitivity of the receiving environment* | |
| Low | Where natural environmental functions and processes are not affected |
| Medium | Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way |
| High | Where environmental functions and processes are altered to the extent that they temporarily or permanently cease |

Using the core criteria above, the significance of the impact is determined:

| ***Significance*** *- attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity* | |
|---|---|
| VERY HIGH | Impacts could be EITHER:<br>of high intensity at a regional level and endure in the long term;<br>OR of high intensity at a national level in the medium term;<br>OR of medium intensity at a national level in the long term. |
| HIGH | Impacts could be EITHER:<br>of high intensity at a regional level enduring in the medium term;<br>OR of high intensity at a national level in the short term;<br>OR of medium intensity at a national level in the medium term;<br>OR of low intensity at a national level in the long term;<br>OR of high intensity at a local level in the long term;<br>OR of medium intensity at a regional level in the long term. |

| ***Significance*** *- attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity* | |
|---|---|
| MEDIUM | Impacts could be EITHER:<br>of high intensity at a local level and endure in the medium term;<br>OR of medium intensity at a regional level in the medium term;<br>OR of high intensity at a regional level in the short term;<br>OR of medium intensity at a national level in the short term;<br>OR of medium intensity at a local level in the long term;<br>OR of low intensity at a national level in the medium term;<br>OR of low intensity at a regional level in the long term. |
| LOW | Impacts could be EITHER<br>of low intensity at a regional level, enduring in the medium term;<br>OR of low intensity at a national level in the short term;<br>OR of high intensity at a local level and endure in the short term;<br>OR of medium intensity at a regional level in the short term;<br>OR of low intensity at a local level in the long term;<br>OR of medium intensity at a local level, enduring in the medium term. |
| VERY LOW | Impacts could be EITHER<br>of low intensity at a local level and endure in the medium term;<br>OR of low intensity at a regional level and endure in the short term;<br>OR of low to medium intensity at a local level, enduring in the short term. |
| INSIGNIFICANT | Impacts with:<br>Zero intensity with any combination of extent and duration. |
| UNKNOWN | Where it is not possible to determine the significance of an impact. |

| ***Status of the Impact*** *- describes whether the impact would have a negative, positive or zero effect on the affected environment* | |
|---|---|
| Positive | The impact benefits the environment |
| Negative | The impact results in a cost to the environment |
| Neutral | The impact has no effect |
| ***Probability*** *- the likelihood of the impact occurring* | |
| Improbable | Possibility very low either because of design or historic experience |
| Probable | Distinct possibility |
| Highly Probable | Most likely |
| Definite | Impact will occur regardless of preventive measures |
| ***Degree of confidence in predictions*** *- in terms of basing the assessment on available information and specialist knowledge* | |
| Low | Less than 35% sure of impact prediction. |
| Medium | Between 35% and 70% sure of impact prediction. |
| High | Greater than 70% sure of impact prediction |

Additional criteria to be considered, which could "increase" the significance rating are:

- Permanent / irreversible impacts (as distinct from long-term, reversible impacts);
- Potentially substantial cumulative effects; and
- High level of risk or uncertainty, with potentially substantial negative consequences.

Additional criteria to be considered, which could "decrease" the significance rating are:

- Improbable impact, where confidence level in prediction is high.

The relationship between the significance ratings after mitigation and decision-making can be broadly defined as follows:

| ***Significance after Mitigation*** *- considering changes in intensity, extent and duration after mitigation and assuming effective implementation of mitigation measures* | |
|---|---|
| Very Low; Low | Will not have an influence on the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented. |
| Medium | Should influence the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented. |
| High; Very High | Would strongly influence the decision to proceed with the proposed project. |

## 5.2. Impacts of Seismic Survey

### 5.2.1 Impacts to Plankton (including ichthyoplankton)

Potential impacts of seismic pulses on plankton and fish eggs and larvae would include mortality or physiological injury in the immediate vicinity of the airgun sound source. Impacts will thus be of high intensity at very close range (<5 m from the airguns) only, and no more significant than the effect of the wash from ships propellers and bow waves. The proposed survey area overlaps to some degree with kingklip and squid spawning areas, and the inshore distribution of anchovy and pilchard eggs (see Figure 4). However, as plankton distribution is naturally temporally and spatially variable and natural mortality rates are high, any impacts would thus 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 consequently 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.

**Mitigation**

Dalen *et al*. (1996) recommended that seismic survey activities should avoid areas of concentrated spawning or spawning migration paths by 50 km, particularly areas subjected to repeated, high intensity surveys. For the current proposed seismic survey, there is potential overlap of the target area with the spawning grounds of various pelagic and demersal species on the Agulhas Bank, overlap with squid spawning grounds in the Cape St Francis to Port

Elizabeth area, potential overlap with pilchard and anchovy egg distribution between Port Elizabeth and Port St Johns. Various reef fish are also reported to spawn on deep-water reefs along the South Coast and undertake spawning migrations eastwards along the coast to KwaZulu-Natal. Despite the spatial extent of the spawning areas and the limited overlap of the proposed survey area with these, avoidance of the inshore spawning grounds is recommended in November and December.

| *Impacts of seismic noise to plankton and ichthyoplankton* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

### 5.2.2 Impacts to Marine Invertebrates

Although some marine invertebrates have mechanoreceptors or statocyst organs that are sensitive to hydroacoustic disturbances, most do not possess hearing organs that perceive sound pressure. Potential impacts of seismic pulses on invertebrates include physiological injury and behavioural avoidance of seismic survey areas. Masking of environmental sounds and indirect impacts due to effects on predators or prey have not been documented and are highly unlikely.

**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, such as less than 15 m away. This implies that only surveys conducted in very shallow water will have any detrimental effects on invertebrates associated with the seabed. Species of potential concern in the proposed survey area are the commercially fished deep-water rock lobster (*Palinurus gilchristi*), which occurs on rocky substrate in depths of 90 - 170 m, and the squid (*Loligo vulgaris reynaudii*), which occurs extensively on the Agulhas Bank out to the shelf edge (500 m depth contour). Adult squid are normally distributed in waters >100 m, except along the eastern half of the South Coast where they also occur inshore, forming dense seasonal spawning aggregations at depths between 20 - 130 m. However, as the survey would be conducted in excess of 100 m depth the received noise at the seabed would be within the far-field range, and outside of distances at which physiological injury of these invertebrates would be expected.

Although causative links to seismic surveys have not been established with certainty, giant squid strandings coincident with seismic surveys have been reported (Guerra *et al*. 2004). The animals showed no external damage, but all had severe internal injuries (including

disintegrated muscles and unrecognisable organs) indicative of having ascended from depth too quickly.

The potential impact of seismic noise on physiological injury or mortality of invertebrates is, however, deemed of low to negligible intensity across the survey area and for the survey duration and is considered to be of **VERY LOW** significance both with and without mitigation. No mitigation measures for potential impacts on marine invertebrates and their larvae are feasible or deemed necessary.

**Behavioural avoidance**

Similarly, there is 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 the received noise at the seabed would be within the far-field range, and outside of distances at which avoidance of benthic invertebrates would be expected, the potential impact of seismic noise on invertebrate behaviour is consequently deemed of low to negligible intensity across the survey area and for the survey duration and is considered to be of **VERY LOW** significance both with and without mitigation, and no mitigation measures are deemed necessary.

Squid are reported to significantly alter their behaviour at an estimated 2 - 5 km from an approaching large seismic source (McCauley *et al*. 2000), so avoidance of airgun sounds by squid during their spawning aggregations may occur. However, although avoidance for squid is deemed to be of medium intensity across the survey area and for the survey duration, the impacts for invertebrates in general is considered to be of **VERY LOW** significance both without and with mitigation. A possible mitigation measure would be to avoid surveying in the area off Port Elizabeth in November and December during the peak inshore (<130 m) spawning aggregations. This is also the time when the highest catches are made by the commercial fishery, and scheduling of the survey to avoid interaction with the fishing fleet thus needs to be considered.

| ***Impacts of seismic noise to marine invertebrates resulting in physiological injury*** | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise to marine invertebrates resulting in behavioural avoidance* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Medium | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

### 5.2.3 Impacts to Fish

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

**Physiological injury and mortality**

The greatest risk of physiological injury from seismic sound sources is for species that establish home ranges on shallow-water reefs or congregate in inshore waters to spawn or feed, 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 physiological injury or severe hearing damage and adverse effect may intensify and last for a considerable time after the termination of the sound source. However, as the proposed survey will be located ~30 km offshore in water depths in excess of 100 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 100 m isobath, particularly the highly migratory pelagic species likely to be encountered in deeper water, it is assumed that the majority of fish species would avoid seismic noise at levels below those where physiological injury or mortality would result. In many of the large pelagic species, however, 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. As there are no seamounts or important fishing banks in the survey area, the likelihood of encountering feeding aggregations of large pelagic species is low. 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 potential physiological impact on demersal and nearshore reef species would, however, be insignificant as they would only be affected in the far-field range. The impact is therefore

considered to be of **LOW** significance without the implementation of mitigation measures, and of **VERY LOW** significance with mitigation measures.

**Behavioural avoidance**

Behavioural responses such as avoidance of seismic survey areas and changes in feeding behaviours of some fish to seismic sounds have been documented at received levels of about 160 dB re 1 μPa. Behavioural effects are generally short-term, however, 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 therefore be of high intensity (particularly in the near-field of the airgun array), over the short term, but limited to the survey area. Consequently it is considered to be of **LOW** significance without mitigation and **VERY LOW** significance with mitigation.

**Reproductive success / spawning**

Fish populations can 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 will depend on the biology of the species and the extent of the dispersion or deflection. Considering the wide range over which the potentially affected species occur, the relatively short duration of the proposed survey and that the migration routes do not constitute narrow restricted paths, the impact is considered to be of **LOW** significance without the implementation of mitigation measures, and of **VERY LOW** significance with mitigation measures.

Indirect effects of mortality to ichthyoplankton (assessed in Section 5.2.1) on recruitment to adult fish populations is also considered to be of **VERY LOW** significance both with and without mitigation.

**Masking of environmental sounds and communication**

Communication and the use of environmental sounds by fish in the offshore environment off the South African South Coast are unknown. Some nearshore reef species, however, are likely to produce isolated sounds or to call in choruses. Impacts arising from masking of sounds are expected to be of low intensity due to the duty cycle of seismic surveys in relation to the more continuous biological noise. Furthermore, as the survey would be conducted at depths in excess of 100 m, any effects on demersal fish species would be in the far field. Such impacts would occur across the survey area and for the duration of the survey and are consequently considered of **VERY LOW** significance both 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 and tunas to pelagic fish 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. Considering the extensive range over which large pelagic fish species feed in relation to the survey area the impact is likely to be of **VERY LOW** significance both with and without mitigation.

**Mitigation**

Recommendations for mitigation include:

- All initiation of airgun firing be carried out as "soft-starts" of at least 20 minutes duration, allowing fish to move out of the survey area and thus avoid potential physiological injury as a result of seismic noise.
- No seismic survey activities within Marine Protected Areas.

| *Impacts of seismic noise on fish resulting in physiological injury* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | High | Low to Medium |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Improbable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise on fish resulting in behavioural avoidance* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | High | Low to Medium |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Improbable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise on reproductive success and spawning* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | High | Low to Medium |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Improbable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise on fish resulting in masking of sounds* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Improbable | Improbable |
| **Confidence** | Low | Low |

| *Impacts of seismic noise on fish resulting in indirect impacts on food sources* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Improbable | Improbable |
| **Confidence** | Low | Low |

### 5.2.4 Impacts to Seabirds

Among the marine avifauna occurring along the South and East Coasts of South Africa, it is only the species that feed by plunge-diving or that rest on the sea surface, which may be affected by the underwater noise of seismic surveys. Potential impacts of seismic pulses to diving birds could include physiological injury, behavioural avoidance of seismic survey areas and indirect impacts due to effects on prey. The seabird species are all highly mobile and would be expected to flee from approaching seismic noise sources at distances well beyond those that could cause physiological injury, but initiation of a sound source at full power in the immediate vicinity of diving seabirds could result in injury or mortality where feeding behaviour override a flight response to seismic survey sounds. The potential for physiological injury or behavioural

avoidance in non-diving seabird species is considered **INSIGNIFICANT** and will not be discussed further here.

**Physiological injury**

The continuous nature of the intermittent seismic survey pulses suggest that African penguins and other diving birds would hear the sound sources at distances where levels would not induce mortality or injury, and consequently be able to flee an approaching sound source. The potential for physiological impact of seismic noise on diving birds and African penguins could be of high intensity but would be limited to the survey area and survey duration (short term). Although the survey area extends from the coastline offshore, a coastal buffer of 10 km will be implemented. Of the plunge diving species that occur along the coastline, only the Cape Gannet regularly feeds as far offshore as 100 km, the rest foraging within 20 km of the shore. There is thus a high likelihood of the survey encountering foraging penguins in the inshore regions of the licence area, and Cape gannets are likely to be encountered further offshore, particularly if the survey schedule overlaps with the annual 'sardine run' between June and August . The potential physiological impact on diving species is, however, considered to be of **LOW** significance without mitigation, and **VERY LOW** significance with mitigation.

**Behavioural avoidance**

Behavioural avoidance by diving seabirds would be limited to the vicinity of the operating airgun within the survey area over the duration of the survey period. The impact is likely to be of medium to high intensity. The potential impact on the behavioural avoidance of feeding areas by diving seabirds is considered to be of **LOW** significance without mitigation, and **VERY LOW** significance with mitigation.

**Indirect impacts due to effects on prey**

As with other vertebrates, the assessment of indirect effects of seismic surveys on diving seabirds 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 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. Most plunge-diving birds, however, 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 seismic survey. The broad ranges of potential fish prey species (in relation to potential avoidance patterns of seismic surveys of such prey species) and extensive ranges over which most seabirds feed suggest that indirect impacts would be **VERY LOW** with and without mitigation.

**Mitigation**

Recommendations for mitigation include:

- All initiation of airgun firing be carried out as "soft-starts" of at least 20 minutes duration.

- An area of radius of 500 m be scanned by an independent observer for the presence of diving seabirds prior to the commencement of "soft starts" and that these be delayed until such time as this area is clear of seabirds.
- Seabird incidence and behaviour should be recorded by an onboard Independent Observer. Any obvious mortality or injuries to seabirds as a direct result of the survey should result in temporary termination of operations.
- Any attraction of predatory seabirds (by mass disorientation or stunning of fish as a result of seismic survey activities) and incidents of feeding behaviour among the hydrophone streamers should be recorded by an onboard Independent Observer.

| *Impacts of seismic noise on diving seabirds resulting in physiological injury* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | High | Low |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Improbable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise on diving seabirds resulting in behavioural avoidance* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Medium to High | Low |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Improbable |
| **Confidence** | Medium | Medium |

| *Impact: Impacts of seismic noise on seabirds resulting in indirect impacts on food sources* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Improbable | Improbable |
| **Confidence** | Low | Low |

### 5.2.5 Impacts to Turtles

Three species of turtles occur on the South Coast of South Africa, with a further two species likely to occur on the East Coast. Although loggerhead and leatherback turtles nest on the beaches of northern KwaZulu-Natal, this is some 400 km to the north of the proposed survey area, and abundances in the survey area are likely to be extremely low comprising occasional vagrants or hatchlings moving southwards in the Agulhas Current. The most likely impacts to turtles from seismic survey operations include physiological injury (including disorientation) or mortality from seismic noise or 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.

**Physiological injury (including disorientation) or mortality**

Although no information could be sourced on physiological injury to turtle hearing as a result of seismic sounds, the overlap of their 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. This applies particularly to hatchlings and juveniles as they are unable to avoid seismic sounds whilst being transported in the Agulhas Current, and consequently are more susceptible to seismic noise. The potential impact could therefore be of high intensity, but remain within the short-term. However, the abundance of adult turtles and hatchlings along the South and East Coasts is low, the likelihood of encountering turtles during the proposed survey is thus also expected to be low. The potential physiological impact on turtles is considered to be of **LOW** significance without mitigation, and **VERY LOW** significance with mitigation.

The potential for collision between adult turtles and the seismic vessel, or entanglement of turtles in the towed seismic equipment and surface floats, is highly dependent on the abundance and behaviour of turtles in the survey area at the time of the survey. As the breeding areas for turtles are located in northern KwaZulu-Natal, turtles encountered during the survey are likely to be migrating vagrants and impacts through collision or entanglement would be of low intensity and short-term. The impacts on turtles through collision or entanglement of seismic equipment is thus considered to be of **LOW** significance without mitigation and **VERY LOW** significance with mitigation.

**Behavioural avoidance**

Behavioural changes by turtles in response to seismic sounds range from apparent lack of movement away from active airgun arrays through to startle response and avoidance by fleeing an operating sound source. 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 area. Given the general extent of turtle migrations relative to seismic survey target grids, the impact of seismic noise on turtle migrations is deemed to be of **LOW** significance without mitigation and **VERY LOW** with mitigation.

**Reproductive success**

Following their emergence on the beaches of northern KwaZulu-Natal between January and March, hatchlings maintain mostly a pelagic existence offshore in the Agulhas Current. As hatchlings are weak swimmers they are more vulnerable to collision with the towed equipment, and to direct seismic noise impacts from the airguns, which may stun them and render them more vulnerable to predation. Parts of the proposed survey area are located in deep waters of the Agulhas Current and hatchling survival may thus be affected. The effect of seismic surveys on recruitment success will be of high intensity but will vary with the distance offshore and timing of the specific survey. If recruitment success is affected, this could impact population size beyond the short-term to the medium-term However, 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.

**Indirect effects due to the effects of seismic sounds on prey species**

The diets of the three common South African turtle species are remarkably diverse. As the proposed survey area is located away from any shallow water habitats known to be important for turtle feeding, destruction or adverse modification of critical habitat would thus be insignificant, and the effects of seismic surveys on the feeding behaviour of turtles is thus expected to be **VERY LOW** both with and without mitigation.

**Masking of environmental sounds and communication**

Breeding adult loggerhead and leatherback turtles undertake large migrations between distant foraging areas and their nesting sites on the beaches of northern KwaZulu-Natal during the summer months October to March, with peak nesting during December and January. Although it is speculated that turtles may use acoustic cues for navigation during migrations, information on turtle communication is lacking. There is no information available in the literature on the effect of seismic noise in masking environmental cues and communication in turtles, but their expected low abundance in the survey area during the proposed scheduling of the survey (November - March) would suggest that the potential significance of this impact (should it occur) would be **INSIGNIFICANT**.

**Mitigation**

A number of mitigation measures are recommended for potential impacts of seismic surveys on turtles:

- All initiation of airgun firing be carried out as “soft-starts” of at least 20 minutes duration.
- An area of radius of 500 m be scanned by an independent observer for the presence of turtles prior to the commencement of “soft starts” and that these be delayed until such time as this area is clear of turtles.
- Daylight observations of the survey region should be carried out by onboard Independent Observers and incidence of turtles and their responses to seismic shooting should be recorded.
- Seismic shooting should be terminated when obvious negative changes to turtle behaviour is observed from the survey vessel, or animals are observed within the

immediate vicinity (within 500 m) of operating airguns and appear to be approaching firing airgun.

- Any obvious mortality or injuries to turtles as a direct result of the survey should result in temporary termination of operations.
- Ensure that 'turtle-friendly' tail buoys are used by the survey contractor or that existing tail buoys are fitted with either exclusion or deflector 'turtle guards'.

| *Impacts of seismic noise on turtles resulting in physiological injury, or collision and entanglement with towed equipment* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | High | Low |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable to Highly Probably | Probable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise on turtles resulting in behavioural avoidance* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | High | Low |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Highly Probable | Probable |
| **Confidence** | High | High |

| *Impacts on recruitment success of turtles through seismic noise or collision* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Medium-term | Short-term |
| **Intensity** | High | Low |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Improbable | Improbable |
| **Confidence** | High | High |

| *Impacts of seismic noise on turtles resulting in indirect impacts on food sources* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Improbable | Improbable |
| **Confidence** | Low | Low |

| *Impacts of seismic noise on turtles resulting in masking of sounds* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | Very Low | Very Low |
| **Significance** | Insignificant | Insignificant |
| **Status** | Negative | Negative |
| **Probability** | Improbable | Improbable |
| **Confidence** | Low | Low |

### 5.2.6 Impacts to Seals

**Physiological injury or mortality**

The physiological effects of loud low frequency sounds on seals have not been well documented. The potential for physiological injury to seals from seismic noise is expected to be low as being highly mobile, fur seals would avoid severe sound sources at levels well below those at which discomfort occurs. Past studies suggest that noise of moderate intensity and duration is sufficient to induce TTS in seals, as individuals did not appear to avoid the survey area. Their tendency to swim at or near the surface will also expose them to reduced sound levels when in close proximity to an operating airgun array. Seal colonies in the vicinity of the proposed survey area are located at Seal Island in Mossel Bay, on the northern shore of the Robberg Peninsula in Plettenberg Bay and at Black Rocks (Bird Island group) in Algoa Bay. As seals are known to forage up to 120 nautical miles offshore, the proposed survey area therefore potentially falls within the foraging range of seals from the nearby colonies, particularly in the Algoa Bay area. There is thus a likelihood of the survey encountering seals. 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 survey area, although injury could extend beyond the survey duration. The significance of the impact without mitigation is **VERY LOW** with and without mitigation.

**Behavioural avoidance**

Although partial avoidance (to less than 250 m) of operating airguns has been recorded for some seals species, Cape fur seals appear to be relatively tolerant to loud noise pulses and, despite an initial startle reaction, individuals quickly reverted back to normal behaviour. The potential impact of seal foraging behaviour changing in response to seismic surveys is thus considered to be of low to medium intensity and limited to the survey area and duration. The significance of behavioural avoidance impacts are consequently deemed **VERY LOW**, both with and without mitigation.

**Masking of environmental sounds 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 firing every 10 to 15 seconds). The impacts of masking are considered **VERY LOW**, both with and without mitigation.

**Indirect effects due to the effects of seismic sounds on prey species**

As with other vertebrates, the assessment of indirect effects of seismic surveys on Cape fur seals 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 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 would be **VERY LOW**, both with and without mitigation.

**Mitigation**

Mitigation measures recommended for potential impacts of seismic surveys on seals are:

- All initiation of airgun firing be carried out as “soft-starts” of at least 20 minutes duration.
- An area of radius of 500 m be scanned by an independent observer for the presence of seals prior to the commencement of “soft starts” and that these be delayed until such time as this area is clear of seals. If after a period of 30 minutes seals are still within 500 m of the airguns, the normal “soft start” procedure should be allowed to commence for at least a 20-minutes duration.
- Daylight observations of the survey region should be carried out by onboard Marine Mammal Observers (MMOs) and incidence of seals and their responses to seismic shooting should be recorded.
- Seismic shooting should be terminated when obvious negative changes to seal behaviour is observed from the survey vessel.
- Any obvious mortality or injuries to seals as a direct result of the survey should be recorded.

| *Impacts of seismic noise on seals resulting in physiological injury* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Medium | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise on seals resulting in behavioural avoidance* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | Low to medium | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | High | High |

| *Impacts of seismic surveys on seals resulting in masking of sounds and communication* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic surveys on seals resulting from indirect effects on their prey* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | High | High |

### 5.2.7 Impacts to Whales and Dolphins

A wide diversity of cetaceans (whales and dolphins) occur off the South and East Coasts of South Africa. The majority of migratory cetaceans in South African waters are baleen whales (mysticetes), while toothed whales (odontocetes) may be resident or migratory. Potential impacts of seismic pulses to 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 prey.

The factors that affect the response of marine mammals to sounds in their environment include the sound level and its prevailing acoustic characteristics, the ecological features of the environment in which the animal encounters the sound and the physical and behavioural state of the animal. When discussing the potential effects of seismic surveys on marine mammals we should bear in mind the lack of data (uncertainty) concerning the auditory capabilities and thresholds of impacts on the different species encountered and the individual variability in hearing thresholds and behavioural responses which are likely to influence the degree of impact (Luke *et al*. 2009; Gedamke *et al*. 2011). This uncertainty and variability can have a large impact on how risk to marine mammals is assessed. Assessing the impact of seismic activity on populations in the Agulhas system is further hampered by a poor understanding of the abundance and distribution of many of the species found here.

Marked differences occur in the hearing of baleen whales (mysticete cetaceans) and toothed whales and dolphins (odontocete cetaceans). The vocalisation and estimated hearing range of baleen whales (centred at below 1 kHz) overlap the highest peaks of the power spectrum of airgun sounds and consequently these animals may be more affected by disturbance from seismic surveys (Nowacek *et al*. 2007). In contrast, the hearing of toothed whales and dolphins is centred at frequencies of between 10 and 100 kHz, suggesting that these may react to seismic shots at long ranges, but that hearing damage from seismic shots is only likely to occur at close range. Mysticete and odontocete cetaceans are thus assessed separately below.

**Physiological injury**

There is little information available on the levels of noise that would potentially result in physiological injury to cetaceans, and no permanent threshold shifts have been recorded. 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. Deep-diving cetacean species (e.g. sperm whale) 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.

The majority of baleen whales migrate to the southern African subcontinent to breed during winter months. Humpback whales are reported to reach the coast in the vicinity of Knysna on their northern migrations around April, continuing through to September/October when the southern migration begins and continues through to December. Southern right whales arrive in coastal waters on the South Coast in June, building up to a maximum in September/October and departing again in December. The proposed survey areas thus lies within the migration paths of Humpback whales, but offshore of areas frequented by Southern Right whales. As the

survey is proposed for the summer months (December to April) encounters with migrating whales should be minimal, although some humpbacks on their return journey in November/December may still be encountered. However, the survey is 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 impact of potential physiological injury to both mysticete and odontocete cetaceans 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 survey area. The impact is therefore considered to be of **MEDIUM** significance without mitigation for resident odontocetes, and of **MEDIUM** significance without mitigation for mysticetes (mainly Humpbacks in November/December). Significance would reduce to **LOW** with mitigation.

**Behavioural avoidance**

Avoidance of seismic survey activity by cetaceans, particularly mysticete species, begins at distances where levels of approximately 150 to 180 dB are received. More subtle alterations in behaviour may occur at received levels of 120 dB. Although behavioural avoidance of seismic noise in the proposed survey area 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 baleen whale species.

The timing of the survey relative to seasonal breeding cycles (such as those observed in migrating baleen whales) may influence the degree of stress induced by noise exposure (Tyack 2008). Displacement from 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. It is likely that the proposed survey area overlaps with migration routes of both humpback and southern right whales to and from their breeding grounds. The humpback whales has its winter breeding concentrations on the east coast of Africa, from northern KwaZulu-Natal northwards and therefore over 400 km to the north-east of the northern boundary of the proposed survey areas. Southern right whales, however, currently have their most significant winter concentrations on the South African South Coast between Port Elizabeth and Cape Town. The nearshore areas of the De Hoop MPA and St. Sebastian Bay at Cape Infanta ranks as probably the most important nursery area for Southern Right whales in the world, containing 70-80% of the cow-calf pairs on the South African coast. The proposed survey area in the Algoa Block is located beyond the 200 m isobath and therefore does not overlap with such known areas. The southern boundary of the Transkei Block is located ~150 km to the northeast and thus similarly does not overlap with important nursery area for Southern Right whales. However 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.

The potential impact of behavioural avoidance of seismic survey areas by mysticete cetaceans is considered to be of high intensity, across the survey area and for the duration of the survey. Considering the distribution ranges of most species of cetaceans, the impact of seismic surveying is considered of **LOW** (Southern Rights) and **MEDIUM** (Humpbacks in November/December) significance before mitigation. Limiting seismic surveys to outside of the winter/spring (June to December) migration would reduce the intensity of potential

impacts to low resulting in **VERY LOW** significance with mitigation. As the survey is likely to commence before the end of the return migration of humpbacks (November/December), additional mitigation measures (PAM) will need to be implemented, and although the intensity of potential impacts would remain high, significance with mitigation would be **LOW**.

Information available on behavioural responses of toothed whales and dolphins to seismic surveys is more limited than that for baleen whales. No seasonal patterns of abundance are known for odontocetes occupying the proposed study area and information on breeding and calving areas and seasons is also lacking. Furthermore, as there is less evidence of avoidance of seismic surveys by toothed whales (including dolphins), a precautionary approach to avoiding impacts is thus recommended. Consequently the impact of seismic survey noise on the behaviour of toothed whales is considered to be of medium to high intensity over the survey area and duration. A number of toothed whale species have a more pelagic distribution and are thus likely to be encountered further offshore. The overall significance will therefore vary between species, and consequently ranges between **LOW** and **VERY LOW** before mitigation and **VERY LOW** with mitigation.

**Masking of environmental sounds and communication**

Baleen whales appear to vocalise almost exclusively within the frequency range of the maximum energy of seismic survey noise, while toothed whales vocalise at frequencies higher than these. As the by-product noise in the mid-frequency range can travel far, masking of communication sounds produced by whistling dolphins and blackfish[2] 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. However, masking of communication signals is likely to be limited by the low duty cycle of seismic pulses. Consequently, the intensity of impact on baleen whales is likely to be low over the survey area and duration, but high in the case of toothed whales. Whereas for mysticetes the significance is rated as **VERY LOW,** both with and without mitigation, for odontocetes it is rated as **LOW** without mitigation and **VERY LOW** with mitigation.

**Indirect impacts due to effects on prey**

As with other vertebrates, the assessment of indirect effects of seismic surveys on resident odontocete cetaceans is limited by the complexity of trophic pathways in the marine environment. However, it is likely that both fish and cephalopod prey of toothed whales and dolphins may be affected over limited areas, although the impacts are difficult to determine. The 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 of **VERY LOW** significance with and without mitigation. Baleen whales do not feed while in the proposed survey area so the significance of indirect effects on their food source is **VERY LOW**.

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

**Other potential impacts**

Given the slow speed (about 4 - 6 kts) of the vessel while towing the seismic array, ship strikes are also unlikely. Entanglement in gear is, however, possible.

**Mitigation**

Mitigation measures to reduce the impact of seismic survey impulses on cetaceans include:

- As far as possible, avoid planning airborne geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November). As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended.
- The regulations for Boat-based Whale Watching and Protection of Turtles (R 725) as part of the Marine Living Resources Act (Act No. 18 of 1998) stipulate that an aircraft or survey vessel must maintain a minimum distance of 300 m from any whale. As this may be both impractical and impossible, an exemption permit must be applied for through the Department of Environmental Affairs and Tourism.
- As far as possible, avoid planning seismic surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November), and ensure that migration paths are not blocked by seismic operations. In addition, avoid surveying during December when humpback whales may still be moving through the area on their return migrations. If surveying during this time cannot be avoided all other mitigation measures must be stringently enforced, and PAM technology, which detects cetaceans through their vocalisations, must be implemented 24-hours a day.
- As no seasonal patterns of abundance are known for odontocetes occupying the study area, a precautionary approach to avoiding impacts is recommended.
- Survey vessels should accommodate dedicated independent MMOs with experience in seabird, turtle and marine mammal identification and observation techniques, to carry out daylight observations of the survey region and record incidence of marine mammals, and their responses to seismic shooting. Data collected should include 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). Both the identification and the behaviour of the animals must be recorded accurately along with current seismic noise levels.
- All initiations of seismic surveys must be carried out as “soft-starts” for a minimum of 20 minutes (JNCC 2010). This requires that the sound source be ramped from low to full power, thus allowing a flight response to outside the zone of injury or avoidance. The rational for the 20 minute “soft-start” period is based on the flight speeds of cetacean species.
- Initiation of firing is only to begin after observations by MMOs have deemed the visual area around the vessel to a distance of 500 m to be clear of all large cetacean species for at least 30 minutes prior to firing, so that deep- or long-diving species can be detected. In the case of small cetacean (particularly dolphins), which are common in inshore waters and 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 airguns. If after a period of 30 minutes small cetaceans are still within 500 m of the airguns, 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 airguns 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 "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. Breaks shorter than 20 minutes should be followed by a "soft-start" of similar duration.
- Seismic shooting should be terminated when obvious negative changes to cetacean behaviour is observed, or animals are observed within the immediate vicinity (within 500 m) of operating airguns and appear to be approaching firing airgun.
- 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.
- All data recorded by MMOs should at minimum form part of a survey close–out report. Furthermore, daily or weekly reports should be forwarded to the necessary authorities to ensure compliance with the mitigation measures.
- Seabird, turtle and marine mammal incidence data and seismic source output data arising from surveys should be made available on request to the Marine Mammal Institute, Department of Agriculture, Fisheries and Forestry, and the Petroleum Agency of South Africa for analyses of survey impacts in local waters.
- Should the survey schedules overlap with the start of the sensitive period in terms of large mammals migrating through the area, ensure that PAM technology is implemented to confirm that no cetaceans are present in the vicinity of the vessel. PAM is also to be used when surveying at night or during adverse weather conditions and thick fog. During the commencement of night-time operations, visual watches should be maintained using night-vision/infra-red binoculars.
- The use of PAM is encouraged by most international guidelines as a mitigation tool to detect marine mammals through their vocalisations, ***particularly if species of particular conservation importance are likely to be encountered in the proposed survey area***, or where a given species or group is difficult to detect by visual observation alone. Such monitoring can provide distance and bearing of the animals from the survey vessel. Although PAM would only identify animals that are calling or vocal, it has the advantage of 24 hour per day availability as opposed to visual monitoring, which can only be confidently carried out during daylight hours, or under adequate visibility conditions. Considering that most of the offshore migrating baleen whale species likely to be encountered are listed as "Endangered", every effort should be made to ensure that the vessel is fitted with PAM technology.
- The use of the lowest practicable airgun volume should be defined and enforced, and airgun use should be prohibited outside of the licence area.
- No seismic survey-related activities are to take place within declared Marine Protected Areas.

[3] As much of the seismic survey would take place in deep waters (>1,000 m) where sperm whales and beaked whales are likely to be encountered, the use of PAM is highly recommended for this survey.

***Potential impact of seismic noise to mysticete cetaceans.***

| *Impacts of seismic noise on baleen whales resulting in physiological injury* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | High | Low to Medium |
| **Significance** | Low – Medium (Humbacks) | Very Low – Low (Humpbacks) |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise on baleen whales resulting in behavioural avoidance* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | High | Low |
| **Significance** | Low – Medium (Humpbacks) | Very Low – Low (Humpbacks) |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | High | High |

| *Impacts of seismic surveys on baleen whales resulting in masking of sounds and communication* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic surveys on baleen whales resulting from indirect effects on their prey* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Very low | Very low |
| **Significance** | Very Low | Very Low |
| **Status** | Neutral | Neutral |
| **Probability** | Improbable | Improbable |
| **Confidence** | High | High |

***Potential impact of seismic noise to odontocete cetaceans.***

| *Impacts of seismic noise on toothed whales and dolphins resulting in physiological injury* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | High | Low to Medium |
| **Significance** | Medium | Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic noise on toothed whales and dolphins resulting in behavioural avoidance* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey. | Short-term |
| **Intensity** | Medium to High | Low to Medium |
| **Significance** | Very Low – Low (species specific) | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | High | High |

| *Impacts of seismic surveys on toothed whales and dolphins resulting in masking of sounds and communication* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | High | Low |
| **Significance** | Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

| *Impacts of seismic surveys on toothed whales and dolphins resulting from indirect effects on their prey* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area. | Local |
| **Duration** | Short-term: for duration of survey | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Probable | Probable |
| **Confidence** | Medium | Medium |

## 5.3. Impacts of Aerial Surveys

Although reported behavioural reactions by seabirds, seals and whales to aircraft are highly variable and often anecdotal, it is safe to assume that any observed effects as a result of the proposed aerial exploration will be in response to both acoustic and visual cues.

The coast of the proposed exploration area lacks offshore islands and thus provides few breeding opportunities for seabirds. The nearest breeding colonies are on are on Dyer Island off Danger Point, some 60 km west of the survey area. Various gulls, terns and cormorants (see Table 3) do, however, breed regularly along the South Coast. In addition, some of the river mouths and estuaries along the South Coast serve as important roosting and foraging sites for coastal and seabirds. Two comparatively small Important Bird Areas (IBAs) also occur adjacent to the survey area (see Figure 21). Indiscriminate or direct flying over seabird colonies and these coastal IBAs could thus have a significant disturbance impact on breeding success or mortalities of juveniles. The potential impact of behavioural changes and disturbance in birds in response to aircrafts, is considered to be of medium intensity, across the survey area and for the duration of the survey. The impact of aerial surveying on coastal birds is considered of **LOW** to **MEDIUM** significance before mitigation and **VERY LOW** significance with mitigation.

Low altitude flights (especially parallel to the coast) can also have a significant disturbance impact on cetaceans during their breeding and mating season, and on seals during the pupping season. The level of disturbance would depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence to the water surface), the prevailing sea conditions. 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.

Indiscriminate low altitude flights over whales and seal colonies could thus have an impact on behaviour and breeding success. Although such impacts would be local, they may have wider ramifications over the range of the affected species and are deemed to range from medium to high intensity. The significance of the potential impact is considered to range from **LOW** to **MEDIUM** significance without mitigation, and **VERY LOW** significance with mitigation.

**Mitigation**

The following mitigation measures are recommended:

- Pre-plan flight paths to ensure that no flying occurs over coastal reserves, bird colonies or IBAs.
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should be avoided, particularly during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November). As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended.
- Aircraft should maintain a minimum altitude of at least 300 m above sea level at all times.
- Aircraft may not approach to within 300 m of whales in terms of the Marine Living Resources Act, 1998. As this may be both impractical and impossible, an exemption

permit must be applied for through the Department of Environmental Affairs and Tourism.
- Aircraft should maintain a minimum altitude of at least 300 m above sea level at all times.
- Aircraft may not approach to within 300 m of whales in terms of the Marine Living Resources Act, 1998.
- The contractor should comply fully with aviation and authority guidelines and rules.
- All pilots must be briefed on ecological risks associated with flying at a low level parallel to the coast.

| *Impacts of aerial surveys on seabirds, seals and cetaceans* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to | Local |
| **Duration** | Short-term | Short-term |
| **Intensity** | Medium to High | Low |
| **Significance** | Low to Medium | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Definite | Definite |
| **Confidence** | High | High |

## 5.4. Impacts of Multi-beam Surveys

Although baleen whales, toothed whales and pinnepeds would be expected to hear sonar signals from most types of oceanographic sonars at frequencies within their functional hearing range, the animals would only be affected if they were within the sonar beam. As the anticipated radius of influence of a multi-beam sonar or the sub-bottom profiler is significantly less than that for an airgun array, and the statistical probability of crossing a cetacean or pinniped with the narrow multi-beam fan several times, or even once, is very small, the effects of high frequency sonars on these fauna can be considered to be of **VERY LOW** significance without mitigation. However, despite the low significance of impacts, the Joint Nature Conservation Committee (JNCC) provides a list of guidelines to be followed by anyone planning marine sonar operations that could cause acoustic or physical disturbance to marine mammals. These have been revised to be more applicable to the southern African situation.

- Onboard MMOs should conduct visual scans for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses.
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
- “Soft starts” should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- Avoid planning geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of June to end of November), and ensure that migration paths are

not blocked by sonar operations. As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended.

- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place in June and / or November;
- A Marine Mammal Observer would be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.
- Minimise impacts in known sensitive areas (e.g. 6-, 12-, 45- and 72-Mile Banks, Alphard Banks, Martha's Reef) and MPAs (De Hoop Marine Reserve).

| *Impacts of multi-beam and sub-bottom profiling sonar on seals and cetaceans* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to survey area | Local |
| **Duration** | Short-term | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Very Low | Very Low |
| **Status** | Negative | Negative |
| **Probability** | Improbable | Improbable |
| **Confidence** | High | High |

## 5.5. Impacts of Drop-Core Sampling and Heat Flow Measurements

The proposed core sampling activities are expected to result in the disturbance and loss of benthic macrofauna through removal of sediments and potential crushing of benthic epifauna in the trigger weight footprint. In the case of the heat flow probe, penetration of the probe into the seabed may lead to disturbance of benthic macrofauna in the 6-cm diameter footprint of the probe.

Assuming a core diameter of 100 mm, each drop-core sample will remove a surface area of ~0.008 $m^2$. Core barrels are typically 6 – 9 m in length thus resulting in the removal of 0.048 $m^3$ or 0.072 $m^3$ of sediment, respectively per sample at maximum penetration. It is proposed to take in the order of 50 cores, thereby impacting a total cumulative area of 0.4 $m^2$ and removing a maximum of 3.6 $m^3$ of sediment.

As benthic fauna typically inhabit the top 20 - 30 cm of sediment, and removal of the sediment samples will result in the elimination of the benthic infaunal and epifaunal biota in the sample footprints. Considering the available area of similar habitat on the Agulhas Bank and off the edge of the continental shelf, this reduction in benthic biodiversity can be considered negligible.

Depending on the texture of the sediments at the target sites, slumping of adjacent unconsolidated sediments into the excavation can be expected over the very short-term. Although this may result in localised disturbance of macrofauna associated with these sediments and alteration of sediment structure, it also serves as a means of natural recovery of the excavations. Studies have shown that some mobile benthic animals are capable of actively migrating vertically through overlying sediment thereby significantly affecting the

recolonization of impacted areas and the subsequent recovery of disturbed areas of seabed (Maurer et al. 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger et al. 2000; but see Harvey et al. 1998; Blanchard & Feder 2003).

Natural rehabilitation of the seabed following sampling or dredging operations, through a process involving influx of sediments and recruitment of invertebrates, has been demonstrated on the southern African continental shelf (Penney & Pulfrich 2004; Steffani 2007b, 2009a, 2009b, 2010a, 2010c). Recovery rates of impacted communities are variable and dependent on the sampling/dredging/mining approach, sediment influx rates and the influence of natural disturbances on succession communities. Ellis (1996) gives typical recovery rates for different grained deposits based on several sources (Table 5). These average time scales conform to those from other studies (see Newell et al. 1998).

The structure of the recovering communities is also highly spatially and temporally variable confirming the high natural variability in benthic communities in the region. The community developing after an impact depends on (1) the nature of the impacted substrate, (2) differential re-settlement of larvae in different areas, and (3) environmental factors such as bedload transport, near-bottom dissolved oxygen concentrations etc. Indications of significant recruitments and natural mortalities in recovering succession communities has provided evidence of natural disturbances (Pulfrich & Penney 1999). Savage et al. (2001) noted similarities in apparent levels of disturbance between mined and unmined areas off the southern African west coast, and areas of the Oslofjord in the NE Atlantic Ocean, which is known to be subject to periodic low oxygen events. They concluded that the lack of clear separation of impacted from reference samples suggests that short-term physical disturbance resulting from mining or dredging is no more stressful than the regular naturally occurring anoxic events typical of the West Coast continental shelf area.

The high-intensity negative impact of sediment removal is unavoidable, but as it will be extremely localised (i.e. confined to the core footprints) the impact can confidently be rated as being **INSIGNIFICANT**.

Table 5: Timing for recovery of seabed habitats after dredging (after Ellis 1996).

| Sediment type | Recovery time |
|---|---|
| *Fine-grained deposits*:<br>muds, silts, clays, which can contain some rocks and boulders | 1 year |
| *Medium-grained deposits*:<br>sand, which can contain some silts, clay and gravel | 1-3 years |
| *Coarse-grained deposits*:<br>gravels, which can contain some finer fraction and some rock and boulders | 5 years |
| *Coarse-grained deposits*:<br>gravels with many rocks and boulders | >5 years |

Some disturbance or loss of adjacent benthic biota can also be expected as a result of the placement on the seabed of the trigger weight, and the penetration into the sediments of the heat flow probe. Epifauna and infauna beneath the footprint of the weight/probe may be

smothered or crushed resulting in a reduction in benthic biodiversity. Crushing is likely to primarily affect soft-bodied species as some molluscs and crustaceans may be robust enough to survive (see for example Savage et al. 2001). The impacts will be of medium to high intensity but highly localised, and short-term as recolonization will occur rapidly from adjacent undisturbed sediments. The potential impact is consequently deemed to **INSIGNIFICANT**.

| *Impacts of drop-core survey on benthic macrofauna through removal or crushing* | | |
|---|---|---|
| | **Without Mitigation** | **Assuming Mitigation** |
| **Extent** | Local: limited to core area or trigger weight footprint | Local |
| **Duration** | Short-term | Short-term |
| **Intensity** | Low | Low |
| **Significance** | Insignificant | Insignificant |
| **Status** | Negative | Negative |
| **Probability** | Definite | Definite |
| **Confidence** | High | High |

**Mitigation**

No mitigation measures are possible, or considered necessary for the direct loss of macrobenthos due to core sampling or indirect loss due to crushing by the trigger weight.

# 6. CONCLUSIONS AND RECOMMENDATIONS

## 6.1. Conclusions

If all environmental guidelines, and appropriate mitigation measures advanced in this report, and the EMPr for the proposed project as a whole, are implemented, there is no reason why the proposed seismic survey should not proceed. The proposal to undertake the survey outside the cetacean migration period has mitigated the potential impact on migratory cetaceans to a large extent. Data collected by independent onboard observers should form part of a survey close-out report to be forwarded to the necessary authorities, and any incidence data and seismic source output data arising from surveys should be made available for analyses of survey impacts in Southern African waters.

The assessments of impacts of seismic sounds provided in the scientific literature usually consider short-term responses at the level of individual animals only, as our understanding of how such short-term effects relate to adverse residual effects at the population level are limited. Data on behavioural reactions acquired over the short-term could, however, easily be misinterpreted as being less significant than the cumulative effects over the long-term, *i.e.* what is initially interpreted as an impact not having a detrimental effect and thus being of low significance, may turn out to result in a long-term decline in the population. A significant adverse residual environmental effect is considered one that affects marine biota by causing a decline in abundance or change in distribution of a population(s) over more than one generation within an area. Natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent. However, the southern right whale population is reported to be increasing by 7% per annum (Best 2000) over a time when seismic surveying frequency has increased, suggesting that, for the southern right population at least, there is no evidence of long-term negative change to population size as a direct result of seismic survey activities.

Reactions to sound by marine fauna depend on a multitude of factors including species, state of maturity, experience, current activity, reproductive state, time of day (Wartzok *et al*. 2004; Southall *et al*. 2007). If a marine animal does react briefly to an underwater sound by changing its behaviour or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the population as a whole (NRC 2005). However, if a sound source displaces a species from an important feeding or breeding area for a prolonged period, impacts at the population level could be significant.

The significance of the impacts both before and after mitigation are summarised overleaf.

## 6.2. Environmentally Sensitive Buffer Zone

The exploration licence area for which the application is being lodged, extends from the coast to approximately 4,000 m depth. To avoid interaction between oil and gas exploration activities and the more sensitive coastal and nearshore ecosystems, a 10 km environmentally sensitive buffer zone adjacent to the coast will be implemented, in which no survey activity will be undertaken (see Figure 1).

Furthermore, no exploration will be undertaken in MPAs.

**Seismic Surveys**

| Impact | Significance (before mitigation) | Significance (after mitigation) |
|---|---|---|
| **Plankton and ichthyoplankton** | | |
| Mortality and/or physiological injury | Very Low | Very Low |
| **Marine invertebrates** | | |
| Mortality and/or physiological injury | Very Low | Very Low |
| Behavioural avoidance | Very Low | Very Low |
| **Fish** | | |
| Mortality and/or physiological injury | Low | Very Low |
| Avoidance behaviour | Low | Very Low |
| Reproductive success / spawning | Low | Very Low |
| Masking of sounds | Very Low | Very Low |
| Indirect impacts on food sources | Very Low | Very Low |
| **Plunge-diving Seabirds** | | |
| Physiological injury | Low | Very Low |
| Avoidance behaviour | Low | Very Low |
| Indirect impacts on food sources | Very Low | Very Low |
| **Turtles** | | |
| Physiological injury, collision and entanglement | Low | Very Low |
| Avoidance behaviour | Low | Very Low |
| Reproductive success | Low | Very Low |
| Indirect impacts on food sources | Very Low | Very Low |
| Masking of sounds | Insignificant | Insignificant |
| **Seals** | | |
| Physiological injury | Very Low | Very Low |
| Avoidance behaviour | Very Low | Very Low |
| Masking of sounds | Very Low | Very Low |
| Indirect impacts on food sources | Very Low | Very Low |
| **Whales and dolphins** | | |
| *Baleen whales* | | |
| Physiological injury | Medium | Low |
| Avoidance behaviour | Medium | Low |
| Masking of sounds | Very Low | Very Low |
| Indirect impacts on food sources | Very Low | Very Low |
| *Toothed whales and dolphins* | | |
| Physiological injury | Medium | Low |
| Avoidance behaviour | Very Low - Low | Very Low |
| Masking of sounds | Low | Very Low |
| Indirect impacts on food sources | Very Low | Very Low |
| **Other Potential Impacts** | | |
| Interaction with vessel traffic | Insignificant | Insignificant |

### Aerial Surveys

| Impact | Significance (before mitigation) | Significance (after mitigation) |
|---|---|---|
| **Birds** | | |
| Disturbance of roosting, nesting and feeding | Low - Medium | Very Low |
| **Seals** | | |
| Disturbance during pupping | Low - Medium | Very Low |
| **Cetaceans** | | |
| Disturbance during breeding and mating | Low - Medium | Very Low |

**Multi-beam Surveys**

| Impact | Significance (before mitigation) | Significance (after mitigation) |
|---|---|---|
| **Marine Fauna** | | |
| Auditory and behavioural disturbance of turtles | Insignificant | Insignificant |
| Auditory and behavioural disturbance of seals and cetaceans | Very Low | Very low |

**Sediment Sampling and Heat Flow Measurements**

| Impact | Significance (before mitigation) | Significance (after mitigation) |
|---|---|---|
| **Benthic Macrofauna** | | |
| Injury and loss of benthic macrofauna through Drop-core sampling and Heat Flow Measurements | Insignificant | Insignificant |

The proposed exploration activities to be undertaken by Impact Africa are expected to result in impacts on marine invertebrate fauna in the licence area ranging from insignificant to very low significance. Only in the case of the seismic survey component are impacts of low to medium significance expected for higher order consumers and marine mammals, particularly when operating in shallower waters within the 10 km environmentally sensitive buffer zone. In much of the exploration area, this would correspond to depths of at least 50 m. Whereas there may thus still be interaction with inshore distributions of plankton, ichthyoplankton and migration pathways of fish and marine mammals, effects on demersal species would largely be in the far-field.

## 6.3. Recommended Mitigation Measures

### 6.3.1 Seismic Surveys

Detailed mitigation measures for seismic surveys in other parts of the world are provided by Weir *et al.* (2006), Compton *et al.* (2007) and US Department of Interior (2007). Many of the international guidelines presented in these documents are extremely conservative as they are designed for areas experiencing repeated, high intensity surveys and harbouring particularly sensitive species, or species with high conservation status. The guidelines currently applied for seismic surveying in South African waters are those proposed in the Generic EMPr (CCA & CMS 2001), and to date these have not resulted in any known or recorded mortalities of marine

mammals, turtles or seabirds. The mitigation measures proposed below are based largely on the guidelines currently accepted for seismic surveys in South Africa, but have been revised to include salient points from international guidelines discussed in the documents cited above.

- Seismic surveys should as far as possible be planned to avoid cetatean migration periods or winter breeding concentrations (June to November), and ensure that migration paths are not blocked. In addition, avoid surveying during December when humpback whales may still be moving through the area on their return migrations. If surveying during this time cannot be avoided all other mitigation measures must be stringently enforced, and PAM technology, which detects cetaceans through their vocalisations, must be implemented 24-hours a day. PAM is also to be used when surveying at night or during adverse weather conditions and thick fog.
- 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.
- The use of the lowest practicable airgun volume should be defined and enforced, and airgun use should be prohibited outside of the licence area.
- During line changes, especially when turning in inshore areas, low level warning airgun discharges should be fired at regular intervals in order to keep fish shoals and marine animals away from the survey operation while the vessel is repositioned for the next survey line.
- Prior to the commencement of "soft starts" an area of 500-m radius around the survey vessel (exclusion zone) should be scanned for the presence of diving seabirds, turtles, seals and cetaceans. There should be a dedicated pre-shoot watch of at least 30 minutes for deep-diving species. "Soft starts" should be delayed until such time as this area is clear of individuals of diving seabirds, seals, turtles and cetaceans. Soft-start should not begin until 30 minutes after the animals depart the exclusion zone or 30 minutes after they are last seen. In the case of fur seals and small odontocetes, which may occur commonly around the vessel, the presence of seals and small odontocetes (including number and position / distance from the vessel) and their behaviour should be recorded prior to "soft start" procedures. If possible, "soft starts" should only commence once it has been confirmed that there is no seal and small odontocetes activity within 500 m of the airguns. However, if after a period of 30 minutes they are still within 500 m of the airguns, the normal "soft start" procedure should be allowed to commence for at least a 20-minute duration (JNCC 2010). Their activity should be carefully monitored during "soft starts" to determine if they display any obvious negative responses to the airguns and gear or if there are any signs of injury or mortality as a direct result of the seismic activities.
- 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. "Soft start" procedures should not be initiated during times of poor visibility or darkness without the use of existing PAM technology to confirm that no cetaceans are present.

- An onboard independent MMO must be appointed for the duration of the seismic survey[4]. The MMO should have experience in seabird, turtle and marine mammal identification and observation techniques. The duties of the MMO would be to:
    - Record initiation of seismic firing activity and associated "soft starts", airgun activities and seismic noise levels;
    - Observe and record responses of marine fauna to seismic shooting, 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 seismic activities. Both the identification and the behaviour of the animals must be recorded accurately along with current seismic sound levels. Any attraction of predatory seabirds, large pelagic fish or cetaceans (by mass disorientation or stunning of fish as a result of seismic survey activities) and incidents of feeding behaviour among the hydrophone streamers should also be recorded;
    - Sightings of any injured or dead protected species (marine mammals and sea turtles) should be recorded, 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 (latitude/longitude) of the strike, and the species identification or a description of the animal should be recorded.
    - Record meteorological conditions;
    - Request the temporarily termination of the seismic survey or adjusting of seismic shooting, as appropriate. It is important that MMOs have a full understanding of the financial implications of terminating firing, and that such decisions are made confidently and expediently. A log of all termination decisions must be kept (for inclusion in both daily and "close-out" reports);
    - Prepare daily reports of all observations, to be forwarded to the necessary authorities on a daily or weekly basis to ensure compliance with the mitigation measures.
- 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.
- Ensure that 'turtle-friendly' tail buoys are used by the survey contractor or that existing tail buoys are fitted with either exclusion or deflector 'turtle guards'.
- Seabird, turtle and marine mammal incidence data and seismic source output data arising from surveys should be made available on request to the Marine Mammal Institute, Department of Agriculture, Fisheries and Forestry, and the Petroleum Agency of South Africa for analyses of survey impacts in local waters.

[4] One observer is the norm, but in high latitudes two are required during summer months due to the longer daylight hours. Brazilian guidelines in contrast require at least three observers to be aboard, in order to allow efficient rotation of duties and maintain full coverage.

- Seismic shooting should be terminated on observation of any obvious mortality or injuries to cetaceans, turtles, seals or large mortalities of invertebrate and fish species as a direct result of the survey. Such mortalities would be of particular concern where a) commercially important species are involved, or b) mortality events attract higher order predator and scavenger species into the seismic area during the survey, thus subjecting them to acoustic impulses. Seismic shooting should also be terminated when obvious changes to turtle, seal or cetacean behaviours are observed from the survey vessel, or turtles and cetaceans (not seals) are observed within the immediate vicinity (within 500 m) of operating airguns and appear to be approaching firing airgun[5]. The rationale for this is that animals at close distances (i.e. where physiological injury may occur) may be suffering from reduced hearing as a result of seismic sounds, that frequencies of seismic sound energy lies below best hearing frequencies (certain toothed cetaceans and seals), or that animals have become trapped within the ensonified area through diving behaviour.
- Should the survey schedules overlap with the start of the sensitive period in terms of large mammals migrating through the area, ensure that PAM technology is implemented to confirm that no cetaceans are present in the vicinity of the vessel, particularly when surveying at night or during adverse weather conditions and thick fog. During the commencement of night-time operations, visual watches should be maintained using night-vision/infra-red binoculars. The use of PAM is encouraged by most international guidelines as a mitigation tool to detect marine mammals through their vocalisations, ***particularly if species of particular conservation importance are likely to be encountered in the proposed survey area***, or where a given species or group is difficult to detect by visual observation alone. Such monitoring can provide distance and bearing of the animals from the survey vessel. Although PAM would only identify animals that are calling or vocal, it has the advantage of 24 hour per day availability as opposed to visual monitoring, which can only be confidently carried out during daylight hours, or under adequate visibility conditions. Considering that most of the offshore migrating baleen whale species likely to be encountered are listed as "Endangered", every effort should be made to ensure that the vessel is fitted with PAM technology.
- No seismic survey-related activities are to take place within declared Marine Protected Areas.

[5] Recommended safety zones in some of the international guidelines include implementation of an observation zone of 3 km radius, low-power zone of 1.5 - 2 km radius (to cater for cow-calf pairs), and safety shut-down zone of 500 m radius around the survey vessel. Alternatively, a safety zone of 160 dB root mean squared (rms) can be calculated based on site-specific sound speed profiles and airgun parameters. The application of propagation loss models to calculate safety radii based on sound pressure levels represents a more scientific approach than the arbitrary designation of a 500 m radius (see Compton *et al*. (2007) for details).

### 6.3.2 Aerial Surveys

The mitigation measures recommended for aerial surveys are:

- Pre-plan flight paths to ensure that no flying occurs over coastal reserves, bird colonies or IBAs.
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should be avoided, particularly during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (June to November). As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended.
- Aircraft should maintain a minimum altitude of at least 300 m above sea level at all times.
- Aircraft may not approach to within 300 m of whales in terms of the Marine Living Resources Act, 1998. As this may be both impractical and impossible, an exemption permit must be applied for through the Department of Environmental Affairs and Tourism.
- The contractor should comply fully with aviation and authority guidelines and rules.
- All pilots must be briefed on ecological risks associated with flying at a low level parallel to the coast.

### 6.3.3 Multi-beam Surveys

The mitigation measures recommended for multi-beam and sub-bottom profiling surveys are:

- Onboard MMOs should conduct visual scans for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses.
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
- “Soft starts” should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- Avoid planning geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of June to end of November), and ensure that migration paths are not blocked by sonar operations. As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended.
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place in June and / or November;
- A Marine Mammal Observer would be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.
- Minimise impacts in known sensitive areas (e.g. 6-, 12-, 45- and 72-Mile Banks, Alphard Banks, Martha’s Reef) and MPAs (De Hoop Marine Reserve).

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## 5 CO-ORDINATION BY FISHERIES LIAISON OFFICER (FLO) PRIOR TO SEISMIC SURVEY

Prior to the commencement of a seismic survey operation a Fisheries Liaison Officer (FLO) (with input from a fisheries specialist, if necessary) should obtain the following information:

**(a) Fisheries information**

Well in advance of the start of the survey (before compilation of the Environmental Notification) liaise with fishing companies, shore and vessel skippers to:

- establish the types of fishing and intensity of activity in the area affected by the seismic survey;
- establish an agreed process whereby the survey can be conducted with maximum efficiency and minimum disruption of the legitimate activities of fishers;
- verify that all fishers are aware of the details of the planned seismic survey and advise them on how to act to minimise conflict with the seismic survey;
- advise the Operator on how to plan the survey to minimise potential conflict with other users of the sea;
- advise the Operator on the need for (1) a chase boat and (2) a sweeper vessel;
- advise the Operator on the need for proper certification of the sweeper vessels and limitations placed on its operation; and
- arrange that the survey vessel is provided with "safe passage" routes to and from the survey area in which the vessel can deploy test and retrieve survey gear and which can also be used in the event of severe sea conditions / problems with equipment etc.

**(b) Requirements for the use of a sweeper vessel**

A sweeper vessel is defined herein as:

*A vessel that has the ability to recover fishing gear in the water, particularly bottom set longlines, crayfish longlines and drifting (pelagic) longlines efficiently and without causing permanent damage to the lines and gear. The operator and skipper of the sweeper vessel should have intimate knowledge of the survey area including fishing activity, types of fishing gear deployed in the area and knowledge of the communication channels used by the fishing vessels in the area.*

A chase boat is defined as:

*A chase boat should be certified to act as a "carrier". Its main functions are (i) to assist in the survey operation, specifically maintenance of gear and retrieval of damaged or lost gear, (ii) to intercept any other vessels that could affect the success of the seismic survey operation.*

In an effort to prevent possible gear interaction between the survey vessel and fishers and fishing gear in an area the following strategy (in collaboration between the on-board FLO, the skipper of the sweeper vessel and the land-based coordination centre) is recommended:

1. Actively engage the fishing industry and other interested and affected parties in a transparent and proactive manner with a view to avoiding conflict through a process of communication and close co-operation with the fishing industry;
2. Deployment of an FLO on the survey vessel who also has intimate knowledge of the fishing activity in the area surveyed, knows the fishers and can communicate freely with them and is in immediate contact with the chase boat and the land-based co-ordinator;
3. The land-based co-ordinator to receive daily reports from the observer on vessel activity as well as reports on all interactions with merchant shipping and fishers in the area and facilitates the communication process with the fishing industry as and when required.

In addition to all of the above, experience has shown that the Chase Boat (normally owned and operated by the survey vessel operators) is usually fully occupied by her gear operational duties. In normal circumstances when a survey might be conducted in remote areas, or where there is little fishing activity, this might suffice. However the South African Coast, particularly the South and East Coasts, is heavily exploited by longlines and there is a high probability of the seismic array fouling a longline and causing significant damage to the fishing gear and seismic array.

In order to prevent this probability, the deployment of a “sweeper” boat is strongly advised. A sweeper boat’s main function is to establish the presence of fishers and fishing gear in the vicinity and or path of the seismic array. It must effectively “sweep” the area to identify stationary or mobile fishing gear prior to the seismic survey vessel(s) deploying their seismic array. The sweeper vessel must have a skipper with the necessary experience to correctly identify the gear and the potential for the gear to damage or inhibit the progress of the survey. The “sweeper” vessel is required, prior to the survey, to facilitate the clearing of the fishing gear identified. This is done in an interactive and co-operative manner with a priority placed on identifying the owner of the gear (mother vessel) such that time is given for the mother vessel to shift her gear (negotiated in a spirit of cooperation between parties and other users of the sea). If this is not possible, the problem must be urgently communicated to the prospecting sublease holder, who must seek alternative solutions. It is important to negotiate the removal of gear prior to start of survey and to use the “sweeper vessel” to verify that fishing vessels and gear do not move back into the survey area.

**MARINE MAMMAL SEARCH RECORD - SEISMIC SURVEYS IN SOUTH AFRICAN WATERS**

| | | | |
|---|---|---|---|
| DATE | | FORM NUMBER | |
| VESSEL | | CLIENT | |
| BLOCK | | CONTRACTOR | |
| | | | |

| ACTIVITY | TIME | POSITION | | | | OBS | WIND | | SWELL | SEA STATE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LAT. | | LONG. | | | SPEED | DIRECTION | | | |
| | | | S | | E | | | | | | |
| | | | S | | E | | | | | | |
| | | | S | | E | | | | | | |
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| | | | S | | E | | | | | | |
| | | | S | | E | | | | | | |

1. A NEW FORM IS TO BE STARTED EACH DAY
2. ACTIVITY : SS = Search Started, SE = Search Ended, SG = Marine Mammals sighted, AS = Airguns started, AF = Airguns at full power, AE = Airguns stopped
3. Sightings are to be numbered in the remarks column and cross referenced to the sighting record.

**MARINE FAUNA SIGHTING RECORD - SEISMIC SURVEYS IN SOUTH AFRICAN WATERS**

| | | | |
|---|---|---|---|
| FORM NUMBER | | | |
| DATE | | SIGHTING NUMBER | |
| VESSEL | | CLIENT | |
| BLOCK | | CONTRACTOR | |

| TIME SIGHTED | POSITION LATITUDE | | LONGITUDE | | CUE |
|---|---|---|---|---|---|
| | | S | | E | |

| SPECIES | NUMBER OF ANIMALS UPPER | LOWER | BEST |
|---|---|---|---|
| | | | |
| | | | |

| SPECIES IDENTITY | | NUMBER OF AINIMALS | | JUVENILES PRESENT | |
|---|---|---|---|---|---|
| DEFINITE | | DEFINITE | | YES (How many) | |
| PROBABLE | | PROBABLE | | NO | |
| POSSIBLE | | POSSIBLE | | UNCERTAIN | |

| DISTANCE FROM VESSEL AT SIGHTING | ANGLE FROM BOW AT SIGHTING | P / S | CLOSEST DISTANCE SEEN | ESTIMATED HEADING OF ANIMALS | TIME LAST SEEN |
|---|---|---|---|---|---|
| | | | | | |

| REMARKS |
|---|
| |
| |
| |

| GENERAL BEHAVIOUR |
|---|
| |
| |
| |

| AIR-GUN ASSOCIATED BEHAVIOR |
|---|
| |
| |

| VESSEL ASSOCIATED BEHAVIOUR |
|---|
| |
| |

| AIR-GUNS FIRING | YES | % FULL VOLUME | NO |
|---|---|---|---|
| | | | |

**MARINE FAUNA SIGHTING RECORD - SEISMIC SURVEYS IN SOUTH AFRICAN WATERS**

**USER NOTES**

**Form number**
Use a separate form for each sighting. Number the forms consecutively so that the form number is consecutive for the survey and is regardless of the sighting number.

**Sighting Number**
The sighting number is for the day, so that the first sighting on each day will be sighting number 001. This must be cross-referenced with the Search Record.

**Time**
Use local ships time.

**Cue**
Provide the cue that first brought your attention to the animals (Blow, Splash; Body; Breach/Jump;

**Species**
Complete as fully as possible. Use the remark block to add further information.
Use a separate form for each species in sightings of mixed groups.

**Number of animals**
Provide an upper, lower and best estimate of the number of animals present.

**Confidence in estimation**
Provide the confidence (Definite/Probable/Possible) of the Species Identity and estimate of School Size.

**Distance and angle**
Provide the distance (nautical miles) and angle of the animals (degrees port or starboard from the bow) from the vessel at the time of first sighting.
Use the Behaviour block to describe any response to the vessel, air-gun array or sound emission.

**Behaviour**
Describe the General Behaviour of the animals and any behaviour that appears to be associated with the Air-Gun array or sounds and any behaviour that appears to be associated with the vessel. Use the rear of the form if necessary.

Use the Remarks Block to provide any further information. Use the rear of the form if necessary.

## 7 UNDERTAKING BY APPLICANT

**Impact Africa Limited**
*Griffin House, West Street*
*Woking, Surrey, GU21 6BS*
*United Kingdom*

Petroleum Agency SA

Tygerport Building
7 Mispel Street
Belville
7530

16 May 2013

UNDERTAKING BY APPLICANT

In terms of the Regulation 51 (b) (viii) of the Mineral and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA) Impact Africa Limited undertakes to:

1. Comply with the specifications in the foregoing Environmental Management Programme (EMPr);
2. Comply with the provisions of the MPRDA and the Regulations thereto.

Signed on 16 May 2013

For and behalf of Impact Africa Limited

Name: Mike Doherty
Designation: Executive Chairman

Witnesses:

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# Henry Camp

Partner



Henry Camp is a Partner based in the Johannesburg, South Africa office. He is a senior leader in the Oil and Gas Practice for the Europe, Middle East and Africa region.

Henry has more that 25 years of broad-ranging professional experience in the environmental field. Over the past 15 years he has focused on the environmental planning and assessment of major capital projects. For these he has been involved in the directing or managing of feasibility studies; scoping studies; environmental, social and health impact assessments (ESHIA); environmental impact statements (EIS); baseline and resource studies; mitigation and environmental management plans (EMP); stakeholder engagement; resettlement plans; and due diligence, compliance, monitoring and audit studies.

Henry has worked and travelled extensively in Africa and conducted projects in more than 20 countries in the region. He has extensive experience in West Africa working in the oil and gas sector and has worked on some of the largest projects in that region. He also has experience in the power generation and transmission, transportation, mining, and manufacturing sectors.

He has worked on numerous projects performed to World Bank and International Finance Corporation standards and guidelines, including the newly revised performance standards. Henry also brings a background of experience working under United States regulatory processes including extensive work on NEPA-guided projects for US public sector clients such as DOE, DOI and DOD.

Henry has been with ERM for three years. Prior to joining ERM, Henry was Vice President of ICF International and before that held a senior position at Arthur D Little in the USA.

**Fields of Competence**

- Environmental, Social, and Health Impact Assessment (ESHIA)
- Monitoring and Evaluation
- Environmental Management Systems
- Public Consultation and Disclosure
- Capacity Building and Training

**Key Industry Sectors**

- Oil and gas
- Mining

**Education**

- BA in Biology, University of Vermont, 1981
- Executive Program for International Business, Johnson School of Management, Cornell University
- Degree in Mass Communications, University of Vermont

**Professional Affiliations and Registrations**

- International Association for Impact Assessment (IAIA)
- Association for the Environmental Health and Sciences (AEHS)
- American Chemical Society (ACS)
- Society of Environmental Toxicology and Chemistry (SETAC)

**Languages**

- English
- German and French (conversational)

## *Financial Institutions Support*

**Environmental and Social Assessments (New Project Appraisals and Portfolio Project Supervision Support), International Finance Corporation, Africa Region, 2007 to 2011**
**Project Director**
Mr. Camp was Project Director for a program supporting IFC on environmental and social performance appraisals of potential new project as well as existing (portfolio) investments. The work involved visits to the project sites, review of environmental and social information, interviews, and evaluation of projects against IFC Performance Standards. Work under this program included assessments of:

- *Oil and gas facility in East Africa*
- *Diversified agribusiness in Mozambique*
- *Rice facility in Uganda*
- *Forest plantations and mills in Tanzania, Uganda, and Mozambique*
- *Soft drink manufacturer and distributer with operations in six East African countries*
- *Toll road development in Africa*
- *Cement company with operations in six West Africa countries*
- *Pulp and paper mill in East Africa*
- *Manufacturing facilities in Kenya*
- *Hotels in Tanzania and Kenya*
- *Aluminium smelter in Mozambique*

**Environmental and Social Due Diligence of a Petroleum Products Storage Terminal, Nigeria, Confidential Client, 2011**
**Lead Assessor**
Mr Camp led the assessment of a planned renovation and expansion of a petroleum products storage and distribution terminal in the Nigeria Delta. The appraisal involved interviews with representatives of local communities and review of project plans and progress with regards to conformance with IFC Performance Standards.

**Environmental and Social Performance Due Diligence of Onshore Oil and Gas Operations, Nigeria, Confidential Client, 2011**
**Lead Assessor**
Mr Camp led the assessment of onshore oil and gas operations in the Nigeria Delta on behalf of a financial institution. The assets evaluated included gas gathering facilities, oil processing facilities, pipelines and oil and gas wells. The appraisal involved interviews with company representatives and inspection of project facilities. with regards to conformance with IFC Performance Standards.

**Environmental and Social Due Diligence of a Housing and Industrial Estate Expansion Project, Nigeria, Confidential Client, 2010**
**Lead Assessor**
Mr Camp led the assessment of a proposed expansion of an existing residential and industrial estate outside of Lagos, Nigeria. The appraisal involved interviews with the developer, review of project plans and progress, and a site visit. The assessment was carried out in consideration of local laws and regulations as well as the requirements of the IFC Performance Standards.

**Environmental and Social Due Diligence of a Proposed Housing Project, Nigeria, Confidential Client, 2011**
**Lead Assessor**
Mr Camp led the assessment of a proposed development of a residential housing estate to be developed outside of Ibadan, Nigeria. The assessment involved interviews with the developer, review of project plans and progress, and a site visit. The assessment was carried out in consideration of local laws and regulations as well as the requirements of the IFC Performance Standards.

**Environmental Due Diligence of Onshore and Offshore Oil and Gas Production Facilities, Confidential Client, Angola, 2009 to 2010**
**Lead Assessor**
Mr Camp carried out a Phase 1 environmental assessment as part of a due diligence process support asset divestiture. The assignment involved desktop based review of project documents (including impact assessments and monitoring data) and a field survey and inspection of the assets including oil wells, connecting pipelines, gathering and processing facilities and export terminal.

**Environmental and Social Performance Appraisal of a Cement Plant Expansion Project, Nigeria, Confidential Client, 2009**
**Lead Assessor**
Mr Camp led the appraisal of a planned expansion of a cement plant in southern Nigeria. The project involved construction of new cement works and expansion of quarry operations as well as installation of new power generation facilities. The appraisal involved interviews with representatives of local communities and review of project plans and progress with regards to conformance with IFC Performance Standards.

**Environmental and Social Assessment and Action Plan for Rubber Plantation and Processing Plant, Cameroon, Confidential Client, 2008**
**Lead Assessor**
ERM was commissioned to conduct an Environmental and Social (E&S) Assessment, and develop Environmental and Social Action Plans to address gaps between existing practices and applicable IFC performance guidelines, and to provide recommendations with regard to the further development of an E&S management system and community engagement systems.

**Environmental and Social Performance Appraisal of a Flower Growing Operation, Kenya and Ethiopia, Confidential Client, 2008**
**Project Director**
ERM carried out an appraisal of a large scale flower growing operations against international; performance standards. The project involved on-site interviews and field studies to determine the compliance with local regulatory requirements as well as with lender requirements. The operation was considering major expansion into greenfield areas and the appraisal was used to determine the applicable social and environmental requirements.

**Environmental and Social (E&S) Assessment and Action Plan for Wheat Farms and Flour Mills, Tanzania, Confidential Client, 2009 to 2010**
**Project Director**
ERM was commissioned to conduct an Environmental and Social (E&S) Assessment, and develop Environmental and Social Action Plans to address gaps between existing practices and applicable IFC performance guidelines, and to provide recommendations with regard to the further development of an E&S management system and community engagement systems.

**IFC Performance Standards Training, Banking Sector Workshop, Egypt and Nigeria, IFC, 2009**
**Lead Trainer**
Mr Camp is providing training to banking sector representatives under a responsible banking initiative of the IFC and co-sponsored by international banking institution. The training covers social and environmental requirements and is built on project-level experience working on IFC financed projects.

**Implementation of the Equator Principles into the Project Finance Process and Training of Staff, Standard Bank, South Africa, 2008**
**Lead Trainer**
Mr Camp directed a project to assist Standard Bank with the implementation of the Equator Principles into the project finance process. The team was responsible for rolling out the system and training staff in using the system, as well as the application of the Equator Principles and IFC Performance Standards.

**IFC Performance Standards Training, Sasol Technology, South Africa, 2007**
**Lead Trainer**
Mr Camp provided training to Sasal HSE staff on the requirements of the IFC Performance Standards and HSE Guidelines. Mr Camp was responsible for presenting the environmental requirements as well as the application of standards and guidelines to oil and gas development.

**Environmental and Social Performance Appraisal of a Fish Processing Company, Madagascar and Cote d'Ivoire, Confidential Client, 2008**
**Project Director**
Mr Camp led the appraisal of a tuna fish processing company with operations in Africa. The evaluation included assessment of fish stocks and sustainability as well as food safety in operations.

## *Environmental Impact Assessment*

**Environmental Support to the Jubilee Field Development, Ghana, Tullow Oil, 2008 to present**
Mr Camp has been leading the assisting to Tullow Oil with a variety of support activities related to the development of the Jubilee Field, a major oil and gas discovery offshore Ghana.
**Project Director for EIA.** Mr Camp directed the ESIA for the Jubilee Field Development, a deepwater oil production and export project offshore Ghana. The project comprises installation of production wells and reinjection wells and a FPSO. The project is the first of its find in Ghana and the ESIA is involving extensive public and stakeholder consultation including major lending institutions such as IFC. A major output of he ESIA are management plans covering waste, discharge, and oil spills.
**Technical Advisor for EMP Implementation.** Mr Camp provided technical support to the development of specific plans and procedures for implementation of the environmental management plans and monitoring programme for FPSO operations.
**Project Director for Communications Strategy.** Mr Camp is leading the development of a public communications strategy for the Jubilee Field Development. The assignment includes stakeholder consultation, branding, and communications strategy related to environmental and social issues.
**Technical Advisor for Fishing and Fisheries Study.** Mr Camp is providing technical inputs and advising on a comprehensive study of fishing and fisheries in the Jubilee Field's area of influence. The study is being carried out as a combination of desktop research (including data gathering with Ghana officials and scientists) and primary data collection including laboratory testing.

**Impact Assessment and Preliminary Environmental Report (PER) for Exploration in the Owo Prospect, Ghana, Tullow Ghana Limited (TGL), 2010**
**Technical Advisor**
Mr Camp provided technical oversight for the preparation of a Preliminary Environmental Report (PER) for planned exploration and appraisal drilling in the Owo prospect located in the Deepwater Tano Block west of the Jubilee Field. The PER covered six exploration and appraisal wells to further delineate the discovery. The PER was prepared to provide the Ghana Environmental Protection Agency (EPA) with sufficient information to issue authorizations for the activity and to meet Tullow corporate requirements.

**Environmental, Social and Health Impact Assessment of the Sonaref Project, Angola, Sonangol, 2006 to present**
**Project Director**
Mr Camp is Project Director for the environmental, social and health impact assessments of a proposed new refinery to be built near Lobito, Angola. The project is being advanced by Sonagol, the state oil company of Angola. The refinery would be situated near Lobito Harbour. Extensive new works are proposed for access to the site including a new loading dock, connecting pipelines, access road, and construction support facilities. The ESHIA is being conducted in accordance to Angolan requirements and in accordance to international best practices. To carry out the work, the project is involving the participation of local specialists and experts.

**Environmental and Social Baseline Survey and Impact Assessment for an Onshore Seismic Survey and Drilling Programme, Cameroon, Kosmos Energy, 2009 to present**
**Project Director**
Mr Camp is directing the environmental and social baseline surveys and impact assessment for a proposed seismic survey and exploration drilling campaign of a on-shore oil and gas deposits in Cameroon. This work is involving a comprehensive ground-based study of the environmental conditions including an extensive survey of the mangrove areas. The social studies involved surveys of remote communities. The ESIA will be used to guide the seismic survey and drilling operations in terms of placement and operational controls.

**West Africa Gas Pipeline (WAGP) Environmental and Socioeconomic Impact Assessment, West Africa, Chevron and Partners, 2002 to 2006**
WAGP, a 600 km onshore and offshore pipeline, is being constructed to connect Nigeria to new gas markets in Benin, Togo and Ghana. Mr Camp played numerous roles in the WAGP ESIA and spent extensive time in Ghana, Togo, Benin, and Nigeria over the course of the project.
**Chief Scientist for Baseline Studies.** As Chief Scientist, Mr Camp led the development of the environmental survey plan and directed the implementation of the field work. Mr Camp actively participated in the two seasons of field work and led the marine surveys which collected data on water and sediment quality and of fish resources. Has also provided technical support and training to Nigerian scientists on matters related to field data acquisition and laboratory support. This aspect of the project involved in-country laboratory auditing, review and training. The program also included evaluation of laboratory capability needs and

coordination of procurement and delivery of laboratory instrumentation.

**Senior Author for Impact Assessment Report.** Mr Camp contributed heavily to the completion of the four country-specific ESIA reports. He was actively engaged in the impact assessment process and led the drafting of major sections of the assessment report. The reports were ultimately granted approval by the World Bank which was supporting project financing, as well as by the four countries where the project will be constructed. Mr Camp participated in extensive stakeholder and public engagement during the report disclosure.

**Project Manager for Environmental Management Plans.** Mr Camp managed the development of detailed environmental and social management and monitoring plans (ESMP) for the project's construction phase. The plans were developed to address the potential impacts identified in the ESIA and to conform to ISO 14001 requirements. The plans were accepted by World Bank as part of the lending process.

**Project Manager for the Environmental and Socioeconomic Audit.** Mr Camp directed an audit of WAGP's compliance with the project's Environmental and Social Management Plan (ESMP) during the construction phase of the project. The audits were conducted through a combination of site visits and documentation reviews. The project also involved training of local environmental scientists in auditing skills in order to build local capacity for compliance monitoring. Field work included evaluation of construction activities at the pipeline shore crossings in Takoradi and Tema in Ghana; Lome, Togo; Contonou, Benin; and in Badagry, Nigeria; as well as the site of the compressor station construction in Nigeria. The audit reported was submitted by WAGP to World Bank as part of environmental and social performance reporting.

**Strategic Environmental and Social Overview and ESIAs, Uganda, Tullow Oil and Heritage Oil and Gas Limited 2006 to 2008**
**Technical Advisor**
Mr Camp provided technical input to the strategic overview study of Lake Albert that provided background information on the limnological (physical, chemical and biological) features of the lake as well as environmental and socio-economic resources (nature reserves, tourism nodes, fishing areas). The strategic overview provided a framework within which ESIAs were undertaken for the offshore drilling project. An extensive pubic participation process was undertaken as part of the ESIAs.

**Environmental, Social and Health Impact Assessment of the OKLNG Project, Nigeria, OKLNG FZE, 2006 to 2008 (design currently under revision)**
**Project Manager**
Mr Camp was Project Manager for the environmental, social and health impact assessments of a proposed new LNG plant to be built in coastal Nigeria. The project sponsors included Chevron, Shell, British Gas and NNPC. In the role of PM, he oversaw the work of the project management and technical teams comprised of Nigerian scientists and experts and international technical experts. The project included baseline data gathering and impact analysis for both the offshore and onshore environments. The ESHIA also interacted with the resettlement planning. To carry out the work, Henry spent significant periods of time in Nigeria working directly with OKLNG and the ESHIA team.

**Escravos Gas to Liquids Plant (EGTL) Environmental Impact Assessment, Nigeria, Chevron Nigeria Limited, 2000 to 2006**
**Program Manager**
Mr Camp was Program Manager for the Escravos Gas to Liquids Plant EIA, a proposed new oil and gas development project in the Delta region of Nigeria. The EIA covered the proposed plant as well as associated connecting pipelines and dredging work. The comprehensive EIA analyzed the proposed gas to liquids process by working side by side with HES and engineering specialists. Project work included working with design engineers to provide environmental impact feedback, integration of a regional baseline survey data, coordination with stakeholders and regulatory authorities, working closely with Nigerian scientific partners, impacts analysis, environmental compliance review, and mitigation and monitoring plans.

**Escravos Gas Plant Expansion Phase 3 (EGP-3) Environmental Impact Assessment, Nigeria, Chevron Nigeria Limited, 2000 to 2004**
**Program Manager**
Mr Camp acted as Program Manager for the Escravos Gas Plant Expansion Phase 3 EIA which analyzed gas plant expansion activities in Nigeria. The development project included the doubling of the onshore plant capacity and addition of new offshore production wells, platforms, and pipeline in sensitive nearshore, beach, mangrove and forest areas. Both offshore development and onshore plant expansions were addressed in a single EIA. The surveys included drilling ground water wells, collecting surface water, sediment, ground water, soil samples, vegetation mapping, wildlife surveys and laboratory analyses for organic, inorganic and conventional analyses. Offshore surveys included cruises using sediment profile imagery, collection of

sediment samples, benthic invertebrate and fish surveys. The assessment followed a stepwise process with an initial screening based and subsequent assessment of the likelihood and significance of a potential impact, using quantitative measures (including modelling).

## *Environmental Management and Monitoring*

**Environmental Management Program for Exploration of the Orange Basin Deep Water License Area, South Africa, Shell South Africa Upstream BV, 2010**
**Project Director**
Mr Camp directed the preparation of a comprehensive Environmental Management Program (EMPr) for Shell's planned exploration in the Orange Basin Deep Water License Area located offshore of the west coast of South Africa. The block is located between 150 km and 350 km offshore in water depths between 500m and 3500m and Shell intends to carry out an exploration programme over the course of five years to include 2D and 3D seismic surveys and exploration drilling. The development of the EMPr included an evaluation of the relevant legal and regulatory requirements; determination of the environmental (biological and physical) and social conditions; determination of potential impacts; and creation of a comprehensive mitigation and management plan. The EMPr was submitted as part of Shell's application to the oversight authority Petroleum Authority South Africa (PASA).

**Arctic Nearshore Impacts Monitoring in the Development Area (ANIMIDA), US Department of the Interior, 1999 to 2006**
Mr. Camp was involved in DOI's MMS Arctic Nearshore Impacts Monitoring in the Development Area (ANIMIDA) program since 1999 functioning in a variety of roles including managing the project in 2004 and 2005. This program assessed and monitored development of oil leases in the Beaufort Sea. The management of this program required oversight and coordination of a diverse team of specialty scientists who participated in the design of the study and the implementation of the field programs which occurred over a three year period. During the early phases, hydrocarbon and metals chemistries, as well as acoustic measurements were performed in the open-water season adjacent to the Northstar and Liberty developments. A winter measurement program collected data under ice-covered conditions. Later phases continued the monitoring effort. Mr. Camp developed plans for the field and analytical work, conducted data analysis and interpretation, and contributed to a variety of the project's report.

## *Permitting and Compliance*

**Legal and Permitting Review for Shale Gas Development, South Africa, Shell International Exploration and Production, 2010**
**Project Director**
Mr Camp directed a detailed review of the legislative requirements and background and contextual information in support of licensing procedures for Shell's Shale Gas Development in the Karoo area of South Africa. Shell is the third company out of five to apply for rights to investigate shale gas potential in South Africa. The review involved identification of the relevant legal and regulatory requirement, a desktop-based review and analysis, discussions with regulatory authorities and environmental law specialists, and development of a permitting strategy and timeline. ERM drew on past experience with permitting for similar complex projects.

**Review of Environmental and Social Studies and Legal and Permitting Requirements for Deepwater Exploration Activities, Tanzania, BG Group, 2010**
**Technical Advisor**
Mr Camp provided technical input to a review of previous environmental and social studies in order to determine gaps for further seismic survey and drilling activities planned for deepwater Blocks 1 and 4 offshore Tanzania. The review included detailed assessment of legal and regulatory requirements; determination of the suitability of previous studies (including marine surveys and impact assessment); and making recommendation to bridge gaps for proposed activities.

**Environmental Permitting of Oil and Gas Services Facilities, Angola, Schlumberger, 2010 to present**
**Project Director**
Mr Camp is directing a project assisting Schlumberger obtain environmental permits for oil services facilities at the Sonils and Kwanda Bases in Angola. The assignment has included consultation with the regulating authority to agree on approach for environmental assessments, site visits and audits of current operations, and development of a comprehensive report to support the application.

**Permitting and Environmental Support for the WACS Submarine Cable Project, West Coast Africa, Alcatel, 2009 to present**
**Project Director**
Mr Camp is directing the permitting and environmental support to Alcatel for the WACS, a planned submarine cable system that would run from Portugal to Republic of South Africa with landings in 12 countries along the coast including South Africa, Namibia, DR Congo,

Republic of Congo, Cameroon, Nigeria, Togo, Ghana, and Cote d'Ivoire. The assignment includes responsibility for all permitting including ESIA as required by the country regulations. The project is being executed using country teams to address the legal, permitting, environmental, and social issues in each of the landing countries. The project is expected to last 18 months.

**Laboratory Audits, Mobil Producing Nigeria Limited, 2003 to 2004**

Mr Camp led the audits of two major environmental laboratories located in Warri and Port Harcourt, Nigeria. The audits were carried out by onsite inspection by Henry Camp and a team of specialists to verify the laboratory quality systems against company standards as defined in a specially designed checklist for the work. The operations were also evaluated against international guidelines for laboratories in terms of quality, safety and worker training and development. This work was done in part to ensure the quality of environmental baseline study data generated to support development permitting, but also to assist in the development of in region capacity of laboratory services.

# Claire Alborough

Consultant
Impact Assessment and Planning Team (IAP)



Claire Alborough joined ERM Southern Africa in 2007 as a consultant in the Impact Assessment and Planning (IAP) team based in Cape Town, South Africa.

Since joining ERM Claire has worked on projects based in South Africa, Namibia, Uganda, Nigeria and Ghana. These projects include large and small scale Environmental Impact Assessments, legislative reviews and permit applications.

Her field of competence includes environmental planning and management, Environmental Impact Assessments (EIAs), South African and international environmental law, and project management. Claire has an Honours degree in Environmental Management and a masters degree in Marine and Environmental Law, her dissertation focussed on the implementation of the NEM: Air Quality Act 39 of 2004.

**Professional Affiliations and Registrations**

- Member of the IAIA (International Association for Impact Assessment) South Africa

**Fields of Competence**

- Environmental Impact Assessments (EIAs)
- Environmental Law
- Environmental Management Plans

**Education**

- MPhil (Marine and Environmental Law), University of Cape Town (UCT), South Africa, 2006
- Postgraduate Certificate in Project Management, Continuing Professional Development Programme, UCT, 2006
- BSc Honours (Environmental Management), UCT, South Africa, 2004
- BSc (Environmental and Geographical Science and Oceanography), UCT, South Africa, 2003

**Languages**

- English
- Afrikaans

**Key Industry Sectors**

- Telcommunications
- Renewable Energy
- Oil and Gas
- Local and national government
- Industrial development

**Key Projects**

**Amendment to an Environmental Management Programme (EMPr) for Exploration in the Algoa/Gamtoos Block, NewAGE, South Africa, 2012.**
South Africa's Mineral and Petroleum Resources Development Act requires an Environmental Management Programme (EMPr) to be compiled and submitted to the Petroleum Agency South Africa as part of an application for an Exploration Right. NewAGE appointed ERM to develop the EMPr and the subsequent amendment required due to a change in work programme. Responsibilities included project management, public consultation, developing the EMPr including the preparation of Environmental Management Plans (EMPs) for seismic surveys and prospect well drilling.

**Port of Saldanha LPG Project, Environmental Impact Assessment, Sunrise Energy, 2012 - current**
Project Consultant for an EIA for the installation of and LPG Importation and Storage Facility within and adjacent to the Port of Saldanha, West Coast, South Africa. Responsible for report writing, public consulatation activities, management of subcontractors, as well as aspects of client liason and financial management.

**Angola Cable System Screening Study, Alcatel Lucent Submarine Networks (ASN), 2012**
Project Manager and co-ordinator for a Screening/Feasibility Study for an offshore optical fibre cable system in Angola. Responsible for client liason, financial management, subcontractor management, report compilation and review.

**West Africa Cable System Project Environmental Impact Assessments, Cote d'Ivoire, Congo, DRC and Togo, 2009 - 2011**
Project Co-ordinator for the EIAs for the submarine telecommunications cable landings in Cote d'Ivoire, Congo, DRC, Togo and Cameroon. Responsible for co-ordination between the ERM team based in France, the client and the overall project management team.

**West Africa Cable System Project Environmental Impact Assessments, South Africa and Namibia, 2009 - 2011**
Project Consultant for the EIAs for the submarine telecommunications cable landings in South Africa and Namibia. Responsible for organisation of site visits, consultation meetings, public participation, conduction of primary and secondary research, liaison with authorities, as well as report compilation and submission. Additional responsibilities included co-ordination of permits required other than the EIA and liason with the client and landing parties.

**Photovoltaic (PV) Solar Power Facility Impact Assessments, Solaire Direct, 2012**
Project Consultant and assistant Project Manager for the EIAs for 2 Solar Power Facilities in the Northern and Eastern Cape. Responsible for aspects of public consultation, subcontractor management, liason with authorities, and report writing and submission. Also responsible for some aspects of financial management and client liason.

**Wind Farm Environmental Impact Assessments, G7 Renewable Energies, 2010 – 2011**
Project Consultant and assistant Project Manager for the EIAs for 5 Wind Farms in the Western and Northern Cape. Responsible for aspects of public consultation, organisation of site visits, conduction of primary and secondary research, liason with authorities, and report writing and submission. Also responsible for some aspects of financial management and client liason.

**Solar Power Farm Environmental Impact Assessments, Intikon Energy, 2010 – 2011**
Project Consultant and assistant Project Manager for the EIAs for 2 Solar Power Farms in the Northern Cape and Free State. Responsible for aspects of public consultation, organisation of site visits, conduction of primary and secondary research, liason with authorities, and report writing and submission. Also responsible for some aspects of financial management and client liason.

**Underground Pipeline Project, Cape Town Refinery, Chevron, 2010 - 2012**
Project Manager for an EIA for the installation of an underground pipeline from the refinery, extending approximately 1.3 km along Koeberg Road. Responsible for client liaison, stakeholder engagement, organising and undertaking a site visit, and report writing.

**Waste Management Licence Basic Assessment, Cape Town Refinery, Chevron, 2011 - current**
Project Consultant for a Waste Management Licence Application and associated Basic Assessment process for the construction of a consolidated waste facility at the Chevron Refinery in Cape Town. Responsible for report writing, stakeholder engagement, site visit and client liason.

**Environmental Management Programme (EMPr) for Exploration in the Ultra Deepwater Orange Basin Block, Shell, South Africa, 2010.**

South Africa's Mineral and Petroleum Resources Development Act requires an Environmental Management Programme (EMPr) to be compiled and submitted to the Petroleum Agency South Africa as part of an application for an Exploration Right. Shell appointed ERM to develop the EMPr. Responsibilities included developing the EMPr including the preparation of Environmental Management Plans (EMPs) for seismic surveys and prospect well drilling.

**MaIN OnE Submarine Cable Project Phase 1 Environmental Impact Assessments, Nigeria and Ghana, Main Street Technologies, 2008 – 2009**
Project Consultant for the Phase 1 Environmental Impact Assessments for a submarine cable and the associated landing sites in both Nigeria and Ghana. Responsible for conducting secondary level research and report compilation, as well as other project related activities.

**Environmental Performance Strategy, City of Cape Town, 2008 – 2009**
The project involved the development of an environmental performance strategy for the City of Cape Town. Responsibilities included attending and taking minutes of interviews undertaken for an 'as is' assessment of the City, assistance with report preparation, the compilation of a case study on the eThekwini Municipality and the drafting of an EIA Manual for the City of Cape Town.

**Environment, Health and Safety Legal Register, Mining Sector, Johannesburg Offices, 2009**
Review of legislation applicable to a Mining Industry client's Johannesburg Offices and the development of an Environment, Health and Safety Legal Register.

**Environment, Health and Safety Legal Register, Ghana, Baker Hughes Oil Tools, 2008 - 2009**
Review of all environmental, health and safety legislation applicable to Baker Hughes current and potential future operations in Ghana and the development of an Environment, Health and Safety Legal Register to be used by incountry EHS staff.

**Basic Assessment for the Installation of LPG Tanks, Simba Parow Industria, 2008**
Project Consultant for the Basic Assessment of two fully-mounded LPG tanks at Simba's Parow Industria facility. Undertook site visit and compiled the Basic Assessment Report, also responsible for public participation and assisting the project manager with client liaison.

**Flare Modernisation Basic Assessment, Cape Town Refinery, Chevron, 2008 – 2009**
Project Consultant for a Basic Assessment for the modernisation of Chevron's Cape Town Refinery's flaring system. Responsible for organising an authorities consultation meeting, submission of notice of intent, liaising with specialists and the client, assisting with stakeholder engagement, and compilation and submission of the Basic Assessment Report.

**Early Production System Environmental Impact Assessment (EIA), Lake Albert, Uganda, Tullow Uganda Operations Pty Ltd, 2007 – November 2008**
EIA for an Early Production System (EPS). Tullow has a MoU with the Government of Uganda to develop an onshore EPS – the first oil production in Uganda. Responsible for researching and writing sections of the biophysical baseline chapter and the legal overview chapter, editing, compiling and submission of the final report, and assisting the project manager with client and sub-contractor liaison.

**Lake Albert Offshore Exploration Drilling EIA, Uganda, Tullow Uganda Operations Pty Ltd, 2007 – May 2008**
EIA for offshore exploration drilling in Lake Albert. The EIA also includes an assessment of the onshore facilities required for the project. Responsible for researching and compiling the legal overview and biophysical baseline sections as well as editing the final report.

**Air Pollution Regulation Review, Zimco Group, 2008**
Reviewed proposed regulations under South Africa's National Environmental Management: Air Quality Act 39 of 2004. The objective of this review was to assess the proposed ambient and point source requirements for five metallurgical and mineral processing facilities.

**Atmospheric Pollution Prevention Act (APPA) Permit Amendment Application, Corning Products South Africa Pty Ltd, 2008**
Researched and liaised with authorities to gather information on the current APPA permitting requirements. Compiled and submitted the amendment application form, this required a thorough understanding of the current and future air pollution legislation.

**Freight Line Upgrade Environmental Impact Assessment, Coega to De Aar, South Africa, Transnet Projects, 2008**
Assisted with the compilation of a stakeholder database and drafting of the stakeholder engagement material for the project.

**NEMA Rectification Applications for above and underground fuel storage tanks, Shell SA Marketing Pty Ltd, 2007 – 2008**
NEMA rectification applications for above and underground fuel storage tanks throughout South Africa. Involved in the undertaking of site visits, report writing and submission of reports to the authorities in the Mpumalanga Province. Also assisted with the compilation of a synopsis of the rectification sites.

**Angara Spit Environmental and Social Baseline Report, Lake Albert, Uganda, Tullow Uganda Operation Pty Ltd, 2007**
Environmental Impact Assessments (EIA) for exploration well drilling on the Angara sand spit near Kaiso village. Responsible for final editing and compilation of the environmental and social baseline report.

# Curriculum Vitae: D.W. Japp

**Updated: March 2012**

| | | | |
|---|---|---|---|
| 1. | Family Name | : | Japp |
| 2. | First name | : | David William |
| 3. | Date and Place of birth : | | Kabwe, Zambia 30th June 1956 |
| 4. | Nationality | : | South African |
| 5. | Civil status and dependants | : | Single |
| 6. | Address (street) | : | 551 Bontebok Street, Scarborough, Cape Town |
| | (Postal) | : | P.O. Box 22717, Scarborough, Cape Town 7975 |
| | Telephone / Fax | : | +27 - 21 – 4252161 / 021-4251994 |
| | Mobile | : | 082 – 788 6737 |
| | Businesses and Address | : | Fisheries & Oceanographic Support Services cc & Capricorn Fisheries Monitoring (CapFish)<br>Unit 15 Foregate Square, Table Bay Boulevard, Cape Town, South Africa |
| | Postal : | | P.O. Box 50035, Waterfront, Cape Town 8002<br>Tel. +27 21 425 2161 Fax: +27 21 425 1994 |

## 7. Education:

| | |
|---|---|
| Institution | Chaplin High School, Gweru, Zimbabwe |
| Date: from - to | January 1970 - 1974 |
| Certificate | O-Levels (seven subjects) & M-Level (Four subjects and University exemption) |
| Institution | Merchant Navy Academy General Botha, Cape Town |
| Date: from – to | 1975 - 1980 |
| Certificate | Second Officer (Foreign) – July 1977, Chief Officer (Foreign) – July 1980 to 1983 |
| Institution | University of Cape Town (undergraduate) |
| Date: from - to | 1983 to 1985 |
| Certificate | Bachelor of Science (Zoology, Marine Biology and Oceanography) |
| Institution | Rhodes University |
| Date: from - to | 1986 |
| Certificate | Bachelor of Science Honours Ichthyology and Fisheries Science (Cum Laude) |
| Institution | Sea Fisheries Research Institute / Rhodes University |
| Date: from - to | 1987 - 1989 |
| Certificate | Masters Degree in Ichthyology and Fisheries Science (Cum Laude) |

## 8. Language skills:

| Language | Reading | Speaking | Writing |
|---|---|---|---|
| English | 5 | 5 | 5 |
| Afrikaans | 3 | 3 | 3 |

## 9. Other:

**Computer Literacy:** Windows 2000, Microsoft Office (Word, Excel, Access and PowerPoint); MapInfo, Word Perfect, Visio Draw , Statistica, SAS, Quick Books Accounting, Arcview (GIS)

**Facilitation:** Conflict resolution course completed in 1996.

**Resource Economics :** Introductory course completed (Rhodes University MBA)

**Business Management :** Management of Company and Corporate structures – formed own companies (*FOSS cc*, Capricorn Fisheries Monitoring cc, CapFish (SA) Pty Ltd

## 10. Years of professional experience:

| Dates | Years Experience | Nature of Employment |
|---|---|---|
| 1997 to present | 10 years + | Consulting: Fisheries, VMS and MCS, Fishing Rights, Scientific observers, economics, research surveys, oil industry surveys. Project development and appraisal. |
| 1987 to 1997 | 10 | Sea Fisheries Research Institute – Research and Management of Demersal Resources (Hake primarily). Surveys and cruise leader for eight years on hake-directed biomass surveys. |
| 1983 to 1989 | 7 | Tertiary education and Marine Research |
| 1975 to 1983 | 9 | Marine Deck Officer and Navigation – Foreign-Going |

## 11. Relevant Commercial Experience

| Country | Organisation | Date: From/to | Position | Job Description |
|---|---|---|---|---|
| South Africa & Sub Cont. | Fisheries & Oceanographic Support Services cc | 1997 → 2010 … | Director | Marine service companies (fisheries mostly), facilitation and training, research and management |
| South Africa & Sub Cont. | CapFish (Marine Monitoring Co.) | 1999 → 2010 ….. | Company with partners | Observer deployment and training, VMS development, specialised projects (local and international) |
| South Africa | Sea Fisheries Research Institute (SFRI) | 1987 – 1997 | Researcher and head Offshore. | Research, Management, Longline (hake and kingklip), Demersal (hake primarily), Pelagic, Deep-water, VMS development, observer deployment |
| South Africa | Rhodes University and SFRI | 1986-1989 | Research Assistance | Research Assistant and Officer – Marine and Fresh Water Fisheries. |
| South Africa & world-wide | SAFMARINE | 1975 to 1983 | Officer | Navigation and Deck Officer – Cadet Training Officer prior to University. |

## 12. Other Relevant Professional Experience:

| Country | Organisation | Date: From/to | Position | Job Description |
|---|---|---|---|---|
| South Africa | CapFish cc | 1999 → | Director | Fisheries, Seismic and numerous other scientific observer deployments. |
| South Africa | Demersal survey management and design | 1990 – 1997 | Cruise Leader | Research and management (2-3 surveys every year) |
| South Africa | Sea-going research on trawlers, longline and many other vessels | 1989 – 1997 | Fisheries Research | Research and management |
| South Africa | Merchant Navy | 1975 – 1983 | Navigation | Extensive sea-going experience, cadet training, salvage, safety at sea, first aid, fire fighting etc. |

## Major Projects - Summary

**Resource Assessment:**

Submission of management advice on hake (TAC assessments from 1989 to 1997);

Biological assessment of hake species in South African waters and determination of ageing and stock structure;

Design of hake-directed biomass surveys and cruise leader on up to four demersal surveys a year from 1989 to 1997;

Demersal Working Group co-ordinator from 1991 to 1997 responsible for the management advice on hake;

Project management (Scientist responsible) of hake-directed longline experiment in SA from 1992-1996

**Oil Industry Specific:**

Facilitation between Oil Industry and fishing industry – meetings and interaction facilitated on behalf of Soekor, Shell International, Ranger Oil, Forest Oil International., Pioneer Oil International., Sasol Oil International., BHP Billiton (UK), Petroleum Agency (SA) and the Fishing Indust. in SA and Namibia.

Evaluation of impacts on fisheries in the immediate area of prospect drilling and seismic surveys for Soekor, MOSSGAS, Sasol International, Pioneer Exploration , Forest Oil International, Shell International (Namibia) and Ranger Oil (2000-2001).

Updating and additional input into the *Lease Specific Environment Management Programme Reports* (LSEMPR) and Generic *Environmental Program Report* (EMPR) for prospect oil exploration on RSA coast (active) for all of the above exploratory seismic surveys and well-drilling prospects.

Supply of marine environmental observers and facilitators (CapFish cc) for seismic surveys since 2000 including 3-D, 2-D and research-based seismics.

Supply and contracting of "sweeper" vessels for the above surveys. Day to day observer reporting to the fishing industry and other IAAP for the above surveys. This included facilitation and resolving issues and crisis's as they arose.

Assessment of the impact of South Coast Gas (PetroSA) on Fishing off the South African south coast.

**Fishery Economics and Governance :**

Preparation of sector economic reports for RSA fisheries to assist with rights allocation procedures:

Hake Longline, Inshore Trawl (Hake and Sole), Shark longline, South Coast Rock Lobster, Patagonian Toothfish, Deepwater Fishery, Midwater Trawl & Hake Handline

Economic Assessment of the Wetfish and Freezer Trawl apportionment of Hake in Namibia

BCLME – Ecosystem Approach to Fisheries – Cost Benefit Analysis (Active project March 2006)

Review of the West Indian Ocean Tuna Fishery and Potential Opportunities and Options for the Development of the Port of Victoria (Seychelles) – Completed March 2008

Assessment of economic loss due to hydrocarbon development – numerous ongoing projects, PetroSA, Forrest Oil west coast gas, CNR well drilling and many others.

Value-Adding of Anchovy *Engraulis encrasicolus* in South Africa and potential for poverty relief.

Governance of Kenya Fisheries – Consultancy and report prepared for IOC Smartfish programme (2011)

**Other Projects Completed or Active :**

Preparation and facilitation of "Industry Rule Books" for rights allocation procedures (2001) including:

- *Midwater Trawling Association* (Horse Mackerel),
- *South East Coast Inshore Fishing Association* (Hake and Sole Trawl)
- *Shark Longline Association*
- *South Coast Hake Handline Industrial Association* (Hake)

Coordination and advice to the following working groups and associations:

- Namibian Deepwater Working Group
- Namibian Monk & Sole Association
- Demersal Working Group (RSA) co-ordinator including collation, assessment and submission of annual TAC recommendations on Hake, Kingklip, Sole and Horse Mackerel
- Shark Longline Assocociation (RSA)
- South Coast Handline Hake Industrial Association
- Midwater Trawling Association of South Africa
- South Coast Inshore Trawling Association (SECIFA).

Comparative assessment (socio-economic) of trawl and Longline fisheries in Benguela Region (BCLME).

Evaluation of deepwater groundfish fishery in South West Indian Ocean 2004/2005 – FAO.

Review of Ecosystem Approach to Fisheries Management for South African Fisheries (BCLME – MCM project).

Review of South Africa's Indian Ocean fisheries – management and policy.

Development of the South West Indian Ocean Fisheries Programme Implementation Plan – World Bank / FAO – Completed March 2007 (preparation of Project Documents for World Bank and GEF).

Ecosystem Approach to Fisheries – BCLME project LMR/EAF/03/01 – Contracted consultant including Risk Assessments and Benefit Cost estimators for EAF – Ongoing as of 5 November 2006.

Indian Ocean Tuna Tagging Programme – 2004-2007 collaborative programme with McAllister Elliot and Partners (UK) and Capricorn Fisheries Monitoring cc (RSA)

Indian Ocean Tuna Commission – 2009 → Collaborative programme between MRAG (UK) and Capricorn Fisheries Monitoring cc for the provision of Observers and monitors on Indian Ocean tuna transhipment vessels.

International Commission for the Conservation of Atlantic Tunas – 2007 → Collaborative programme between MRAG (UK) and Capricorn Fisheries Monitoring cc for the provision of Observers and monitors on Atlantic tuna transhipment vessels.

Domestic contract awarded (Sept. 2007) for the monitoring of national and high seas tuna longline fisheries, all trawl and small pelagic sectors and deep water rock lobster trap fisheries

FAO / World Bank – review of Tanzania MACEMP programme with WB surveillance team (2008, 2009, 2010, 2011, 2012)

FAO / World Bank – initiation of the South West Indian Ocean Fisheries Project – development of Project Implementation Manual and Observer programme (Mombassa – 2007- 2009)

FAO / World Bank – Project development – Kenya Coastal Development Project (KCDP) – Ongoing 2010-2012

FAO – EAF-Nansen Programme – Mozambique Sofala Bank Shrimp fishery management plan – development of effort management recommendations.

ICCAT Tuna Transhipment Programme Observers – CapFish project executant (2009 to 2012) - ongoing

IOTC Tuna Transhipment Programme Observers – CapFish project executant (2010-2012) – ongoing

Tuna Longline – RSA Observer deployments – 100% coverage on Deep Water Fishing Nations (RSA) – Project executant (2007-2012) - ongoing

**Marine Stewardship Council :**

Contracted February 2003 – March 2004 as assessor of the South African Deepsea Trawl Fishery.

Ongoing surveillance / audit of Certification (2004 – 2008)

MSC Certification – Project with Deepsea Trawling Industry Assoc. - Assessment of trawling intensity and impact on substrate type of the South African Coast (GIS-modelling)

Specialist project testing two species hake splits (on-going 2005-2007)

Active – 2009/2010 – Hake Trawl (RSA) re-certification (with Moody Marine)

Pre-Assessment (MSC) of RSA Tuna pole and bait fishery (With Mc Allister and Elliot) – May 2008-07-2

Socio-Economic evaluation of RSA hake MSC certification (Collaborative with MRAG Ltd. (UK)

Chain of Custody Certifier – CapFish (Moody) – 2008.

MSC-Africa – MSC course (Cape Town) in November 2008 on MSC and RBF

Preassessment of Patagonian toothfish longline (French Fishery – CCAMLR) with MEP.

Preassessment with Moody Marine : Mozambique Shallow and Deep-Water shrimp fisheries (August 2009)

Preassessment with Moody Marine : Kenya Lobster (Active project 2009)

Preassessment with Moody Marine : Tanzanian Octopus (Active project 2009)

Full Assessment (2011) – Tristan Lobster (P2)

Full Assessment – Sea of Okhotsk Pollock (P2) – 2011-2012 (ongoing)

**Marine Compliance:**

Vessel Monitoring System development at *Marine & Coastal Management* - initiated and managed project in South Africa from 1994 to 2002.

Scientific Observer deployment (Initiated program in RSA) – Management and observer deployment of the "Offshore Resources Observer Programme " through *Capricorn Fisheries Monitoring cc* (R11 million (two-year contract) awarded in June 2002 to June 2004 on behalf of *Marine & Coastal Management.*

Renewal of the above contract – Offshore Observer Programme 2005 – 2010

Deployment of International and High Seas Observers (ex Capfish) since 1997.

SADC study on IUU fishing in SADC region (completed June 2008)

**Acoustics :**

Surveys of the Orange Roughy Fishery on Spawning aggregations off the Chatham Rise, New Zealand in July 2002 and 2003.

**Lecturing and Document Preparation:**

Extensive lecturing and seminar presentations (20 years) as well as detailed project and document preparation experience.

Presentation of 5 x International courses in Namibia on International Agreements, UNCLOS, RFO's etc to Inspectors, Observers and Fisheries Managers.

**Publications:**

Publication record includes 25 publications in both local and international journals of marine science (available on request). Author FAO technical reports on Shark Fishery in RSA, By-catch in RSA and Rights Allocation procedures in the hake fishery, RSA Fisheries Profiles, Offshore Marine Protected Areas.

**Communication:**

National and International experience with different organisations including CCAMLR (initiation of Patagonian Toothfish Fishery in South Africa) and development of the South East Atlantic Fishing Organisation (SEAFO)

**Diving:** CMAS Class four sport diver, CMAS club instructor and trainer

## 13. Fisheries & Oceanographic Support Services cc (FOSS cc) – Project Management

- Fishing Industry rights allocation "Rule Book" (allocation of rights) development (SECIFA, MWTA, SCHHIA)
- Economic study reports
- Facilitation between fishing Industry and Oil Industry (surveys and other)
- Facilitation of the Namibian Deep-Water Working Group;
- Facilitation of the Shark Longline Association;
- Industry, MCM and Fisher liaison for the development of the hake-directed longline fishery in South Africa;
- Participation in the development of the Small, Micro and Medium enterprises (SMME's) with a view to transformation of the fishing industry;
- Assessment and submission of data and report on the historical and present fishing activity in the proposed *SEAFO* area (Dr Oelofsen and Dr Miller refers);
- Specialised acoustic survey of New Zealand Orange Roughy stocks (sub-contract July 2002)
- Development of fisheries effort plans for Sofala Bank Shrimp and RSA hake longline.

Many other projects have been undertaken including many confidential industry-specific contracts. Details of the above activities can be given and supported if requested.

## 14. REFEREES

| | |
|---|---|
| Dr A. Payne : | Director: Research: Sea Fisheries Research Institute (MCM), Private Bag X2, Roggebaai, 8012, Cape Town. South Africa Tel. (021) 402 3105 (w). From May 2000: Appointed to left MCM and appointed to CEFAS - Lowestoft (UK). |
| Dr L. Hutchings: | Deputy Director: Wholes Systems: Sea Fisheries Research Institute, Private Bag X2, Roggebaai, 8012, Cape Town. South Africa Tel. (021) 402 3911 |
| Mr R. Bross: | Deepsea Trawling Association, 9th Floor Pearl House, Cape Town 8001. Tel. (021) 252727 |
| Mr M. Kuster | 29 Esme Rd, Newlands, Cape Town 7700. Tel. (021) 64 2675 (h) 613086 (w) |

## 15. PUBLICATIONS


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

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

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

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

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

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

7. WICKENS, P.A., JAPP, D.W., SHELTON, P.A., KRIEL, F., GOOSEN, P.C., ROSE, B., AUGUSTYN, C.J., BROSS, C.A.R., PENNEY, A.J. AND R.G. KROHN 1992 - Seals and fisheries in South Africa - competition and conflict. In: *Benguela Trophic Functioning.* Payne, A.I.L., Brink, K.H., Mann, K.H. and R. Hilborn (Eds). *S. Afr. J. mar. Sci.* **12:** 773-789.

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

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

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

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

12. JAPP, D.W. 1996 - Discarding practices and bycatches for fisheries in the Southeast Atlantic region (Area 47). ***FAO report*** 30 pp.

13. PAYNE, A.I.L. , BADENHORST, A. AND D.W. JAPP 1996 - Managing fisheries following political transition in South Africa, faced with multiple objectives and aspirations. ***ICES* C.M. 1996/P.5**

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

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

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

18. JAPP, D.W and A. JAMES 2005 - Potential exploitable deepwater resources and exploratory fishing off the South African coast and the development of the deepwater fishery on the south Madagascar Ridge. *FAO*

*Fisheries Proceedings 3/2.* Deep Sea 2003 : Conference on the Governance and Management of Deep-sea Fisheries. R. Shotton ed.

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

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

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

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

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

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

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

26. Japp, D.W, Heinecken, C and T Lieman. - Value-Adding of Anchovy *Engraulis encrasicolus* in South Africa and potential for poverty relief. (active).

In addition to the above many reports related to surveys, working group documentation and projects are available.

PISCES



ENVIRONMENTAL SERVICES (PTY) LTD

# COMPANY PROFILE

**January 2013**

Contact Details:

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# DESCRIPTION OF THE COMPANY AND THE COMPANY'S QUALIFICATIONS

## A.1 Pisces Environmental Services (Pty) Ltd: Company Profile

Pisces Environmental Services (Pty) Ltd was established in January 1998 to help fill the growing need for an expert interface between users of the coastal and marine environment and the various national and provincial management authorities. Since then, PISCES has been providing a wide range of information, analyses, environmental assessments, advice and management recommendations to these user groups, particularly the South African and Namibian marine diamond mining and fishing industries.

### *A.1.1 Services Offered*

Based on a broad range of experience, Pisces Environmental Services are well-positioned to offer the following services in the marine and coastal environment:

- Identification and evaluation of coastal and marine issues of concern.
- Monitoring and data collection in the coastal, estuarine and marine environments.
- Environmental impact assessments and management programme reports.
- Development of fisheries and marine environmental management advice.
- Scientific diving surveys.
- Data capture, analysis and production of scientific and illustrative graphics.
- Public presentation and discussion of results.
- Development of proposals for resolution of conflicts between user groups.

### *A.1.2 Managerial Capability*

Since its founding in 1998, Pisces Environmental Services have successfully completed a broad variety of assignments, and its list of established clients provides testimony to its ability to design, implement, conduct and successfully conclude a wide range of projects, ranging from technical field surveys and baseline data collection, to sophisticated statistical analyses, reporting and public presentation of results. The Company has acquired a reputation among its clients for reliable, efficient, and result-orientated work. Whenever acceptable to clients, its work is professionally peer-reviewed by an acknowledged and independent expert in the field concerned, and a number of studies have been published in the internationally reviewed scientific literature (see publications list).

## A.2 Client List

To date, Pisces Environmental Services have conducted work for the following clients:

- AECI Operations Services (Pty) Ltd
- AGES (Pty) Ltd
- Anchor Environmental Consultants CC
- Auas Diamond Company (Pty) Ltd
- Aurecon
- Benguela Operations South Africa (Pty) Ltd
- Benguela Operations Namibia (Pty) Ltd

- CSIR Environmentek
- CCA Environmental (Pty) Ltd
- De Beers Marine Namibia (Pty) Ltd
- De Beers Marine, South Africa (Pty) Ltd
- De Beers Namaqualand Mines
- Diamond Fields International Limited
- EcoSence CC
- Eden Island Development Company (Seychelles) Limited
- Ectocon (Pty) Ltd (Botswana)
- EnviroDynamics (Pty) Ltd
- EnviroFish Africa (Pty) Ltd, Rhodes University, Grahamstown
- EnviroScience (Windhoek)
- ERM
- GOPA-Cofad (Germany/Namibia)
- Investec (Australia)
- Lwandle Technologies (Pty) Ltd
- Marine & Coastal Management, Department of Environment Affairs & Tourism
- Metago Environmental Engineers (Pty) Ltd
- Mineral Sands Resources (Pty) Ltd (Australia)
- Namagroen Prospecting & Investments (Pty) Ltd
- Namdeb Diamond Corporation (Pty) Ltd
- Prime Resources (Pty) Ltd
- SRK Consulting (South Africa) (Pty) Ltd
- South African National Ports Authority
- Sue Lane & Associates
- Trans Hex Operations (Pty) Ltd
- Turgis Consulting (Pty) Ltd

## A.3 Projects Undertaken

Since establishment in 1998, Pisces Environmental Services have successfully completed the following projects:

- Population dynamics and stock assessment of giant periwinkles *Turbo sarmaticus*, *Turbo cidaris* and *Oxystele sinensis*, in the southwestern Cape for M&CM.
- Evaluation of coastal fauna community composition and pesticide contamination levels in northern False Bay, Cape Town for AECI Operations Services.
- Evaluation of deepwater benthic community composition changes and recovery rates in the Atlantic 1 Mining Licence Area off Namibia, for De Beers Marine.
- Evaluation of the impact of nearshore diver-operated diamond mining on rock-lobster and benthic communities near Lüderitz, Namibia, for Namdeb Diamond Corporation.
- Evaluation of the effects of shore-based contractor mining and fines deposition from the Elizabeth Mine on rock-lobster abundance, and intertidal and subtidal communities, for Namdeb Diamond Corporation.
- Review of the interactions between the rock-lobster fishery and marine diamond mining along the southern African West Coast, for GOPA-Consultants/GTZ.

- Environmental Management Program Reports for South African west coast (a), (b), (c) and (d) marine diamond mining concessions, for Benguela Operations, Trans Hex Group, Namagroen Prospecting and Investments, GeoMining and Wealth 4 U.
- Environmental impact assessment for proposed beach terrace mining at Karoetjies Kop by De Beers Namaqualand Mines for Metago Environmental Engineers.
- Beach macrofaunal survey to assess the impacts of beach mining operations by Trans Hex Operations.
- Development and implementation of an at-sea observer program for the South African experimental pelagic longline fishery, for Department of Environment Affairs: Marine & Coastal Management.
- Development of fisheries development and management advice for the South African pelagic longline fishery, for the SA Tuna Longline Association.
- Development of fisheries management advice and representation of the South African Deep Sea Angling Association.
- Specialist reviews of the potential effects of sediments derived from proposed pocket-beach and off-beach mining operations in Namibia on intertidal and subtidal benthic communities, for Namdeb Diamond Corporation and De Beers Marine.
- Compilation of an EIA and EMPR for the construction of a new jetty in Lüderitz Bay Harbour.
- Preparation of national launchsites database in support of prospective launchsite applications for the SA Deep Sea Angling Association.
- Conducting of a benthic community baseline diving survey in the Cape Peninsula National Park marine zone, for SA National Parks.
- Conducting of Fisheries Independent Abalone Surveys (FIAS) for Marine & Coastal Management, and comparative abalone diving survey for the abalone industry.
- Prospecting permit application and EMPR compilation for the extraction of heavy mineral sands in the Geelwal Karoo area for the Australian-based company Mineral Sands Resources Ltd.
- Baseline marine survey of intertidal and subtidal rocky shore habitats in the Brand-se-Baai Complex and associated EIA and EMP for surf-zone, diver-operated diamond mining for De Beers Namaqualand Mines.
- Baseline marine survey and annual monitoring of intertidal and subtidal rocky shores and beaches at Elizabeth Bay, Namibia, for Namdeb Diamond Corporation (ongoing).
- Macrofaunal sample analysis and baseline and monitoring reports on Benthic Communities in the De Beers ML3/2003 Mining Licence Area, for De Beers Marine South Africa.
- Macrofaunal sample analysis and report on Benthic Communities in ML-43, ML-44, ML-45, ML-47 and ML-128 off Namibia, for Namdeb Diamond Corporation.
- Compilation of a Scoping Report, EIA and EMP for marine dredging operations in the Chameis Bay and the Atlantic 1 Mining Licence areas, for De Beers Marine Namibia.
- Reports on the recovery and rehabilitation of marine diamond mining operations off the southern African West Coast, for De Beers Marine South Africa, De Beers Marine Namibia and Namdeb Diamond Corporation.
- Compilation of a scoping report reviewing the EIA and EMPR for De Beers South African Sea Areas Prospecting and Mining Concessions along the West Coast, for De Beers Marine South Africa.
- Assessment the potential effects of dredging-related suspended sediments on intertidal and subtidal communities in the Chameis Bay area, for De Beers Marine Namibia.

- Development and management of a Fisheries Independent Monitoring Survey (FIMS), and small-scale mark-and-recapture experiment for rock lobsters off the southern Namibian coastline, for De Beers Marine Namibia.
- Management of an infra-red aerial photographic survey of the southern Namibian kelp beds, for De Beers Marine Namibia.
- Study on the cumulative impacts of scouring of sub-tidal areas and kelp cutting by diamond divers in near-shore areas of the BCLME region (BEHP/CEA/03/04), for the BCLME Task Group on Management of Mining and Petroleum Exploration and Production Activities.
- Data gathering and gap analysis for assessment of cumulative effects of marine diamond mining activities on the BCLME region (BEHP/CEA/03/02).
- Marine Ecology Specialist Study and EIA for the development of Eden Island in Republic of Seychelles.
- Baseline and monitoring surveys of the effects of Pocket Beach mining at Site 11/12 on nearshore reef habitats in the Bogenfels Licence Area for Namdeb Diamond Corporation (ongoing).
- Baseline and monitoring surveys of the effects of fine-tailings discharges from diamond treatment plants in Mining Area 1, for Namdeb Diamond Corporation (ongoing).
- Development of a medium- to long-term benthic sampling program to ascertain the recovery rate of the macrofaunal benthic communities after disturbance through mining in De Beers Marine's SASA ML3, for De Beers Marine (Pty) Ltd.
- Compilation of EIAs and EMPRs for Namdeb's Inshore and Inner Shelf Projects, for Namdeb Diamond Corporation (Pty) Ltd.
- Preparation and submission of a Letter of Intent and Draft Basic Assessment Report for land-based aspects associated with proposed dredging operations in Namagroen's concessions 8(a) and 9(a), for GeoMining.
- Review of, and input into De Beers Marine's Biodiversity Action Plan, for De Beers Marine (Pty) Ltd.
- Review of, and input into Namdeb's Biodiversity Action Plan, for Namdeb Diamond Corporation (Pty) Ltd.
- Compilation of the EIA-Amendment and EMPR for Namdeb's Elizabeth Bay Optimisation Study.
- Basic Assessment Report and Stakeholder Engagement for Namdeb's Southern Coastal Unconstrained Accretion (SCUBA) Project.

In addition, Pisces Environmental Services has successfully contributed to the following joint projects with various associates and partners:

- Intertidal beach and rocky-shore specialist study for Dollas Downs EIA, for CSIR Environmentek.
- Economic study of the South African pelagic longline and abalone fishing sectors, for EFA.
- Evaluation of shark by-catches in southern African shark longline fisheries, for EFA.
- Specialist input to an EIA on proposed pocket-beach mining by Namdeb Diamond Corporation, for EnviroScience.
- Review of the potential effects of increased sediment disposal from the Elizabeth Bay mine (Namibia) on shallow water marine communities, for CSIR.
- Identification of deepwater benthic organisms collected in seabed benthic community surveys in mined areas off Namibia, for De Beers Marine Namibia.

- A review of information relevant to development of effective co-operative arrangements for the management of shared fish stocks in the SADC region, for EFA.
- Drafting of a cave conservation and management plan for Gcwihaba Cave, Botswana, for Ectocon Limited.
- Compilation of an EIA and EMPR for proposed Wet Overburden Mining in Namdeb's Mining Area 1, with Anchor Environmental Consultants.
- Specialist study on the potential impacts on marine ecosystems in Table Bay of the expansion of the container storage terminal in Cape Town harbour, for CSIR Environmentek.
- Baseline and monitoring surveys of sandy beach and intertidal rocky shore habitats of the pocket beaches in the Bogenfels Licence Area for Namdeb Diamond Corporation, with Anchor Environmental Consultants.
- Assessment of a proposed cooling water discharge from the Kudu Power Plant near Oranjemund, into the marine environment, for CSIR Environmentek.
- Assessment of the cumulative effects of sediment discharges from on-shore and near-shore diamond mining activities on the BCLME (BEHP/CEA/03/03), with CSIR Environmentek.
- Assessment of a cooling water discharge on the marine environment, from the proposed 2400 MW gas-fired combined cycle power generator at Coega, for CSIR Environmentek.
- Assessment of an effluent discharge from proposed Reverse Osmosis Plants at the Multipurpose Terminal in Saldanha Bay and Swakopmund Namibia on the marine environment, for CSIR Environmentek.
- Specialist Marine Environmental Impact Assessment Study, baseline survey and Environmental Management Plan for the proposed Reverse Osmosis Plant for the Trekkopje Uranium Mine, Namibia, for Turgis Consulting (Pty) Ltd.
- Review and compilation of EIAs and EMPRs for Namdeb's offshore mining licence areas mined under exclusive contract by De Beers Marine Namibia, with CSIR Environmentek.
- Compilation of an EMPR for vessel and shore-based diving by Diamond Fields Namibia in the Lüderitz concessions, with Jeremy Midgley & Associates.
- Specialist Assessment of tailings plumes from De Beers' Horizontal Mining Vessel Operating in South African Sea Areas Mining Licence Area ML3/2003, with Dr Robin Carter, for De Beers Marine.
- Specialist Marine Environmental Impact Assessment Study, Baseline Survey and Environmental Management Plan for the proposed NamWater Reverse Osmosis Plant near Swakopmund, Namibia, for CSIR Environmentek.
- Marine Specialist input into the Basic Assessment for the proposed marine lift facility in the Small Boat Harbour, Saldanha Bay, for CCA Environmental (Pty) Ltd.
- Compilation of Marine Faunal Assessments for proposed seismic surveys off the East, South West and South Coasts of South Africa, and off central and southern Namibia, for CCA Environmental.
- Compilation of a Marine Specialist Study for the Feasibility Assessment for the proposed expansion of the Port of Lüderitz, for Aurecon Namibia.
- Compilation of a Marine Specialist Study for the AfriSam Saldanha Cement Project, for Aurecon South Africa (in progress).
- Marine environmental risk assessment for an industrial park near Swakopmund, with CSIR Environmentek.
- Marine Specialist Study and EIA Review for the proposed Tormin heavy mineral sands mining north of the Olifants River mouth for GCS.

- Marine Specialist Report for the EIA and EMP for proposed prospecting for shell and sand off Richard's Bay, with AGES (Pty) Ltd.
- Marine Specialist Study for the proposed Saldanha Bay Desalination Plant, with CSIR Environmentek (in progress).
- Marine Baseline Report for the proposed Cacata Phosphate Project in Cabinda Province, Angola, with Prime Resources (Pty) Ltd.
- Environmental Screening for Reverse Osmosis Plants in KwaZulu-Natal, with Aurecon South Africa (Pty) Ltd.
- Marine Ecological Assessment for the proposed Anadarko LNG Development, Palma Bay, Northern Mozambique with Lwandle Technologies (Pty) Ltd for ERM (Pty) Ltd.
- Compilation of Marine Faunal Assessments for proposed seismic surveys off the South Coast of South Africa for ERM.

## A.4 Publications

Principal publications by individual members and by the Company are listed below. In addition to the publications listed, a number of other scientific articles, reports, conference presentations and popular articles have been produced by the director. Details of these additional publications are available on request.


ANCHOR ENVIRONMENTAL CONSULTANTS CC & PISCES ENVIRONMENTAL SERVICES (PTY) LTD, 2003. Final Environmental Impact Assessment Report: Namdeb Wet Overburden Mining System. Volume I. Final EIA Report. *EIA prepared for Namdeb Diamond Corporation (Pty) Ltd., November 2003*. 85pp.

ANCHOR ENVIRONMENTAL CONSULTANTS CC & PISCES ENVIRONMENTAL SERVICES (PTY) LTD, 2003. Final Environmental Impact Assessment Report: Namdeb Wet Overburden Mining System. Volume II. Supplementary Volume of Specialist Reports. *EIA prepared for Namdeb Diamond Corporation (Pty) Ltd., November 2003*. 85pp.

BENGUELA OPERATIONS (PTY) LTD & PISCES RESEARCH AND MANAGEMENT CONSULTANTS CC, 1999, Environmental Management Programme Report for geotechnical survey in Grant EPL 2495. *EMPR prepared for Auas Diamond Company (Pty) Ltd and Benguela Concessions (Namibia)(Pty) Ltd, May 1999*. 27pp.

CLARK, B.M., ATKINSON, L.J. & A. PULFRICH, 2005. Sandy Beach and Rocky Intertidal Monitoring Studies in the Bogenfels Mining Licence Area, Namibia. Monitoring Report 2005. *Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia*.

CLARK, B.M., ATKINSON, L.J., STEFFANI, N. & A. PULFRICH, 2004. Sandy Beach and Rocky Intertidal Baseline Monitoring Studies in the Bogenfels Mining Licence Area, Namibia. Monitoring Report 2004. *Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia*.

CLARK, B.M., HUTCHINGS, K. & A. PULFRICH, 2009. Survey of sandy-beach macrofaunal communities and *Tylos granulatus* in the Bogenfels Mining Licence Area. 2009 Monitoring Report. *Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia*. 74pp.

CLARK, B.M., PULFRICH, A. & L.J. ATKINSON, 2006. Sandy Beach and Rocky Intertidal Monitoring Studies in the Bogenfels Mining Licence Area, Namibia. Monitoring Report 2006. *Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia*. 133pp.

CLARK, B.M., MEYER, W.F., EWART-SMITH, C, PULFRICH, A. & J. HUGHES, 1999. Synthesis and assessment of information on the BCLME, Thematic Report 3: Integrated overview of diamond mining in the Benguela Current region. *AEC Report # 1016/1 to the BCLME*. 63pp.

CSIR, 2008. Atlantic 1 Mining Licence Area (MLA47). Environmental Management Programme Report. CSIR/NRE/RBSD/ER/2008/002/C. Stellenbosch. x pp including Appendices and Summary. Prepared for De Beers Marine Namibia (Pty) Ltd.

CSIR, 2008. Mining Licence Areas 128 A, B and C. Environmental Impact Assessment and Management Report. CSIR/NRE/RBSD/ER/2008/003/C. Stellenbosch. x pp including Appendices and Summary. Prepared for De Beers Marine Namibia (Pty) Ltd.

CSIR, 2007. Marine Dredging Project. Feasibility Phase. Environmental Impact Assessment Report CSIR/NRE/RBSD/ER/2007/0156/C. Stellenbosch. x pp including Appendices and Summary. Prepared for De Beers Marine Namibia (Pty) Ltd.

CSIR, 2007. Marine Dredging Project. Feasibility Phase. Report of Risk Assessment and Data Gap Analysis Workshop. CSIR/NRE/RBSD/ER/2007/0137/C. Stellenbosch. Prepared for De Beers Marine Namibia (Pty) Ltd.

CSIR, 2008. Atlantic 1 Mining Licence Area (MLA47). Rehabilitation and Closure Plan. CSIR/NRE/RBSD/ER/2008/0065/C. Stellenbosch. Prepared for De Beers Marine Namibia (Pty) Ltd.

LAMBERTH, S. & A. PULFRICH, 1997. Specialist study of the fish and fisheries of the Arniston area and on the intertidal flora and fauna of Portion 7 of Dolla's Downs 264. *Report to CSIR Environmentek, June 1997*, pp29.

MIDGLEY, J. & A. PULFRICH, 2008. EMPR for Marine Diamond Mining in ML-32. Prepared for Diamond Fields Namibia (Pty) Ltd. pp94.

NEL, R. & A. PULFRICH, 2002. An assessment of the impacts of beach mining operations on beach macrofaunal communities between the Sout River and Olifants River mouth. *Pisces Environmental Services (Pty) Ltd. Report to Trans Hex Operations (Pty) Ltd.* September 2002, 38pp.

NEL, R., PULFRICH, A. & A.J. PENNEY, 2003. Impacts of Beach Mining Operations on Sandy Beach Macrofaunal Communities on the Beaches of Geelwal Karoo. *Pisces Environmental Services (Pty) Ltd. Report to Trans Hex Operations (Pty) Ltd. October 2003*, 54pp.

PENNEY, A.J., 2005. Scoping Report: Review of the EIA and EMPR for De Beers South African Sea Areas Prospecting and Mining Concessions along the West Coast. *Report to De Beers Marine, South Africa.* 94pp.

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## A.5 Company Director: *Curriculum Vitae*

Included below is an **abridged** *curriculum vitae* for the company director. A detailed CV will be supplied on request.

# Dr Andrea Pulfrich

### Personal Details


| | |
|---|---|
| Born: | Pretoria, South Africa on 11 August 1961 |
| Nationality and Citizenship: | South African and German |
| Languages: | English, German, Afrikaans |
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### Academic Qualifications

- BSc (Zoology and Botany), University of Natal, Pietermaritzburg, 1982
- BSc (Hons) (Zoology), University of Cape Town, 1983
- MSc (Zoology), University of Cape Town, 1987
- PhD, Department of Fisheries Biology of the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany, 1995

### Membership in Professional Societies

- South African Council for Natural Scientific Professions (Pr.Sci.Nat. No: 400327/06)
- South African Institute of Ecologists and Environmental Scientists
- International Association of Impact Assessment (South Africa)
- Registered Environmental Assessment Practitioner (Certification Board for Environmental Assessment Practitioners of South Africa).

### Employment History and Professional Experience

**1998-present:** Director: Pisces Environmental Services (Pty) Ltd. Specifically responsible for environmental impact assessments, baseline and monitoring studies, marine specialist studies, and environmental management plan reports.

During 1999, also senior researcher on contract to NAMDEB and De Beers Marine South Africa, at the University of Cape Town; investigating and monitoring the impact of diamond mining on the marine environment and fisheries resources; experimental design and implementation of dive surveys; collaboration with fishermen and diamond divers; deep water benthic sampling, sample analysis and macrobenthos identification.

**1996-1999:** Senior researcher at the University of Cape Town, on contract to the Chief Director: Marine and Coastal Management (South African Department of Environment Affairs and Tourism); investigating and monitoring the experimental fishery for periwinkles on the Cape south coast; experimental design and implementation of dive

surveys for stock assessments; collaboration with fishermen; supervision of Honours and Masters students.

**1989-1994:** Institute for Marine Science at the Christian-Albrechts University of Kiel, Germany; research assistant in a 5 year project to investigate the population dynamics of mussels and cockles in the Schleswig-Holstein Wadden Sea National Park (employment for Doctoral degree); extensive and intensive dredge sampling for stock assessments, collaboration with and mediation between, commercial fishermen and National Park authorities, co-operative interaction with colleagues working in the Dutch and Danish Wadden Sea, supervision of Honours and Masters projects and student assistants, diving and underwater scientific photography. Scope of doctoral study: experimental design and implementation of a regular sampling program including: (i) plankton sampling and identification of lamellibranch larvae, (ii) reproductive biology and condition indices of mussel populations, (iii) collection of mussel spat on artificial collectors and natural substrates, (iv) sampling of recruits to the established populations, (v) determination of small-scale recruitment patterns, and (vi) data analysis and modelling. Courses and practicals attended as partial fulfilment of the degree: Aquaculture, Stock Assessment and Fisheries Biology, Marine Chemistry, and Physical and Regional Oceanography.

**1988-1989:** Australian Institute of Marine Science; volunteer research assistant and diver; implementation and maintenance of field experiments, underwater scientific photography, digitizing and analysis of stereo-photoquadrats, larval culture, analysis of gut contents of fishes and invertebrates, carbon analysis.

**1985-1987:** Sea Fisheries Research Institute of the South African Department of Environment Affairs and Tourism: scientific diver on deep diving surveys off Cape Agulhas; censusing fish populations, collection of benthic species for reef characterization.

South African National Research Institute of Oceanography and Port Elizabeth Museum: technical assistant and research diver; quantitative sampling of benthos in Mossel Bay, and census of fish populations in the Tsitsikamma National Park.

University of Cape Town, Department of Zoology and Percy Fitzpatrick Institute of African Ornithology; research assistant; supervisor of diving survey and collection of marine invertebrates, Prince Edward Islands.

**1984-1986:** University of Cape Town, Department of Zoology; research assistant (employment for MSc Degree) and demonstrator of first year Biological Science courses. Scope of MSc study: the biology, ecology and fishery of the western Cape linefish species *Pachymetopon blochii*, including (i) socio-economic survey of the fishery and relevant fishing communities, (ii) collection and analysis of data on stomach contents, reproductive biology, age and growth, (iii) analysis of size-frequency and catch statistics, (iv) underwater census, (v) determination of hook size selectivity, (vi) review of historical literature and (vii) recommendations to the Sea Fisheries Research Institute of the South African Department of Environment Affairs and Tourism for the modification of existing management policies for the hottentot fishery.