

**BASIC ASSESSMENT REPORT FOR THE PROPOSED
PROSPECTING IN SEA CONCESSION AREA 14C BY TRANS
ATLANTIC DIAMONDS (PTY) LTD**

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TRANS ATLANTIC
DIAMONDS

**Appendix 3:
Marine Specialist Study**

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MARINE SPECIALIST IMPACT ASSESSMENT FOR EXPLORATION AND PROSPECTING ACTIVITIES IN SOUTH AFRICAN SEA AREA 14C



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Report prepared for:

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EXECUTIVE SUMMARY

Anchor Environmental Consultants were requested to undertake a marine specialist study for Trans Atlantic Diamonds (Pty) Ltd who are applying for a diamond prospecting right for Concession Area 14C, offshore of the Western Cape Coast. Proposed activities include geophysical exploration and sampling/prospecting to detect the presence of palaeo-beach deposits at different submerged sea levels that occur in Concession 14C, which are known from other concessions to contain diamondiferous gravels. Seismic surveying will be conducted using a dedicated survey vessel with a hull-mounted MBES (high frequency range) and Topas sub-bottom profiler (SBP) system (mid-frequency range) collecting high-resolution acoustic data along lines 50 m to 200 m apart throughout the concession area. Sampling will be undertaken in targeted areas identified through the analysis of the acoustic survey data. Four potential methods of collecting geophysical samples from the seabed are being considered. A Van Veen grab with a sampling capacity of approximately 50 kg will be used to collect baseline environmental data on sediment and benthic macrofauna at 20-50 sites. Geotechnical samples to assist in understanding the sea floor geology and resource evaluation will be collected at 100-200 sites using either vibracoring, gravity coring or sonic coring. In addition to the above, prospective targets will be analysed by a uniquely designed drill tool that can dredge gravel from the seabed. Pending the final tool design, the drill bit footprint will be between 3 and 5 m² with an expected average hole depth of 3 m. Sample volumes are anticipated to be in the range of 9 to 15 m³ per sample. An estimated total of 300 samples spaced at roughly 300 m apart from north to south will be required. Material from drill sampling will be processed onboard and tailings will be discarded overboard, thereby causing sediment plumes, in this instance as a near-shore deposit.

A description of the affected environment is provided. Habitat and biota of conservation importance were identified and mapped in relation to the proposed survey area. The likelihood of occurrence of affected marine fauna within the proposed survey area was ascertained from available literature. Important user groups such as fisheries are described and mapped in relation to the proposed survey area. Potential impacts from the proposed exploration and prospecting activities were identified. Impacts were assessed and, where possible, mitigation measures have been identified to avoid/minimise/reduce any impacts.

Assessment of potential impacts associated with the proposed activities range from medium to insignificant, but with effective mitigation these are all reduced to very low, low or insignificant (see Summary Table below).

The potential impact of most concern that was assessed as MEDIUM negative significance prior to mitigation was the seismic disturbance to marine mammals. It is known that migrating humpback and southern right whales are frequently encountered on the west coast of southern Africa and encounters with odontocetes such as dusky dolphins and Heaviside's dolphin (the latter is listed as near threatened on the IUCN red data list) are likely throughout the year. Furthermore, humpback calves are vulnerable during the southern migration which takes place during the months of September and October. Of the proposed seismic survey activities, the Topas sub-bottom profiler system which uses shallow (35-45 kHz) and medium penetration (1-10 kHz) "Chirp" seismic pulses to map the sediment horizon could present a risk to dusky and Heaviside's dolphins. These species are regarded as mid-frequency cetaceans that could be at risk during the proposed seismic survey. Effective implementation of mitigation measures should ensure that potential impacts on marine mammals

arising from the proposed seismic survey activities in concession 14C would be reduced to LOW significance. Cumulative impacts, however, are assessed to be of MEDIUM significance (duration increased to long-term).

Table i Summary table of potential marine ecological and fisheries impacts associated with offshore diamond exploration activities (seismic survey and sampling/prospecting) in South African Sea Area concession 14C.

Impact	Consequence	Probability	Significance	Status	Confidence
Seismic disturbance to invertebrates No mitigation	Very low	Possible	INSIGNIFICANT	-ve	Medium
Cumulative Impact	Medium	Possible	LOW	-ve	Low
Seismic disturbance to fish No mitigation	Very low	Possible	INSIGNIFICANT	-ve	High
Cumulative Impact	Medium	Possible	LOW	-ve	Low
Seismic disturbance to marine mammals	Medium	Probable	MEDIUM	-ve	Medium
With mitigation	Low	Improbable	VERY LOW	-ve	Medium
Cumulative Impact	High	Improbable	MEDIUM	-ve	Low
Seismic disturbance to seabirds	Low	Probable	LOW	-ve	High
With mitigation	Very low	Improbable	INSIGNIFICANT	-ve	High
Cumulative Impact	High	Improbable	MEDIUM	-ve	Low
Seismic disturbance to turtles No mitigation	Very low	Improbable	INSIGNIFICANT	-ve	High
Cumulative impact	Medium	Improbable	LOW	-ve	Low
Marine megafauna collisions with survey vessels	Low	Possible	VERY LOW	-ve	High
With mitigation	Very Low	Improbable	INSIGNIFICANT	-ve	High
Cumulative impact	Medium	Possible	LOW	-ve	Low
Offshore based seabed sampling and tailings disposal No mitigation	Low	Definite	LOW	-ve	High
Cumulative impact	Medium	Possible	LOW	-ve	Low

Fine sediment plumes No mitigation	Very low	Definite	VERY LOW	-ve	High
Cumulative impact	Very low	Definite	VERY LOW	-ve	Low
Waste discharges during vessel operations	Very low	Probable	VERY LOW	-ve	High
With mitigation	Very low	Improbable	INSIGNIFICANT	-ve	High
Cumulative impact	Low	Improbable	VERY LOW	-ve	Low
Impact on fisheries	Very Low	Probable	VERY LOW	-ve	High
With mitigation	Very Low	Possible	INSIGNIFICANT	-ve	High
Cumulative Impact	Low	Probable	LOW	-ve	Low

Seismic disturbance to seabirds was assessed to be of LOW risk and with the implementation of mitigation (see below) is reduced to INSIGNIFICANT (Table 7). For the cumulative impact assessment, however, the extent increases to regional and duration increases to long-term (>15 years), and this raises the overall consequence from very low to high and the overall significance from INSIGNIFICANT to MEDIUM. However, our confidence for the assessment of cumulative impacts decreases from medium to low due to the paucity of information available from various rights holders.

Temporary exclusion of fishing vessels from the concession area during seismic survey and sampling/prospecting activities is also of potential concern. The historical fishing catch and effort reported by the potentially affected small pelagic, tuna pole and traditional handline sectors in the 14C concession area is of limited national importance but may well be significant at an individual vessel and right holder level. The offshore location of the 14C concession area means that impacts on local small-scale fisherman due to prospecting in this concession area are highly unlikely. Overall, the potential impacts on fisheries are assessed to be of VERY LOW negative significance and cumulative impacts on fisheries as LOW negative significance.

Offshore reef habitat is expected to be encountered in concession 14C. These offshore rocky reefs are colonised by a range of epifauna including bryozoans, encrusting and upright sponges, solitary and colonial ascidians, sea anemones and cold-water coral colonies – the latter being slow-growing and taking many years to become established. These reefs are considered sensitive habitat and may be directly impacted (mined) (LOW negative significance) but are also at risk of being indirectly impacted by smothering from tailings disposal (VERY LOW negative significance) – the latter is unlikely in this case as only grab samples are expected to be processed on board.

Mitigation measures recommended to reduce the severity of the potential impacts associated with the proposed prospecting in Concession 14C are summarised below.

Essential mitigation measures:

- A designated onboard Marine Mammal and Seabird Observer (MMSO) to ensure compliance with mitigation measures during geophysical surveying.
- MMSO to conduct pre-survey visual scans of at least 15 minutes for the presence of cetaceans, feeding seabirds and marine turtles around the survey vessel prior to the initiation of any acoustic impulses.
- “Soft starts” should be carried out for equipment with source levels greater than 210 dB re 1 μ Pa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity. Where this is not possible, the equipment should be turned on and off over a 20-minute period to act as a warning signal and allow cetaceans to move away from the sound source.
- Terminate the survey if any marine mammals, seabirds or turtles 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.
- For the months of June and November ensure that Passive Acoustic Monitoring (PAM) is incorporated into any survey programme.
- Record incidences of encounters with marine life (mammals, seabirds, turtles, seals, fish) their behaviour and response to seismic survey activity. Ensure that MMSOs compile a survey close-out report incorporating all recorded data to the relevant DFFE authorities.
- Vessel transit speed not to exceed 12 knots (22 km/hr), except within 25 km of the coast where it should be kept to less than 10 knots (18 km/hr), as well as when sensitive marine fauna are present in the vicinity.
- Prospect outside of fishing seasons, i.e., August – December (avoiding the small pelagic fishing during January-July and snoek line fishing peak during April- May).

Best Practice Mitigation (Recommended):

- Planning and management of potential discharges to ensure that tailings are not discarded onto potentially sensitive habitats;
- Inform & empower all staff about sensitive marine species & suitable disposal of waste;
- Ensure compliance with relevant MARPOL standards;
- Develop a waste management plan using waste hierarchy;
- A Shipboard Oil Pollution Emergency Plan (SOPEP) must be prepared for all vessels and should be in place at all times during operations;
- Deck drainage should be routed to a separate drainage system (oily water catchment system) for treatment to ensure compliance with MARPOL (15 ppm);
- All process areas should be bunded to ensure drainage water flows into the closed drainage system;
- Drip trays should be used to collect run-off from equipment that is not contained within bunded areas, and the contents routed to the closed drainage system;
- Low-toxicity biodegradable detergents should be used in the cleaning of all deck spillages;

- All hydraulic systems should be adequately maintained, and hydraulic hoses should be frequently inspected;
- Spill management training should be provided, and crew members made aware of the need for thorough cleaning-up of any spillages immediately after they occur in order to minimise the volume of contaminants washing off decks; and
- Prior to survey commencement, key stakeholders (Potentially affected Fishing Industry Associations, organs of state and neighbouring concession holders) should be consulted and informed of the proposed survey activity and the likely implications thereof.

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GLOSSARY

Amphipod/a	Crustaceans with no carapace and a laterally compressed body
Anthropogenic	Environmental pollution originating from human activity
Baseline	Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured.
Benthic	Pertaining to the environment inhabited by organisms living on or in the ocean bottom
Benthic/benthos	The ecological region at the lowest level of a body of water such as an ocean, lake, or stream, including the sediment surface and some sub-surface layers
Biodiversity	The variability among living organisms from all terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems.
Biomass	The mass of living biological organisms in a given area or ecosystem.
Biota	Living organisms within a habitat or region
Bryozoan	A sedentary aquatic invertebrate of the phylum Bryozoa, which comprises the moss animals.
Chlorophyll a	A green pigment, present in all green plants (including algae) and cyanobacteria, which is responsible for the absorption of light to provide energy for photosynthesis.
Community	In ecology, a community is a group or association of populations of two or more different species occupying the same geographical area and in a particular time.
Community composition	The number of species in that community and their relative numbers.
Crustacea/n	Generally differ from other arthropods in having two pairs of appendages (antennules and antennae) in front of the mouth and paired appendages near the mouth that function as jaws.
Cumulative impacts	Direct and indirect impacts that act together with current or future potential impacts of other activities or proposed activities in the area/region that affect the same resources and/or receptors.
Diatoms	A type of phytoplankton group that form a silica-based cell wall.
Dinoflagellate	A type of flagellate phytoplankton. Some produce toxins that can accumulate in shellfish, resulting in poisoning when eaten.
Ecological function	The potential of an ecosystem to deliver a service that is itself dependent on ecological processes and structures.
Ecology	The relations of organisms to one another and to their physical surroundings.
Environment	The external circumstances, conditions and objects that affect the existence of an individual, organism or group. These circumstances include biophysical, social, economic, historical and cultural aspects.
Faunal community	A naturally occurring group of native animals that interact in a unique habitat.
Filter feeding	(Off an aquatic animal) feeding by filtering out plankton or nutrients suspended in the water.
Geomorphology/ical	Relating to the physical features of the surface of the earth and their relation to its geological structures.
Impact	A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.

Important Bird and Biodiversity Area	An area identified using an internationally agreed set of criteria as being globally important for the conservation of bird populations.
Invertebrate	An animal without a backbone (e.g., a starfish, crab, or worm)
Isopod/a	An order of freshwater, marine, or terrestrial crustaceans of the order or suborder Isopoda, with seven pairs of legs and a dorsoventrally flattened body.
Macrofauna	Animals larger than 0.5 mm.
Macrophyte	An aquatic plant large enough to be seen by the naked eye.
Mean Sea Level	An average level of the surface of the oceans from which heights such as elevation may be measured. MSL is a type of vertical datum (a standardised geodetic datum).
Megafauna	Large marine species such as sharks, rays, marine mammals and turtles. These animals are key components of marine ecosystems but, as they are long-lived and have low reproductive rates, their populations are usually the first to be reduced by human pressures.
Mitigation measures	Design or management measures that are intended to minimise or enhance an impact, depending on the desired effect. These measures are ideally incorporated into a design at an early stage.
Mollusc/a	Invertebrate with a soft unsegmented body and often a shell, secreted by the mantle.
Operational phase	The stage of the works following the Construction Phase, during which the development will function or be used as anticipated in the Environmental Authorisation.
Physico-chemical	Dependent on the joint action of both physical and chemical processes.
Phytoplankton	Ocean dwelling microalgae that contain chlorophyll and require sunlight in order to live and grow.
Plankton	Organisms drifting in oceans, seas, and bodies of fresh water. The word zooplankton is derived from the Greek zoon, meaning "animal", and planktos, meaning "wanderer" or "drifter". Typically comprised of phytoplankton and zooplankton, as well as the eggs, larvae and juveniles of larger animals.
Polychaete/a	Also known as the bristle worms. A paraphyletic class of annelid worms, generally marine. Each body segment has a pair of fleshy protrusions called parapodia that bear many bristles, called chaetae, which are made of chitin.
Specialist study	A study into a particular aspect of the environment, undertaken by an expert in that discipline.
Species	A category of biological classification ranking immediately below the genus, grouping related organisms. A species is identified by a two-part name; the name of the genus followed by a Latin or Latinised un-capitalised noun.
Species richness	The number of different species represented in an ecological community. It is simply a count of species and does not take into account the abundance of species.

LIST OF ABBREVIATIONS

Anchor/ AEC	Anchor Environmental Consultants (Pty) Ltd.
BCS	Benguela Current System
CBD	Convention on Biological Diversity
CPUE	Catch per unit effort
DFFE	Department of forestry, fisheries and the Environment (Formerly DEFF and DAFF)
DIN	Dissolved Inorganic Nitrogen
DMR	Department of Mineral Resources
DO	Dissolved Oxygen
EBSA	Ecologically or Biologically Significant Area
EEZ	Exclusive Economic Zone
FLO	Fisheries Liaison Officer
IBA	Important Bird and Biodiversity Area
IEM	Integrated Environmental Management
IUCN	International Union for Conservation of Nature
LMP	Linefish Management Protocol
MARPOL	The International Convention for the Prevention of Pollution from Ships
MBES	Multi Beam Echo Sounder
MMI	Marine Mammal Institute
MMSO	Marine Mammal and Seabird Observer
MMO	Marine Mammal Observer
MPA	Marine Protected Area
MPRDA	Mineral and Petroleum Resources Development Act (Act 28 of 2002, as amended)
MSL	Mean Sea Level
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act No. 107 of 1998, as amended
NH3-N	Ammonia
OMP	Operational Management Plan
PAM	Passive Acoustic Monitoring
PNE	Protected Natural Environment
PSU	Ocean salinity is generally defined as the salt concentration in sea water. It is measured in unit of PSU (Practical Salinity Unit), which is a unit based on the properties of sea water conductivity. It is equivalent to per thousand or (o/00) or to g/kg.
PTS	Permanent threshold shift
RQO	Resource Quality Objectives
ROV	Remotely Operated Vehicle
SADCO	Southern African Data Centre for Oceanography
SAMLMA	South African Marine Linefish Management Association
SAMSA	South African Maritime Safety Authority
SANBI	South African National Biodiversity Institute
SAPFIA	South African Pelagic Fishing Industry Association
SBP	Sub-bottom profiler

SOPEP	Shipboard Oil Pollution Emergency Plan
TAC	Total allowable catch
TAD	Trans Atlantic Diamonds (Pty) Ltd
TAE	Total allowable effort
TSS	Total Suspended Solids
TTS	Temporary threshold shift
VHF	Very High Frequency

1 INTRODUCTION

Trans Atlantic Diamonds (Pty) Ltd (hereafter referred to as TAD) is applying for a prospecting right for Concession Area 14C, offshore of the Western Cape coast. Anchor Environmental Consultants (Pty) Ltd (AEC) were appointed as the Environmental Assessment Practitioner (EAP) to undertake the required Basic Assessment Process and support TAD with this application. AEC has inhouse marine and fisheries specialist expertise and also undertook the Marine Specialist Impact Assessment Study.

1.1 Terms of Reference

This Marine Specialist Study was required to identify and assess potential impacts that the proposed prospecting activities could have on the marine environment and other user groups. The Terms of Reference included requirements for the following:

- A project description adequate for the purposes of the marine impact assessment study;
- A description of the marine ecology within and surrounding the affected area;
- The identification and description of potentially sensitive habitats and species receptors of impacts (e.g. endangered, threatened and protected species, important feeding, breeding or migration routes, sensitive habitats, etc.);
- The identification of other user groups and potential user conflict based on area of overlap and regional importance of the concession area (including fisheries, commercial and recreational vessel traffic, other marine mining activities);
- The identification of potential direct, indirect and cumulative impacts resulting from the proposed prospecting activities;
- An assessment of identified impacts and cumulative impacts using an objective, and consistent methodology that meets the National South African legislative requirements (National Environmental Management Act No. 107 of 1998, as amended); and
- The identification of mitigation measures to avoid/minimise/reduce impacts and enhance benefits.

1.2 Diamond mining in South Africa

1.2.1 Background

The first discovery of diamonds originating from marine deposits was in 1908 on the Namibian coastline near Lüderitz (Levinson 1983; Penney *et al.* 2007). This led to the discovery of vast diamond deposits along the west coast of southern Africa; extending from Hottentot Bay (Namibia) in the north, southwards to the Olifants River in South Africa (Gurney *et al.* 1991; Penney *et al.* 2007). The primary source of diamonds is kimberlite – igneous intrusions or “pipes” projecting through the Earth’s crust (Gurney *et al.* 1991; Penney *et al.* 2007). These diamondiferous kimberlites have been eroded extensively since their formation and diamonds have been exposed to various transport mechanisms. Sediment transportation from kimberlites in the interior part of Southern Africa is largely confined to the Orange River drainage system (Dingle & Hendry 1984). For the past 80 million years, sediment has been transported from the continental interior to the Atlantic Ocean via two main river courses; the Orange and Olifants River (Gurney *et al.* 1991). These rivers are believed to be the major westward

transport mechanisms responsible for deposition of diamondiferous sediments along the west coast of Southern Africa and southern Namibia (Gurney et al.1991; Penney et al. 2007). Some diamonds were deposited in gravel terraces along riverbanks, but the majority were carried down to the coast and deposited in the sea. With the influence of currents, swell and tidal action, diamonds gradually accumulated on gravel beaches along the coast (Penney et al. 2007). Today, these deposits extend from the coast down to 150 m depth (approximately 50–60 km offshore) where they are found in gullies and potholes which have been covered with sediment over time. It is this marine diamondiferous gravel which is of interest to the modern marine diamond mining industry (Penney et al. 2007).

The inshore portion of Sea Concession 14C will likely host diamonds and other heavy minerals in bedrock depressions, palaeo-channels and wave-cut platforms on the Precambrian inner shelf bedrock surface. The offshore portion of Concession 14C will likely be typified by storm lag beach deposits at various sea levels below current sea level that are known to contain mineralised gravels containing diamonds and other heavy minerals and metals. These favourable mineralised sea silt sand levels have been well documented in various other (C) concessions along the South African west coast. Years of erosion and natural forces (wind, rain, water currents) wash gemstones and other valuable minerals from their primary deposits in kimberlite pipes to beaches where they are typically deposited. TAD intends to undertake geophysical exploration (seismic survey) and sampling to detect the presence of Paleo-beach deposits, which are known from other concessions to contain diamondiferous gravels and precious metals, at different submerged sea levels.

1.2.2 Marine Concession Areas in South Africa

Diamond-mining concession areas in South Africa are grouped into three categories: Land, Surf-Zone and Marine (offshore) Concession Areas (Figure 1; Clark *et al.* 1999; Penney *et al.* 2007). The Land and Surf-Zone concessions areas are considered as “onshore mining” operations with mines located between the Orange River mouth and slightly south of the Olifants River in South Africa. While most of the diamond production in South Africa are large-scale land-based mining operations, marine and coastal diamond mining operations are rapidly increasing.

Marine Concession Areas are those allocated offshore and extend southwards from the border of Namibia to an area just south of Saldanha Bay (Clark *et al.* 1999). These concession areas are further divided into four sub-areas (Figure 1 and Figure 2): the A concession extends 31.5 m west of the low-water mark to 1000 m west of the high water mark, the B concession extends from this boundary to 5 000 m west of the high water mark offshore from the western boundary of A, the C concession extends westward of this point to the 200 m isobaths, and the D concession extends offshore to the 500 m isobath. Diamond mining concession areas in South Africa were mapped according to their licence (Figure 2). The exploration, prospecting and mining rights allocations (prior to 2018) are indicated in the inset map in Figure 2.

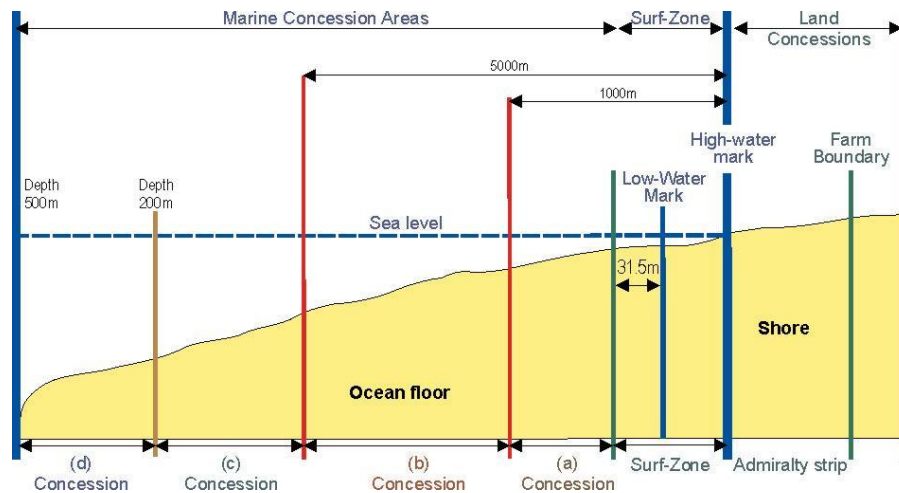


Figure 1 Diagram of the onshore and offshore boundaries of the South African marine diamond mining concession areas (from Penney *et al.* 2007)

A range of different techniques are used to access diamond resources in the marine environment. Typical onshore operators in the coastal environment use cofferdam and seawall mining techniques. Other methods for accessing resources in shallow subtidal gullies and small bays include, depending on the depth of the resource and access to the shoreline, shore and boat-based diving operations. Lastly, diamond mining operations also occur in the offshore environment where tools such as crawlers and drilling rigs are deployed from vessels to extract diamond-rich gravel from the seafloor.

1.3 Description of the proposed activity

The proposed prospecting programme will be completed within 5 years and includes a combination of non-invasive and invasive activities. The non-invasive activities are mostly related to geophysical exploration, data acquisition and analysis. The invasive activities are those related to sampling (collection of drill, core and grab samples). Should a prospecting right be approved, it will allow TAD to determine if diamond mining within concession area 14C is economically viable. It is understood that the Prospecting Right will not provide the required environmental authorisation for mining activities to be undertaken. As such, any future intention to undertake mining within the application area would require a further application, specialist investigation and public consultation process.

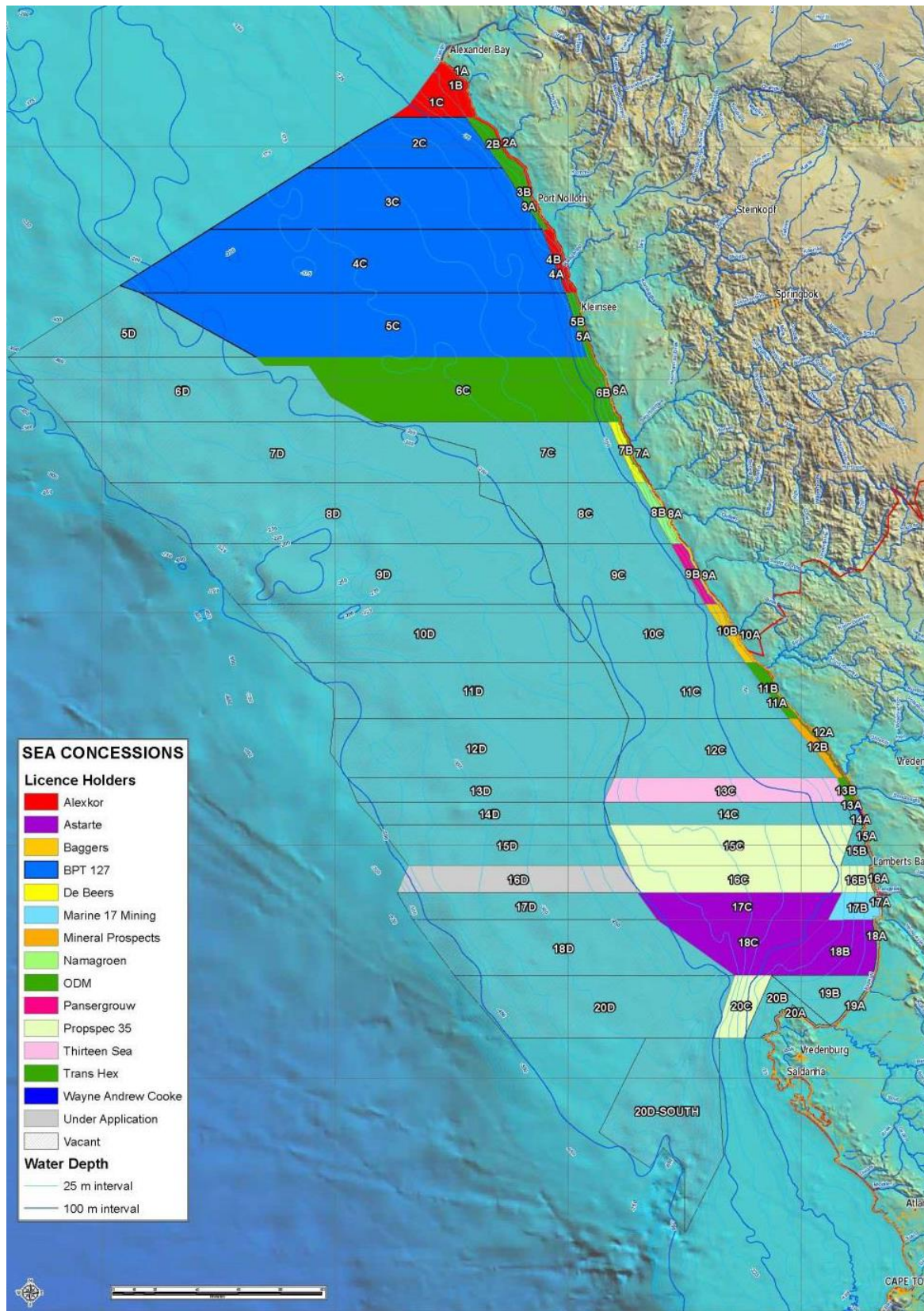


Figure 2 The offshore diamond mining lease areas in South African waters. The coastal shelf waters have been divided into 20 contiguous, parallel strips which have been further subdivided into the onshore and offshore concession areas (A, B, C, D).

1.3.1 Concession 14C

TAD is applying for a Prospecting Right to undertake geophysical surveying and sampling to target (potentially) diamondiferous and gemstone deposits in addition to other heavy minerals, industrial minerals, precious metals, as well as ferrous and base metals that may exist within Sea Area 14C, in terms of the Mineral and Petroleum Resources Development Act (Act 28 of 2002, as amended) (MPRDA).

The application area is Sea Area 14C (i.e., Concession 14C) and is an area of sea covering 106 100 ha offshore of the Western Cape coast of South Africa. It is situated approximately 30 km west and offshore of Doringbaai (Figure 3). The area stretches from just south of Strandfontein to around 25 km north of Lamberts Bay. The inshore boundary of this concession area is located approximately 5 km offshore and the outer boundary is about 100 km offshore. Water depth across the concession area ranges from approximately 67 m to 202 m (Figure 4).

1.3.2 Geophysical/Seismic Exploration

It is proposed that geophysical surveying be conducted using a dedicated survey vessel with a hull-mounted multibeam echo sounder (MBES) and Topas sub-bottom profiler system designed to collect high-resolution acoustic data along lines 100 m to 1000 m apart, throughout the concession area. The use of this geophysical survey equipment allows the operator to produce a digital terrain model of the seafloor. These findings will ultimately allow the applicant to identify prospecting targets within the concession area and would also provide an indication of what drilling method should be used. Further to this, geophysical survey results would also enable the identification of potentially sensitive benthic habitats, therefore providing an opportunity to minimize any anticipated environmental impacts.

The MBES provides depth sounding information on either side of the vessel's track across a swath width of approximately two times the water depth, while the Topas sub-bottom profiler generates profiles up to 60 m beneath the seafloor, thereby giving a cross section view of the sediment layers. The source sound level of the MBES is variable but will be a maximum of 221dB re 1 μ Pa @ 1m, with a frequency range of between 200 and 400 kHz. The sub-bottom profiler (Topas system) uses shallow (35 to 45 kHz) and medium penetration (1 to 10 kHz) "Chirp" seismic pulses. This equipment has a variable power output and can therefore have the power ramped up in accordance with survey requirements and be contained within acceptable environmental noise levels. As a result, it is also capable of "soft starts". The use of a magnetometer to detect magnetic signatures will also be required.

Low frequency seismic sources travel the greatest distance in the marine environment. Conversely, high frequency sources have greater attenuation over distance. Due to the higher frequency emissions of the MBES equipment, noise levels tend to dissipate over a relatively short distance, whereas the mid-frequency Topas chirp system will generate noise that will travel a greater distance. The acoustic footprint of the intended survey equipment is much lower than that of airgun arrays. It should be noted that a decibel is a logarithmic scale for noise where each unit of increase represents a tenfold increase in the quantity being measured.

TAD will be using the IMD SA survey vessel DP Star to conduct the geophysical acoustic surveys. This vessel is regularly used for similar survey work along the west coast of southern Africa. This type of survey typically does not require the vessel to tow any cables, however, it will be “restricted in its ability to manoeuvre” during the survey due to the operational nature of this work. Geophysical surveying will be undertaken over a two-month period of suitable, calm sea and weather conditions (the survey speed of the DP Star is typically 100 km/day). The bathymetry of 14C will be modelled using processed seismic survey data before sampling can take place – it is estimated that this would take approximately one month.

1.3.3 Sampling activities

Sampling will be undertaken in targeted areas identified through the analysis of the acoustic survey data. Four potential methods of collecting geophysical samples from the seabed are being considered. A Van Veen grab with a sampling capacity of approximately 50 kg will be used to collect baseline environmental data on sediment and benthic macrofauna at 20-50 sites. Total volume of the grab is 0.03 m³ and it will disturb an area covering approximately 0.1 m². The total area expected to be disturbed by the Van Veen grab will be approximately 5m².

Geotechnical samples to assist in understanding the sea floor geology and resource evaluation will be collected at 100-200 sites using either vibracoring, gravity coring or sonic coring. The latter is an advanced form of drilling that employs high-frequency, resonant energy generated inside the Sonic head to advance a core barrel or casing into subsurface formations, i.e., can penetrate some subsurface rock, whilst gravity and vibracoring can only sample unconsolidated material. The diameter of core samples will be approximately 10 cm, the corers will penetrate to depths of 3–8 m and the material brought to the surface for analysis. The volume per core is calculated at 0.24 m³. The total volume for the 200 cores is calculated at 4.71 m³. The 200 cores will cover a total surface area of 1.57 m², although the core might impact a surface area slightly larger than this. The area over which the coring will span is 106 001 ha. The core samples do not require onboard processing (i.e. no sediment spill in the ocean) as all material collected will remain intact within core tubes which are to be analysed on land.

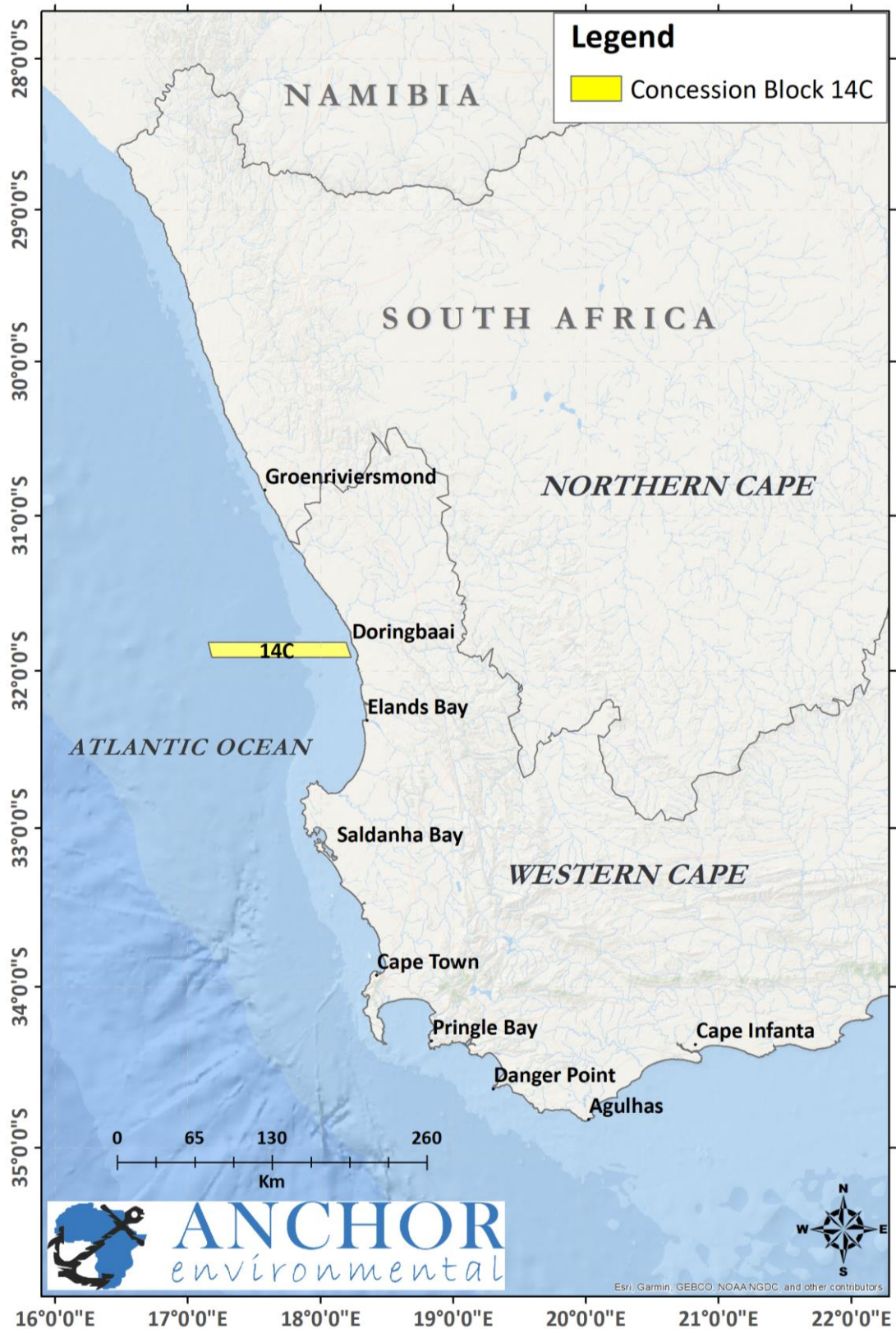


Figure 3 Location of the concession area 14C off the Western Cape Coast. The inshore boundary of this concession area is located approximately 5 km offshore and the outer boundary is about 100 km offshore.

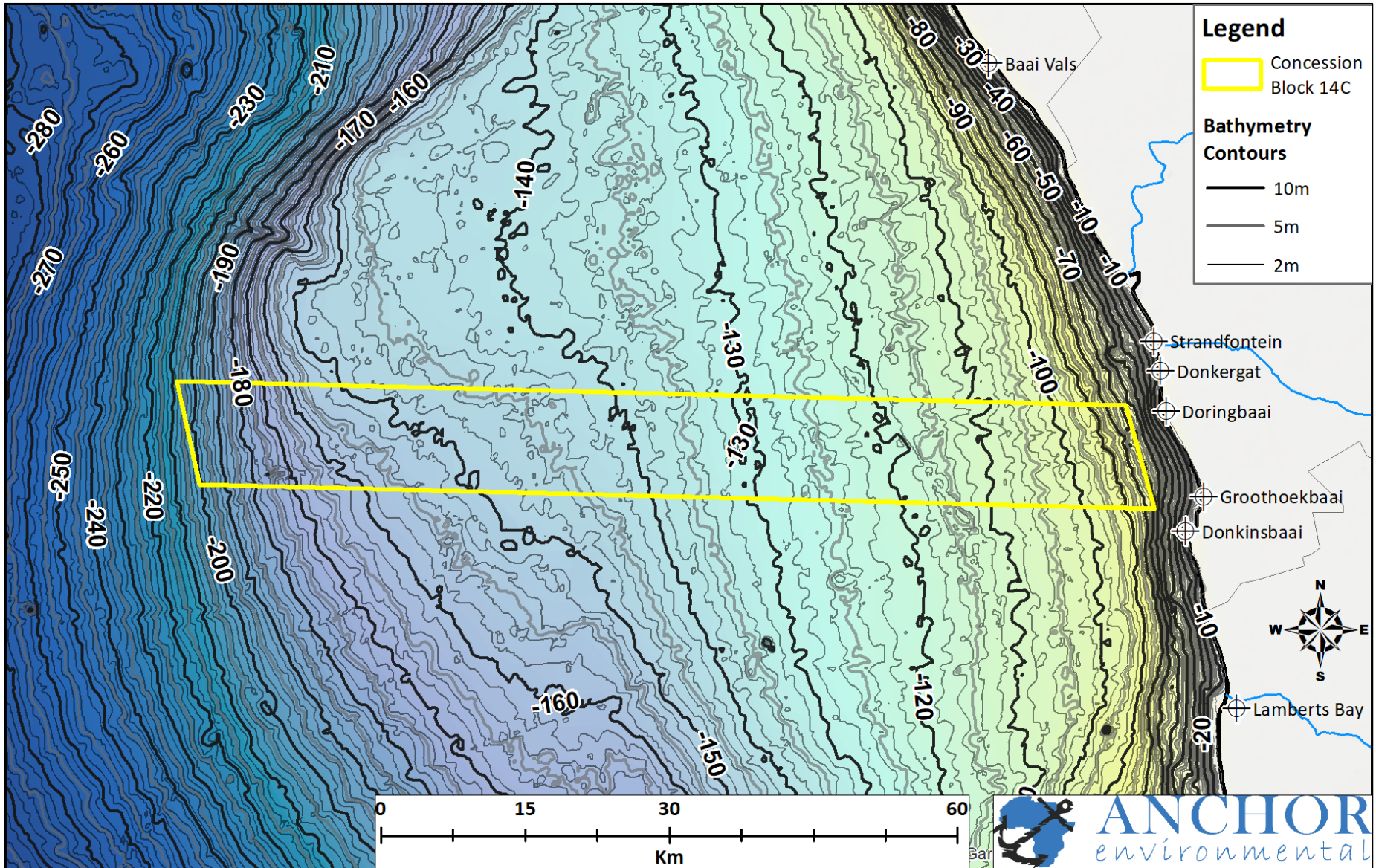


Figure 4 Sea concession 14C off the Western Cape Coast with bathymetry (at 2 m intervals).

2 DESCRIPTION OF THE AFFECTED ENVIRONMENT

2.1 Regional oceanography

The Benguela system is influenced predominantly by the wind-driven upwelling of deep nutrient rich water close to the coast. Wind is the primary driver of life in the system, strongly influencing both water temperature and inorganic nutrient levels, and in turn, primary production. The prevailing south-easterly winds displace surface water offshore during the summer, and cause cold, nutrient rich water to rise from deeper water masses to replace this surface water. These upwelling events are the trigger for minimum temperatures and maximum nutrient levels (Branch and Griffiths 1988). The oceanic primary producers, phytoplankton, bloom when upwelled inorganic nutrients become available for photosynthesis in the presence of sunlight. These are consumed by zooplankton, which are in turn consumed by small pelagic fish species, such as anchovy and sardine. The Benguela is one of the world's most productive systems, supporting rich fishing grounds and attracting large colonies of sea birds and seals (Branch 1981).

The West Coast is subject to semi-diurnal tides, with each successive high (and low) tide separated by 12 hours. Spring tides occur once a fortnight during full and new moons. Tidal activity greatly influences the biological cycles (feeding, breeding and movement) of intertidal marine organisms, and has an influence on when people visit the coastline to partake in various activities such as bathing and the harvesting of marine resources. The tidal variation on the West Coast usually ranges between 0.28 m (relative to the chart datum) at mean low water springs and 1.91 m at mean high water springs, with the lowest and highest astronomical tide being 0.056 m and 2.25 m, respectively.

The west coast of South Africa typically experiences high wave energy and is dominated by south-westerly swells with a long fetch and a period of 10 to 15 seconds (Branch and Griffiths 1988). Southerly and south-westerly waves frequently exceed 2 m (Figure 5 and Figure 6). The predominant SW swell direction in this area results in a northward-flowing littoral current that runs parallel to the coast (MacDonald and Rozendaal 1995). The average water temperature during the summer months is cool due to upwelling (approximately 11°C) and slightly warmer during downwelling events, which are caused by westerly winds or occasional Benguela Niños when unseasonal westerly winds result in a breakdown of the upwelling front with movement of warm oceanic water towards the coast (Laird and Clark 2018).

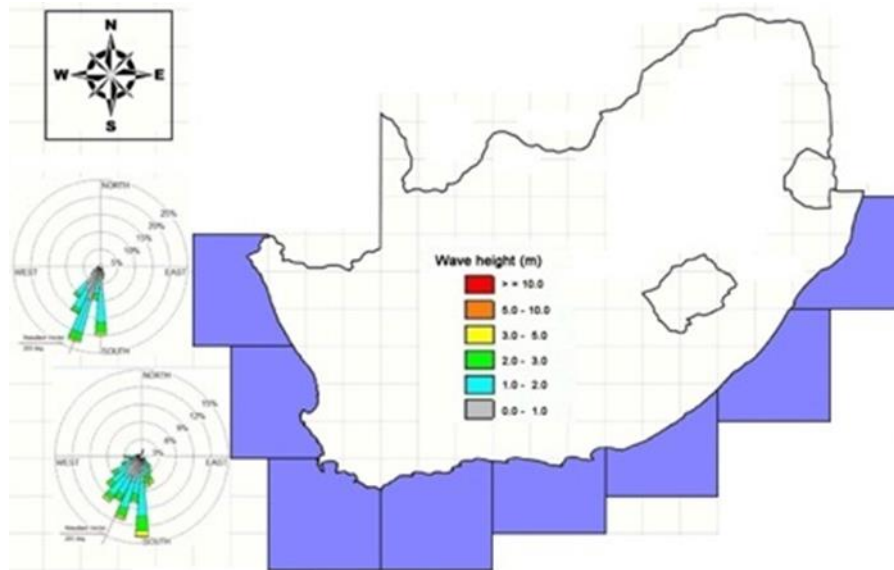


Figure 5 Wave roses showing the frequency of significant wave heights and direction on the West Coast (Source: SADC Voluntary Observing Ships data).

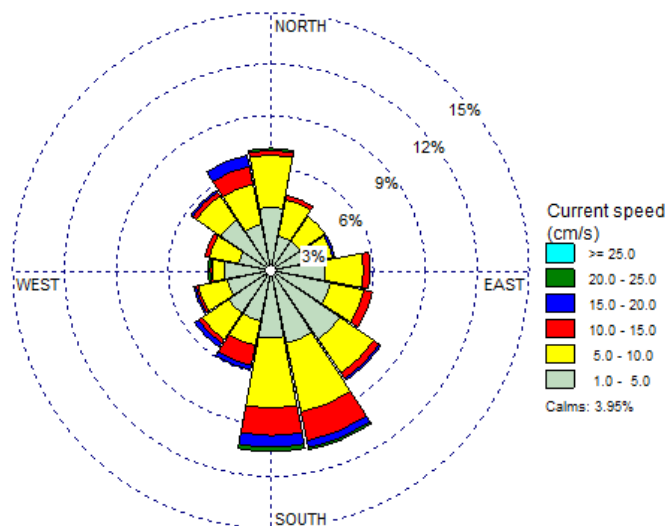


Figure 6 Current rose showing current direction and strength data at -12 m water depth approximately 15 km north of the Olifants River Mouth (inshore and south of concession area 14C). (Source: Laird and Clark 2018).

2.2 Biogeography

Concession Area 14C is positioned in the southern section of the Benguela Current System (BCS), which extends along the west coast of southern Africa between Cape Agulhas and Angola. The area spans the Namaqua inner shelf and Southern Benguela outer shelf ecozones, which is nested within the Southern Benguela Ecoregion as defined by Sink *et al.* (2012) (Figure 7).

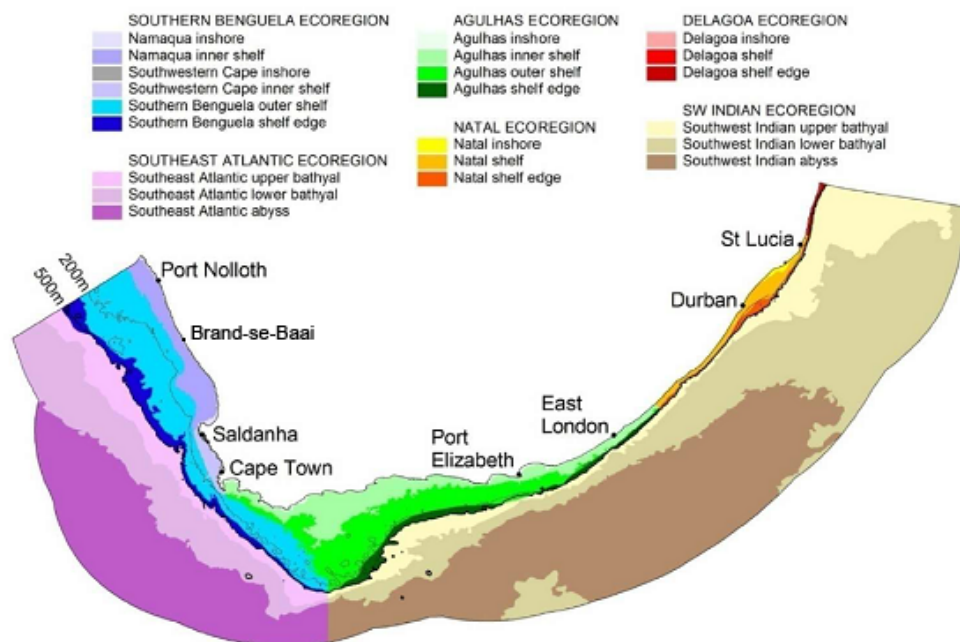


Figure 7 Six marine ecoregions with 22 ecozones incorporating biogeographic and depth divisions in the South African marine environment as defined by Sink *et al.* (2012).

2.3 Ecology

As discussed above, wind-driven coastal upwelling is the predominant physical driver that shapes the high levels of biological productivity in the southern Benguela, providing nutrients for primary producers, and food for diverse fauna, such as pelagic (pilchards, anchovy) and demersal (hakes, kingklip) fish stocks, near shore fisheries (linefish, rock lobster), mammals (seals and whales) and seabirds (penguins, gannets, cormorants etc.). There are three broad marine habitats within or adjacent to the 14C Concession Area. These include sandy benthic habitat, rocky reefs and the water column or pelagic habitat.

2.3.1 Subtidal sandy benthic habitat

Fauna and flora that inhabit the surfaces of subtidal sand are called benthic epifauna, while those that burrow or dig into the soft sediments are called benthic infauna (Castro and Huber 1997). The distribution of infauna and the depth at which organisms can live in the substrate is largely dependent on sediment particle size. More porous, larger grained substrates allow for greater water circulation through the sediment, thereby replenishing the oxygen that is used up during the decomposition processes.

Much of the benthic infauna on the west coast of South Africa are deposit feeders (e.g., worms), which either ingest sediments and extract organic matter trapped between the grains, or actively collect organic matter and detritus (Castro and Huber 1997). Suspension feeders eat drifting detritus and plankton from the water column (e.g., seapens and some species of crabs), while filter feeders actively pump and filter water to extract suspended particles (e.g., bivalves and some species of amphipods and polychaetes). Predators in soft bottom habitats either burrow through sediments or catch their

prey on the surface (Castro and Huber 1997). Most bottom-dwelling fish in soft bottom habitats are predators that scoop up prey (e.g., rays and skates), while flat fish (e.g., monk fish and sole) lie camouflaged on the bottom. Predators such as crabs, hermit crabs, lobsters and octopuses, which inhabit rocky areas, may move to sandy benthos to feed (Castro and Huber 1997). Similarly, reef-associated fish also rely on sandy substrate for food. Macrofauna living within benthic substrata play an important role in the reworking of sediments. These organisms assist in promoting the exchange of oxygen and nutrients within the substrate by enhancing sediment porosity. Macrofaunal communities also provide an important food source for fish and other invertebrate species.

Benthic macrofauna are the biotic component most frequently monitored to detect changes in the health of a marine environment as they are short-lived, and their community composition responds rapidly to environmental change (Warwick 1993). They also tend to be directly affected by pollution, are easy to sample quantitatively, and are scientifically well-studied compared to other sediment-dwelling components. Anthropogenic physical disturbance will negatively affect benthic macrofauna and is likely to result in the proliferation of opportunistic pioneer species following a disturbance event. Harmer *et al.* (2013) showed that polychaetes are generally most abundant, followed by amphipods and gastropods. The soft sediment infauna of the Namaqua inner shelf ecozone of the west coast of South Africa is moderately well studied. Benthic sampling undertaken by Anchor Environmental Consultants in concessions 1B, 1C and 2C (similar depth range and biogeographical zone as 14C) yielded a benthic macrofaunal community consisting of 45 species with an average biomass of 85.9 g/m² (1B), 31.8 g/m² (1C) and 38.9 g/m² (2C) respectively (Mostert *et al.* 2016 and Biccard *et al.* 2020a). This is much lower than the diversity and biomass of macrofaunal communities found in the shallower, sheltered and retentive bays along the west coast (diversity: >150 species; biomass: St. Helena Bay = 846.53 g/m², Saldanha = 970.78 g/m²) (Biccard *et al.* 2020c; Clark *et al.* 2020). Available evidence suggests that the macrofaunal communities of Concession 14C are more similar to those found in the offshore, open coast areas such as 1C and 2C than the sheltered, productive west coast bays, but this will be confirmed during the proposed baseline sampling.

2.3.2 Offshore rocky reefs

The offshore environment is divided into six areas: the inner and outer shelf, the shelf edge, the upper and lower bathyal zones, and the abyssal zone. According to the National Biodiversity Assessment (NBA), offshore benthic habitat types include six broad ecosystem groups: rocky shelf, rocky shelf edge, seamounts and unconsolidated shelf, unconsolidated shelf edge and deep-sea sediments (Sink *et al.* 2012). Concession 14C lies within what is mostly classified as sandy inner shelf habitat interspersed with rocky outcrops (Figure 8). The sandy inner shelf habitat type has the greatest extent within our Exclusive Economic Zone (EEZ), with muddy, gravel and mixed sediment habitat types constituting smaller areas (Sink *et al.* 2012). These offshore rocky reefs are colonised by a range of epifauna including bryozoans, encrusting and upright sponges, solitary and colonial ascidians, sea anemones and cold-water coral colonies – the latter being slow-growing and taking many years to become established (Biccard *et al.*, 2020b). Studies undertaking assessments of prospecting and mining-related impacts on these habitats in this region are relatively new and the time taken for disturbed epifaunal communities inhabiting offshore rocky reefs to recover has not yet been determined (Biccard *et al.*, 2020b).

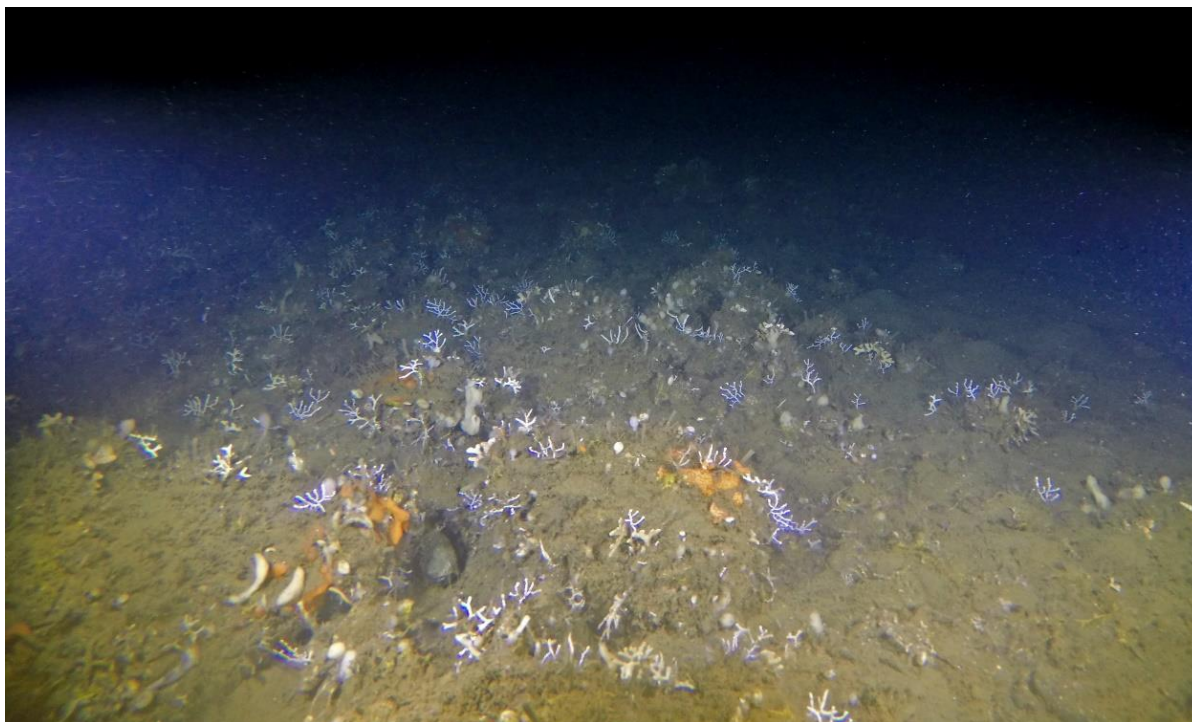


Figure 8 A typical hard-bottom inner shelf benthic habitat off the west coast of South Africa consisting of both epifauna and infauna. Source: Anchor Environmental.

These offshore reefs within Concession area 14C should be visually assessed (by means of drop camera deployments or remotely operated underwater vehicle) during the baseline environmental survey with regular repeat surveys following mining operations in the area – offshore reefs may not be directly impacted (mined) but are at risk of being indirectly impacted by tailings disposal.

2.3.3 Pelagic habitat

This habitat type constitutes the largest of all habitats and is loosely defined as the water column of the open ocean, which can be further divided into regions by depth. Pelagic communities are largely defined by the physical properties of the water column. Main physical drivers include temperature, turbidity, dissolved oxygen, nutrient levels and light. These parameters vary with depth and play a large role in shaping the structure of pelagic communities. The major oceanic currents on the east and west coast of South Africa differ in terms of these parameters, and as such, harbour different pelagic communities. Where the Agulhas and Benguela current meet, off the southern coast of South Africa, these different communities merge and interact over several hundred kilometres resulting in rich pelagic biodiversity. In contrast to demersal and benthic biota that are associated with the seabed, pelagic species live and feed in the open water column. Pelagic communities are divided into plankton and fish, and their main predators, seabirds, marine mammals (seals, dolphins and whales) and turtles.

2.3.3.1 Planktonic communities

The ecology of the open water pelagic habitat within Concession 14C is typical of the Benguela upwelling region and the Namaqua inshore ecozone. Pulsed inputs of nutrients (nitrates, phosphates

and silicates) due to wind driven upwelling result in high primary productivity with phytoplankton communities dominated by dinoflagellates and diatoms. Phytoplankton are consumed by a variety of zooplankton that typically consist of crustacean copepods, euphausiids, mysids and a myriad of eggs and larvae from almost all marine phyla. For example, ichthyoplankton in the southern Benguela are composed mainly of small pelagic anchovy and sardine fish eggs and larvae, with some hakes and mackerel (Shannon and Pillar 1986). Zooplankton are in turn the food source for large numbers of small pelagic fish, particularly sardine *Sardinops sagax*, anchovy *Engraulis encrasicolus*, red eye round herring *Etrumeus whiteheadi* and maasbanker, *Trachurus capensis*. These small pelagic fish exert a controlling influence on the abundance of both their zooplankton prey and their predators that include commercially important fish species such as snoek *Thyristes atun*, yellowtail *Seriola lalandi* and hake *Merluccius* sp. (Cury *et al.* 2000; Shannon *et al.* 2020).

2.3.3.2 Seabirds

Fourteen species of seabirds breed in southern Africa; Cape Gannet, African Penguin, four species of Cormorant, White Pelican, three Gull and four Tern species (Table 1). Species listed as endangered on the IUCN red data list include the African penguin, Cape cormorant and the bank cormorant. Breeding areas are distributed around the coast with islands being particularly important. The number of successfully breeding birds at each breeding site varies with the abundance of food. Most of the breeding seabird species forage for small pelagic fish at sea with most birds being found relatively close inshore (within 30 km of the coast). Of the diving birds that occur along the coast, only *Morus capensis*, the Cape gannet, regularly feeds from the inshore environment as far as 100 km offshore and African penguins have also been recorded as far as 60 km offshore. Most of the species listed here are likely to be encountered in concession 14C (the inner margin is located only 5 km offshore - Figure 3 and Figure 4).

Table 1 Breeding seabirds present on the west coast of South Africa (adapted from Pulfrich 2021).

Common name	Species name	Global IUCN Status
African Penguin	<i>Spheniscus demersus</i>	Endangered
Great Cormorant	<i>Phalacrocorax carbo</i>	Least Concern
Cape Cormorant	<i>Phalacrocorax capensis</i>	Endangered
Bank Cormorant	<i>Phalacrocorax neglectus</i>	Endangered
Crowned Cormorant	<i>Phalacrocorax coronatus</i>	Near Threatened
White Pelican	<i>Pelecanus onocrotalus</i>	Least Concern
Cape Gannet	<i>Morus capensis</i>	Vulnerable
Kelp Gull	<i>Larus dominicanus</i>	Least Concern
Greyheaded Gull	<i>Larus cirrocephalus</i>	Least Concern
Hartlaub's Gull	<i>Larus hartlaubii</i>	Least Concern
Caspian Tern	<i>Hydroprogne caspia</i>	Least Concern
Swift Tern	<i>Sterna bergii</i>	Least Concern
Roseate Tern	<i>Sterna dougallii</i>	Least Concern
Damara Tern	<i>Sterna balaenarum</i>	Near Threatened

Pelagic seabirds such as albatross, petrels and shearwaters are also likely to be encountered in the offshore waters of 14C. A large number of these seabirds are supported by the small pelagic fish stocks of the Benguela system. The area between Cape Point and the Orange River is said to support 38% and 33% of the overall population of pelagic seabirds in winter and summer, respectively (Baker and Arnott 2021). Pelagic seabirds classified as being common in the southern Benguela are listed in Table 2. Species listed as endangered include the black-browed albatross and yellow-nosed albatross. Most of the species in the region reach highest densities offshore of the shelf break (200 – 500 m depth) (Baker and Arnott 2021), mostly offshore of concession 14C.

Table 2 Pelagic seabirds common to the southern Benguela region (Crawford *et al.*, 1991).

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

2.3.3.3 Marine mammals

The marine mammal fauna occurring off the southern African coast includes several species of baleen whales, toothed whales, beaked whales, dolphins and one resident seal species. Based on the available literature we have identified thirty-six marine mammals that may occur in the proposed survey area (Table 3); each of these have been placed into marine mammal hearing groups as per Southall *et al.* (2019). Various research papers and reports were used to ascertain the relative likelihood of occurrence within the proposed survey area – Table 3 (Lane and Carter 1999; Penney *et al.* 2007; Child *et al.* 2016; Biccard *et al.* 2018; Baker and Arnott 2021; Pulfrich 2021). Conservation status from the IUCN (2021) red data list is provided. Of the species listed, the blue whale is considered 'Critically endangered', fin and sei whales are 'Endangered' and two (humpback and sperm

whale) are considered vulnerable (IUCN Red Data list Categories). Altogether 10 species are listed as “data deficient” underlining how little is known about cetaceans, their distribution and population trends. Current information on the distribution, population sizes and trends of most cetacean species occurring on the west coast of southern Africa is lacking (Pulfrich 2021). Our knowledge on the smaller cetaceans that occupy deeper waters is particularly poor and it is recommended that caution be applied when considering possible encounters with cetaceans in the area of interest (Pulfrich 2021). The most abundant baleen whales in the Benguela are humpback whales and southern right whales (Figure 9). During the last decade, the prevalence of both species on the West Coast of South Africa outside of the usual June-November whale season has increased with feeding behaviour observed in upwelling zones off Kommetjie, Saldanha and St Helena Bay (Barense *et al.*, 2011; Mate *et al.*, 2011). Increasing numbers of summer records of both species from the southern half of Namibia suggest that animals may also be feeding in the Lüderitz upwelling cell (NDP unpublished. data) and will therefore occur in or pass through the area of interest (Pulfrich 2021).

Table 3 Marine mammals thought to occur within the proposed survey area. Each species listed has been placed into a marine mammal hearing group as defined by Southall *et al.* 2019. The relative abundance and likelihood of occurrence within the proposed survey area during the survey period in late summer is indicated for each species. Conservation status from the IUCN (2021) red data list is indicated.

Marine Mammal hearing group (Southall <i>et al.</i> 2019)	Species	Shelf/Offshore	Likely encounter frequency in 14C and seasonality in parentheses	IUCN Conservation status
Low frequency cetaceans (Baleen whales) Generalised hearing range: 7 Hz to 35 kHz	<i>Balaenoptera bonaerensis</i> (Antarctic minke whale)	Shelf and offshore	Monthly (winter)	Least concern
	<i>B. acutorostrata</i> (Dwarf minke whale)	Shelf and offshore	Occasional (year-round)	Least concern
	<i>B. physalus</i> (Fin whale)	Shelf and offshore	Occasional (rarely in summer)	Endangered
	<i>B. musculus</i> (Blue whale)	Offshore	Unlikely (seasonality unknown)	Critically Endangered
	<i>B. borealis</i> (Sei whale)	Shelf and offshore	Occasional (winter)	Endangered
	<i>B. brydei</i> (offshore Bryde’s whale)	Shelf and offshore	Occasional (summer)	Not assessed
	<i>B. brydei</i> (<i>subsp.</i>) (inshore Bryde’s whale)	Shelf and offshore	Occasional (year-round)	Vulnerable
	<i>Eubalaena australis</i> (Southern right whale)	Shelf	Daily (year-round, higher in early spring & summer)	Least concern
	<i>Megaptera novaeangliae</i> (Humpback whale)	Shelf and offshore	Daily (year-round, higher in summer)	Vulnerable
High frequency cetaceans (Dolphins, toothed whales, beaked whales) Generalised hearing range: 150 Hz to 160 kHz	<i>Lagenorhynchus obscurus</i> (Dusky dolphin)	Shelf (0-800 m)	Daily (year-round)	Data deficient
	<i>Cephalorhynchus heavisidii</i> (Heaviside’s dolphin)	Shelf (0-200 m)	Daily (year-round)	Near threatened
	<i>Tursiops truncatus</i> (Common bottlenose dolphin)	Shelf and offshore	Monthly (year-round)	Least concern
	<i>Delphinus delphis</i> (Common short beaked dolphin)	Shelf and offshore	Monthly (year-round)	Least concern

Marine Mammal hearing group (Southall <i>et al.</i> 2019)	Species	Shelf/Offshore	Likely encounter frequency in 14C and seasonality in parentheses	IUCN Conservation status
	<i>Lissodelphis peronii</i> (Southern right whale dolphin)	Shelf and offshore	Occasional (year-round)	Least concern
	<i>Stenella coeruleoalba</i> (striped dolphin)	Offshore	Unlikely (unknown)	Least concern
	<i>S. attenuate</i> (Pantropical spotted dolphin)	Shelf edge and offshore	Unlikely (year-round)	Least concern
	<i>Globicephala melas</i> (Long-finned pilot whale)	Shelf edge and offshore	Monthly (year-round)	Least concern
	<i>G. macrorhynchus</i> (Short-finned pilot whale)	Unknown	Unlikely (unknown)	Least concern
	<i>Steno bredanensis</i> (Rough-toothed dolphin)	Unknown	Unlikely (unknown)	Least concern
	<i>Orcinus orca</i> (Killer whale)	Shelf and offshore	Occasional (year-round)	Data deficient
	<i>Pseudorca crassidens</i> (False killer whale)	Shelf and offshore	Monthly (year-round)	Least concern
	<i>Feresa attenuate</i> (Pygmy killer whale)	Offshore	Occasional (unknown)	Least concern
	<i>Grampus griseus</i> (Risso's dolphin)	Shelf edge and offshore	Occasional (unknown)	Least concern
	<i>Kogia breviceps</i> (Pygmy sperm whale)	Shelf edge and offshore	Occasional (year-round)	Data deficient
	<i>K. sima</i> (Dwarf sperm whale)	Shelf edge	Unlikely (unknown)	Data deficient
	<i>Physeter macrocephalus</i> (Sperm whale)	Shelf edge and offshore	Occasional (year-round)	Vulnerable
	<i>Ziphius cavirostris</i> (Cuvier's beaked whale)	Offshore	Occasional (year-round)	Data deficient
	<i>Berardius arnouxii</i> (Arnoux's beaked whale)	Offshore	Occasional (year-round)	Data deficient
	<i>Hyperoodon planifrons</i> (Southern bottlenose beaked whale)	Offshore	Occasional (year-round)	Least concern
	<i>Mesoplodon layardii</i> (Layard's beaked whale)	Offshore	Occasional (year-round)	Data deficient
	<i>M. mirus</i> (True's beaked whale)	Offshore	Unlikely (year-round)	Data deficient
	<i>M. grayi</i> (Gray's beaked whale)	Offshore	Occasional (year-round)	Data deficient
	<i>M. densirostris</i> (Blainville's beaked whale)	Offshore	Unlikely (year-round)	Data deficient
Phocid carnivores in water (PCW)	<i>Mirounga leonine</i> (Southern elephant seal)	Shelf and offshore	Unlikely (unknown)	Least concern
	<i>Hydrurga leptonyx</i> (Leopard seal)	Shelf and offshore	Unlikely (unknown)	Least concern

Marine Mammal hearing group (Southall <i>et al.</i> 2019)	Species	Shelf/Offshore	Likely encounter frequency in 14C and seasonality in parentheses	IUCN Conservation status
Other marine carnivores in water (OCW)	<i>Arctocephalus pusillus</i> (Cape fur seal)	Shelf	Daily (year-round)	Least concern

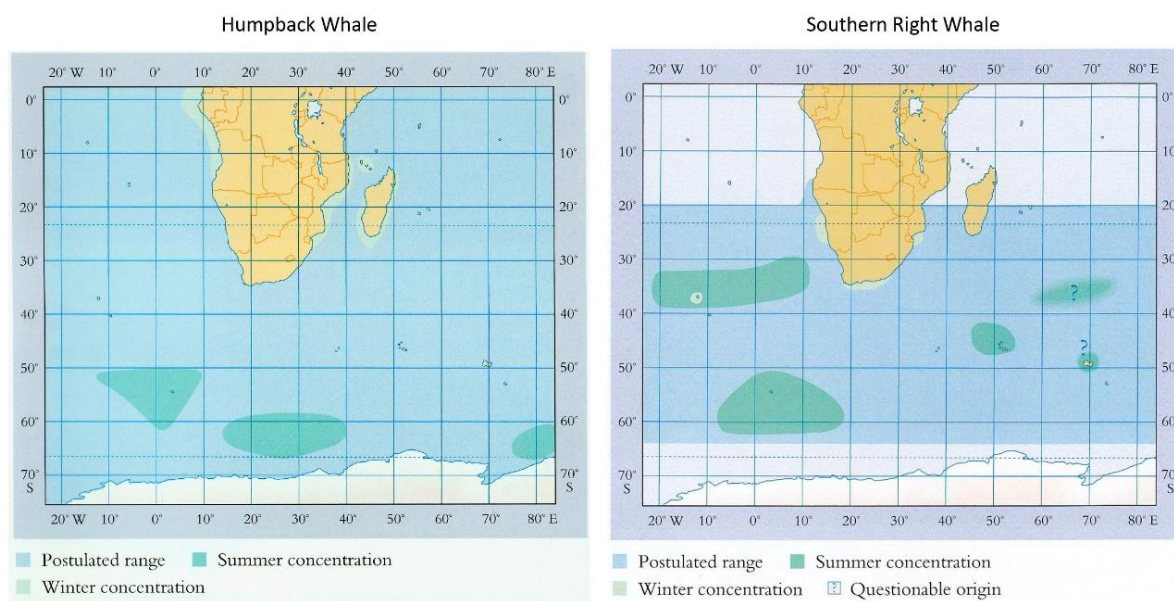


Figure 9 Migration routes are inferred from the seasonal distribution of humpback (left) and southern right (right) whales off the coast of southern Africa. Source: Best (2007).

2.4 Sensitivity and significance

The 2018 National Biodiversity Assessment (NBA) for marine benthic and coastal habitat threat status layer is shown in Figure 10 together with concession area 14C. This Ecosystem Threat Status developed by SANBI (2018) is an indicator of how threatened ecosystems are, specifically the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function, or composition (Harris *et al.* 2018). Ecosystem types are categorised as “Critically Endangered”, “Endangered”, “Vulnerable”, “Near Threatened” or “Least Concern”, based on the proportion of the original extent of each ecosystem type that remains in good ecological condition relative to a series of biodiversity thresholds. According to the latest available data from the 2018 NBA, the entire area covered by Concession Area 14C is classified as “Least Concern” (Figure 10).

In terms of conservation status and protected area status, the 14C concession block is not identified as part of a National Marine Protected Area (MPA). However, the entire area falls within the Benguela upwelling system Ecological and Biologically Significant Area (EBSA) (Figure 11). EBSAs are defined by the Convention on Biological Diversity (CBD) as “geographically or oceanographically discrete areas that provide important services to one or more species/populations of an ecosystem or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics, or otherwise meet the [EBSA] criteria”.

The Benguela Upwelling System (BUS) is one of the four major eastern boundary upwelling systems in the world (Bakun 1996). The proposed BUS EBSA runs along the southwestern African coast, starting from Cape Point in the south and ending to the Angola-Namibia border in the north (UNEP 2014, Figure 11). This system is globally recognized as unique due to being the only cold-water upwelling system that is bordered by warm-water systems in the north (Angola current) and in the south (Agulhas current) (Shillington *et al.* 2007). Furthermore, it is greatly characterized by its high primary production output (>1000 mg C/m²/day); which in turn support abundant pelagic and demersal fish as well as encompassing key spawning and nursery areas for sardine, anchovy and horse mackerel (Hutchings *et al.* 2009). Such productive environments like the BUS can sustain numerous top predator populations such as seabirds; of which many breed in the region; mammals and several cetacean species (Best *et al.* 1997; Best 2007; Crawford 2007; Kemper *et al.* 2007). There are six confirmed coastal Important Biodiversity Areas (IBA's) within this EBSA and an additional 12 IBAs that have been proposed (BirdLife International 2013). In the northern Benguela ecosystem, overfishing and changes in the ecosystem have led to the decline of pelagic species, resulting in the system to reach a "degraded" state (Roux *et al.* 2013). The latter has been reflected in population declines in the breeding populations of several piscivorous predators. However, the southern Benguela ecosystem appears to be stable due to the implementation of conservative fisheries management strategies. Nonetheless, there have been gradual shifts in the geographical distribution of important prey species, such as sardines, anchovy and west coast rock lobsters moving eastwards, (Roy *et al.* 2007; Cockcroft *et al.* 2008; Coetzee *et al.* 2008) which have a negative knock-on effect on the seabirds of west coast of South Africa within the proposed area (Crawford *et al.* 2008a, 2008b). In summary, the proposed BUS is relevant in terms of the following EBSA criteria: 'Uniqueness or rarity'; 'Special importance for life-history stages of species'; 'Importance for threatened, endangered or declining species and/or habitats' and 'Biological productivity'.

The BUS EBSA is approximately 49,676,698 ha (Almost 50 million ha) in size and the area to be impacted in 14C is 0.75 ha ($1.51 \times 10^{-8}\%$ or 0.000000015% of the entire EBSA; Figure 12). Numerous anthropogenic activities take place within the BUS EBSA that encompasses the entire SA west coast. The proportion of the EBSA represented by 14C is extremely small and it is anticipated that the impacts of the proposed exploration and prospecting activities on the EBSA as a whole are virtually negligible.

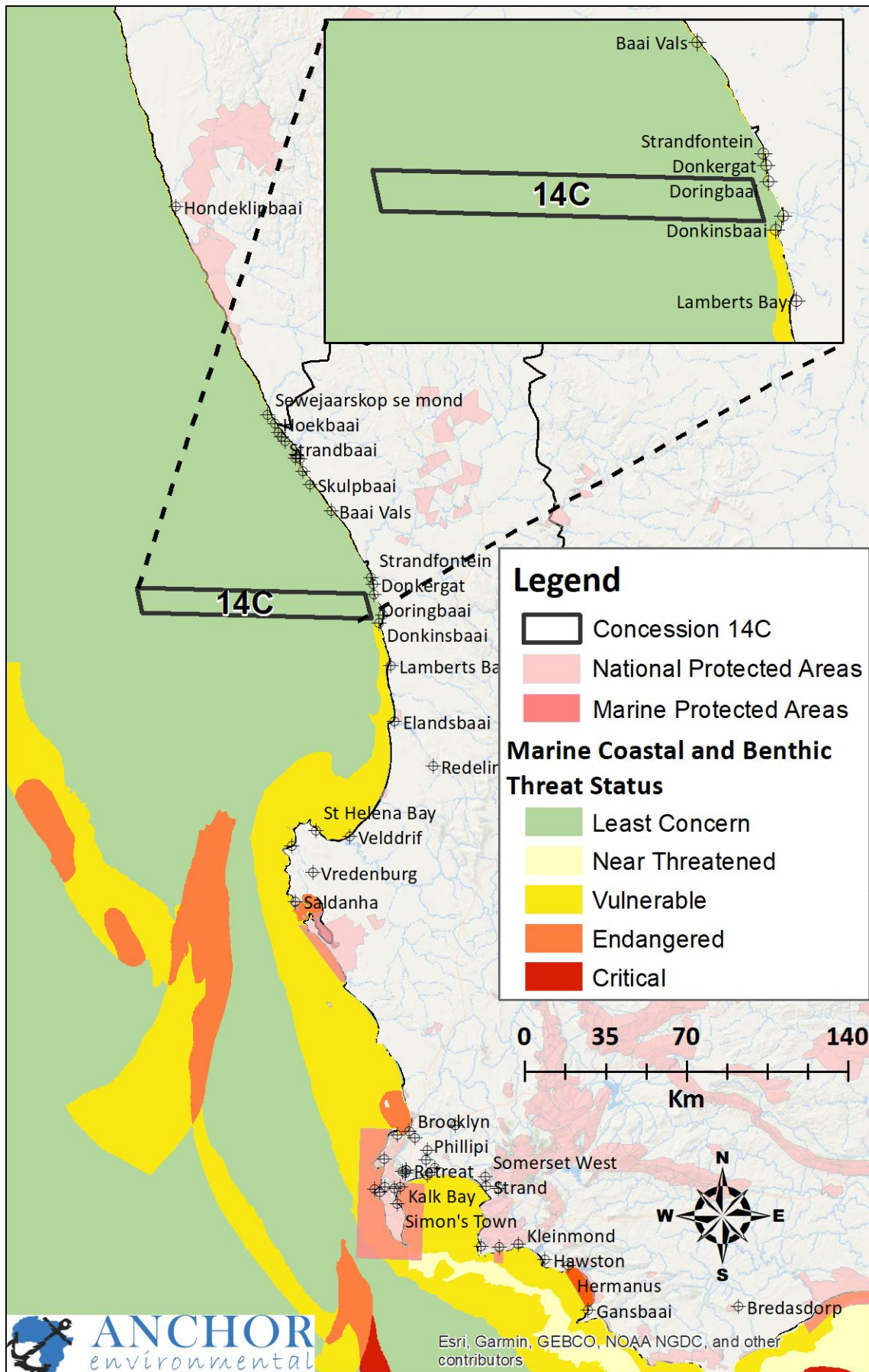


Figure 10 SANBI Ecosystem Threat Status and location of concession area 14C. Source: <https://bgis.sanbi.org/>

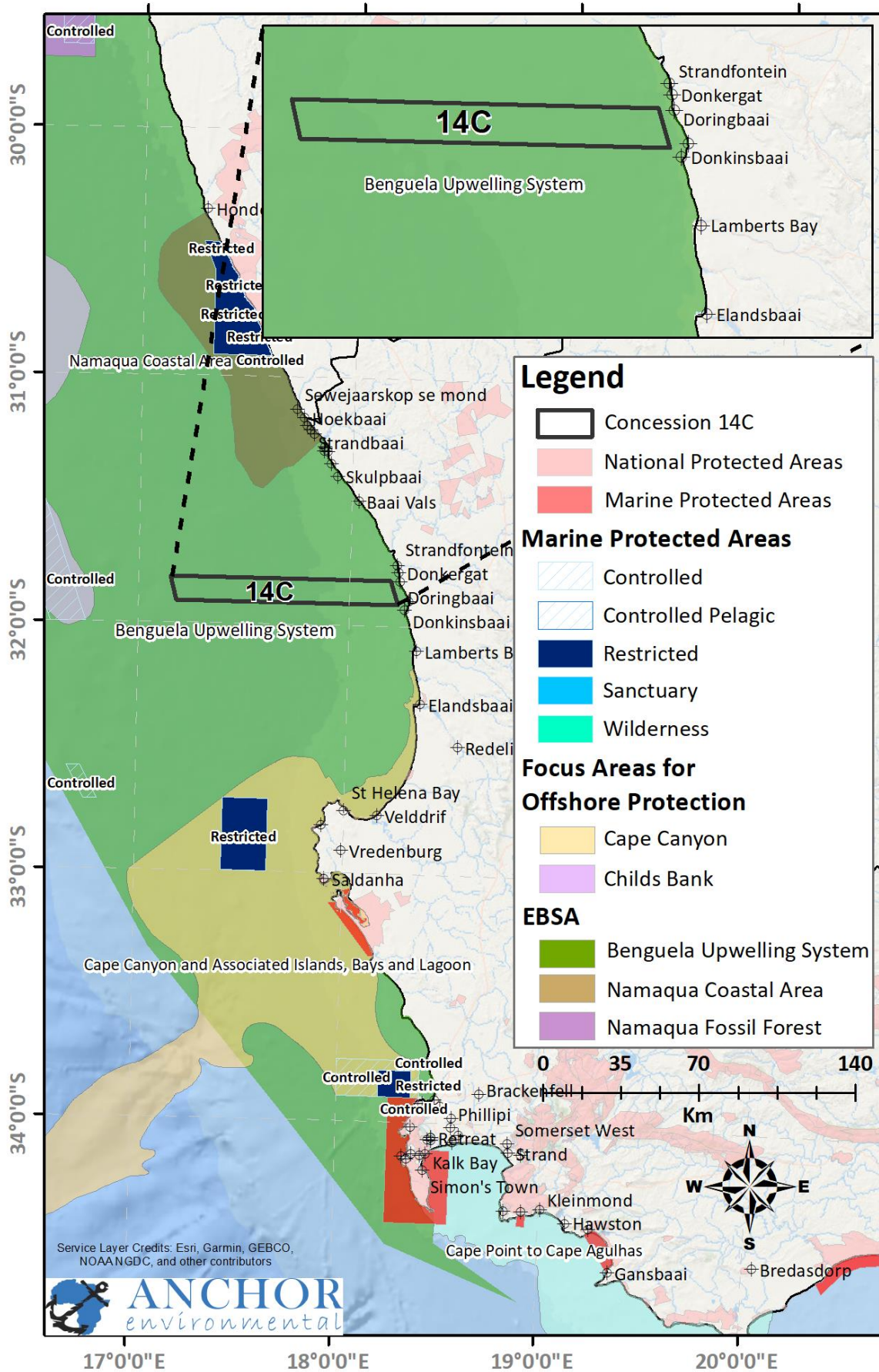


Figure 11 Marine protected Areas (dark blue), proposed EBSA's and the location of concession area 14C. Source: <https://bgis.sanbi.org/>.

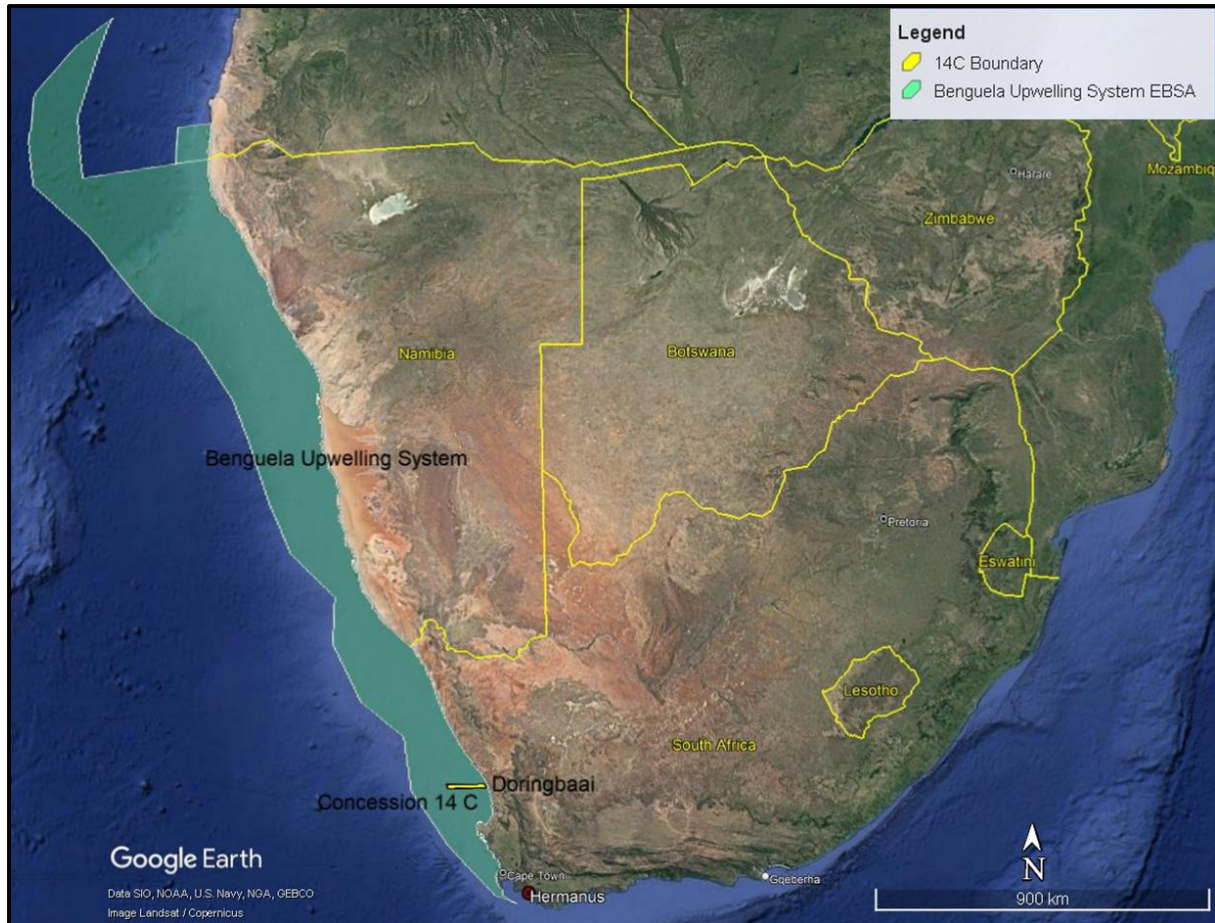


Figure 12 Concession area 14C (yellow) in relation to the Benguela Upwelling System (light green). Source: <https://www.benguelacc.org/>

2.5 User groups

The main users of the sea space in Concession 14C are the commercial shipping, diamond mining, oil and gas and fishing industries. The wave exposed and linear nature of the coast and lack of nearby ports suitable for large vessels means that most merchant shipping would travel offshore of the concession area along the continental shelf edge. Most shipping vessels crossing the Concession area would be fishing vessels and other prospecting or mining vessels. This marine specialist report covers the potentially affected fisheries, whilst potential impacts on the other identified user groups (shipping, mining, oil and gas) are covered in the Basic Assessment Report. Marine research activities that may interact with the proposed prospecting on concession 14C include the annual demersal biomass survey conducted in January or February and the bi-annual small pelagic acoustic surveys conducted in May/June and November by the Department of Forestry, Fisheries and the Environment (DFFE). These surveys are conducted at a national level and the probability of an overlap in space and time with the relatively short duration of planned prospecting activities in concession 14C is considered very low. Despite the low probability of an interaction, should the planned prospecting and fisheries survey vessels happen to coincide within the concession 14C, this could be easily managed through consultation with the research managers at DFFE to ensure that the survey vessels do not hinder each other (i.e., adjustment of the prospecting programme) and implementation of standard marine safety/navigation protocols. Implementation of this simple mitigation would result in NO impacts of prospecting on the research activities (i.e., screened out).

The potential spatial overlap of commercial fisheries with Concession Area 14C was investigated based on published reports (specifically Norman *et al.* 2018), other EIA reports for the region (SLR 2021a, b) and an analysis of spatially referenced commercial catch return data obtained from the Department of Forestry, Fisheries and the Environment (DFFE). The demersal trawl, demersal hake longline and large pelagic longline commercial fishing sectors that are active along the west coast, all operate offshore of the 14C Concession Area (Figure 13), whilst the West Coast Rock Lobster commercial and interim relief nearshore and fishery operates inshore, in water shallower (15-30 m) than the concession area (DEFF 2020, Norman *et al.* 2018). Small scale fishers including interim relief west coast rock lobster and line fish right holders may, on rare occasions fish within the inshore areas of concession 14C, but almost all the small-scale fishing effort is expected to be within 3 NM (5.5 km) of the coast. Due to the very low probability of interaction with small scale fishers, the low intensity, small spatial scale (only inshore margin of 14C) and the very short duration the proposed prospecting activities are expected to have NO impact on small scale fishers (i.e., screened out). The gill net fishery that targets mullet *Chelon richardsonii* also takes place in near shore waters (<50 m depth), whilst kelp collection concessions are restricted to kelp beds or drift cast collected from the intertidal zone. A land-based abalone farm operates in Doringbaai harbour and an application for an abalone ranching right in the area from Doringbaai to Strandfontein has been submitted. Prospecting activities within concession 14C are not expected to have any impacts on abalone aquaculture and ranching in the area. Possible spatial overlap with the small pelagic, traditional line fish and tuna pole fisheries was, however, identified. These three fisheries are considered in more detail below.

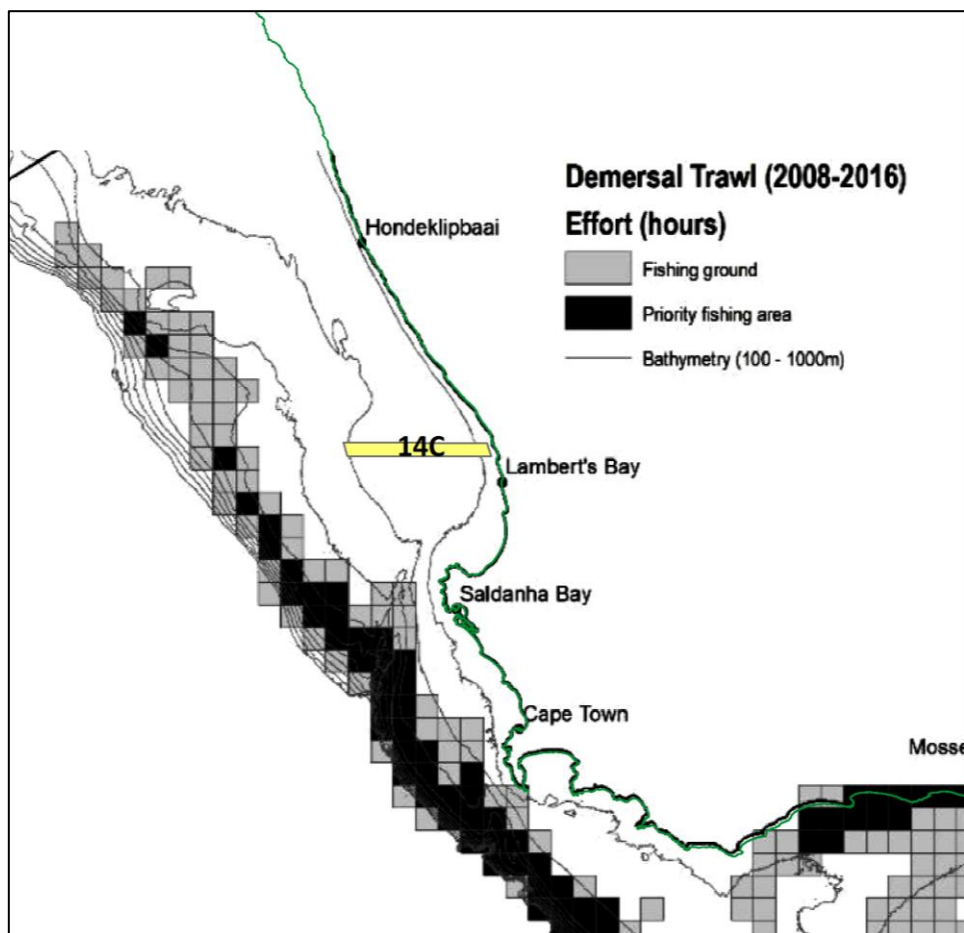
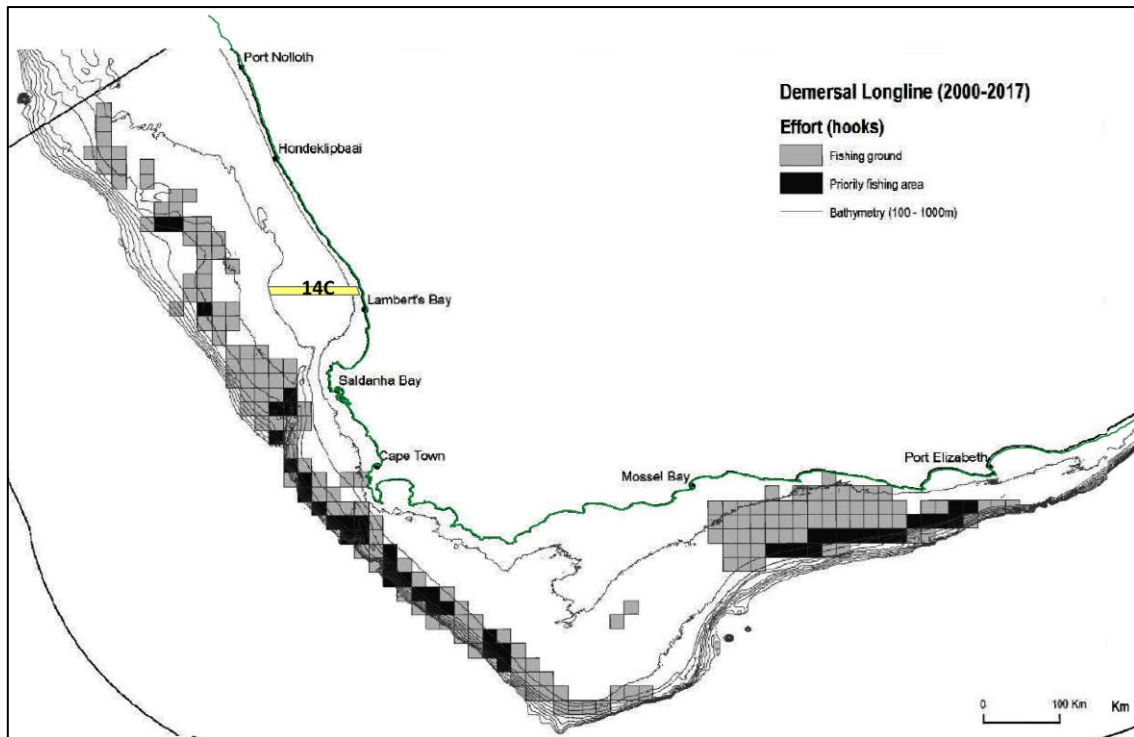


Figure 13 Distribution of demersal longline (top) and trawl (bottom) fishing effort in relation concession area 14C. (Source: Norman et al 2018)

2.5.1 Small Pelagic Purse Seine

The South African small pelagic fishery developed in the 1940s with sardines *Sardinops sagax* primarily targeted along the west coast. Catches peaked in the early 1960s at around 400 000 tonnes but collapsed thereafter, thought to be a direct result of overfishing. The industry switched to smaller nets and began targeting anchovy *Engraulis encrasicolus*, which dominated the catches from about 1964 to the mid-1990s when recovery of the sardine stock was achieved under a stock rebuilding management strategy. Catches of both species have been at similar levels (around 250 000 tonnes) since then, as biomass increased from the mid-1990s until recently when a boom (1997-2004 with an associated eastward movement of the sardine stock) and bust scenario took place (crash in sardine biomass from ~2005 onwards). The fishery also targets red eye *Eutremeus whiteheadi* to a lesser degree, which along with anchovy, is processed into fish meal. The sardine catch is mostly canned with some marketed as fresh fillets or frozen for bait or human consumption. The fishery utilizes wooden, fiberglass or steel hulled purse-seine vessels and most of the large processing factories are located on the west and southwest coast (between St Helena Bay and Gansbaai) where purse seine fishing was historically concentrated.

The small pelagic fishery has the largest catch volume for any of the South African fishery sectors and has the second largest annual catch value, estimated at around R2.164 billion in 2017, which is approximately one fifth of the combined value of South African Fisheries (Japp & Wilkinson 2021). The industry supports around 4 500 full time staff, 2 500 seasonal staff and more than 700 fishers. The support industries support a further 2 400 jobs. The small pelagic fishery is managed using an Operational Management Plan (OMP) that involves a trade-off between maximizing overall sardine and anchovy catches, whilst minimizing the risk of resource collapse. This trade-off is required as juvenile anchovy (which form the bulk of the anchovy catch) and juvenile sardine shoal together for much of the year. Allowance is therefore made for a sardine total allowable by-catch (TAB) of juvenile sardine in both the early and late anchovy allocations as well as a fixed TAB for adult sardine in the round herring directed fishery. The OMP is tuned to minimize risk of resource collapse which is defined as the probability of adult biomass falling below defined historical levels at least once during the simulation model projection period of 20 years. Until recently the stock status of anchovy and round herring was considered optimal, whilst sardine stocks are considered depleted (DAFF 2020). The 2019 and 2020 OMP, however, required implementation of “exceptional circumstances” allowing large or rapid declines in Total Allowable Catch (TAC) for both sardine and anchovy due to low biomass estimates. Total pelagic catches in 2019 were 226 872 tonnes which was well below the long-term average of around 334 000 tonnes.

The small pelagic purse-seine fishery operates between the Orange River and East London, mostly in nearshore waters (within 10 km of the coast). The 14C Concession Area does overlap with identified priority fishing areas for anchovy and with the sardine directed fishing ground (Figure 14) (Norman *et al.* 2018). Small pelagic fishing activity in the vicinity of 14C takes place in the late summer mainly during the months of February to July (SAPFIA pers. comm).

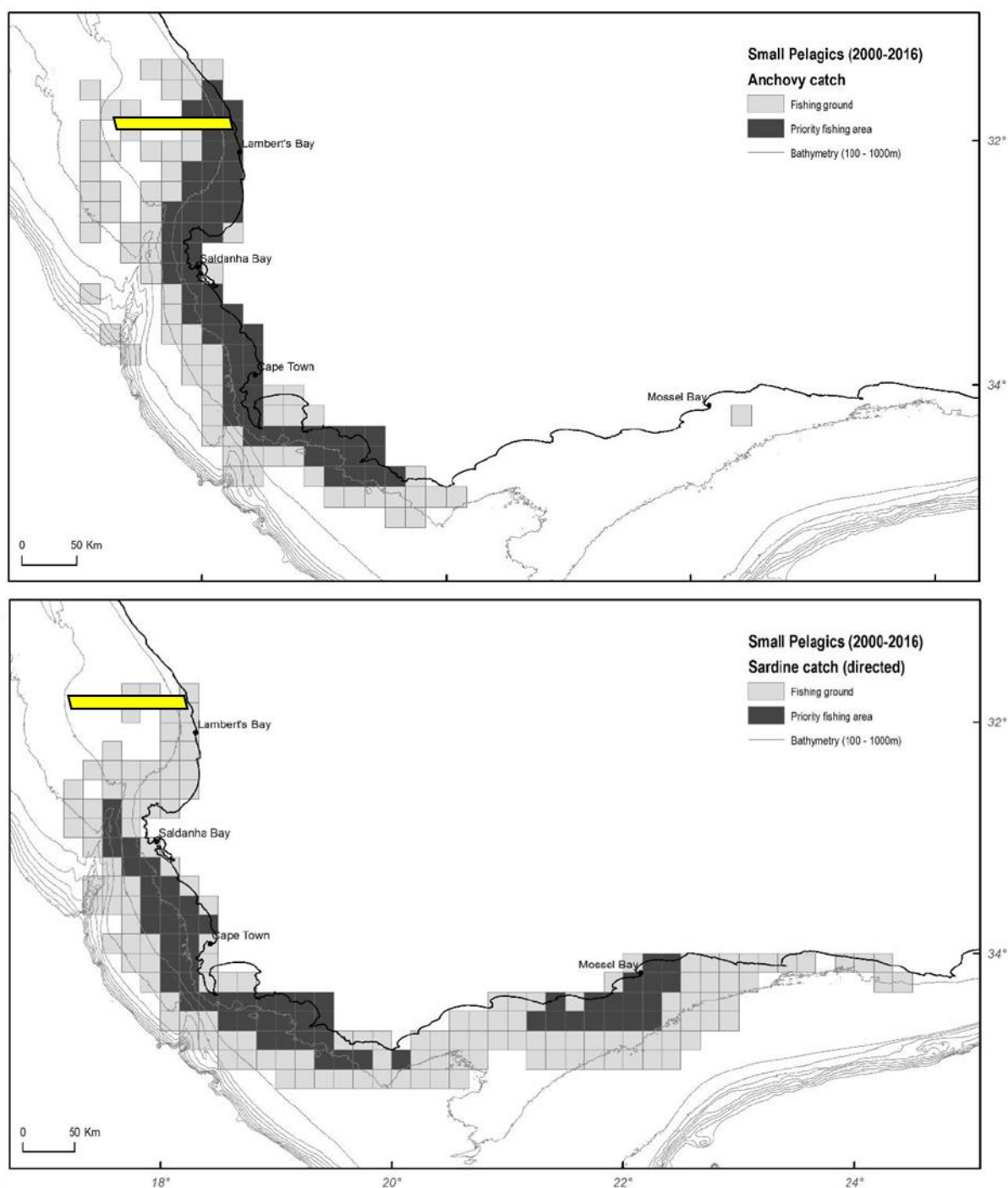


Figure 14 Spatial distribution of anchovy (top) and sardine (bottom) purse seine catch (2000-2016) with identified priority fishing areas (Source: Norman *et al.* 2018).

A quantitative spatial analysis using commercial catch return data (all small pelagic species combined) for the period 2006-2011, shows that Concession Area 14C partially overlaps 16 small pelagic reporting grid blocks where an annual average of 6 880 tonnes of fish were landed over the 2006-2011 period which is equivalent to about 1% of the national total catch (Figure 15). Assuming small pelagic catches are randomly and evenly distributed within grid blocks, however, the area of direct overlap will account for average annual catches of approximately 1 700 tonnes within concession 14C, equivalent to ~ 0.26 % of the average national total for this period (Figure 15). This is not considered a substantial

proportion of the national catch, but potential impacts of prospecting within this important small pelagic fishing area may be significantly negative at the individual vessel or right holder level. However, the target species are pelagic, and their distribution is variable, so the fishery as a whole is unlikely to be significantly negatively affected by small temporary closures/exclusion zones around survey vessels and geotechnical survey sites.

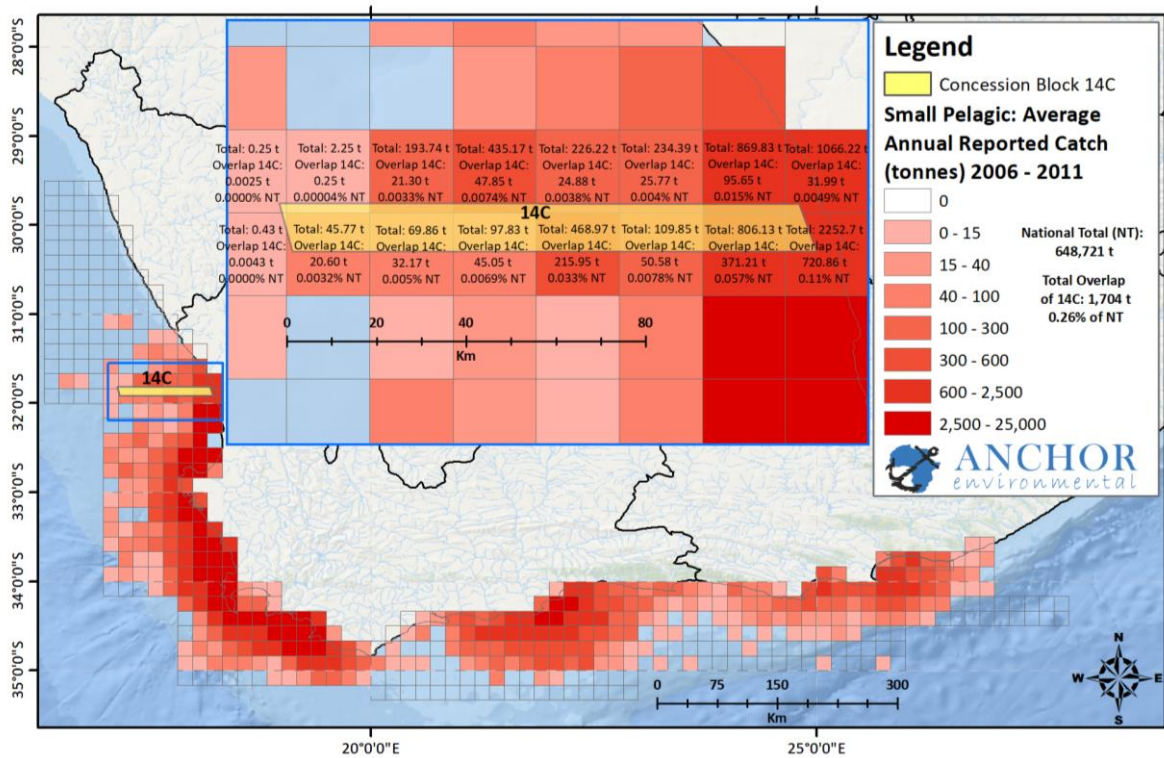


Figure 15 Average annual reported small pelagic catch 2006-2011 (tonnes) and the calculated proportion of the average national total catch made within Concession Area 14C (Data source: DFFE).

The 14C concession area does lie within the important west coast nursery ground that is utilised by several small pelagic fish species including sardine, horse mackerel (*Trachurus capensis*) and anchovy that utilise Agulhas Bank and west coast spawning grounds (Hutchings et al 2002). The west coast nursery area extends along much of the west Coast shelf, and is bookended by the Cape Columbine upwelling cell in the south to Luderitz upwelling cell in the north (Hutchings et al 2002). Spawning of anchovy and sardines mostly takes place during the Spring and Summer months with recruits reaching the west coast via general north-westerly drift of Agulhas Bank surface waters and a coastal jet current off Cape Point and Cape Columbine. Models of egg and larval dispersal estimate that most recruits would reach the west coast within 1-3 weeks of spawning i.e., December to May would see the greatest abundance of juvenile small pelagic fish in West Coast nursery grounds (Hutchings et al 2002). The area around the 14C concession does overlap with one of several areas of high juvenile anchovy abundance, with much of the west coast between St Helena Bay and Port Nolloth constituting the anchovy recruit habitat (Figure 16).

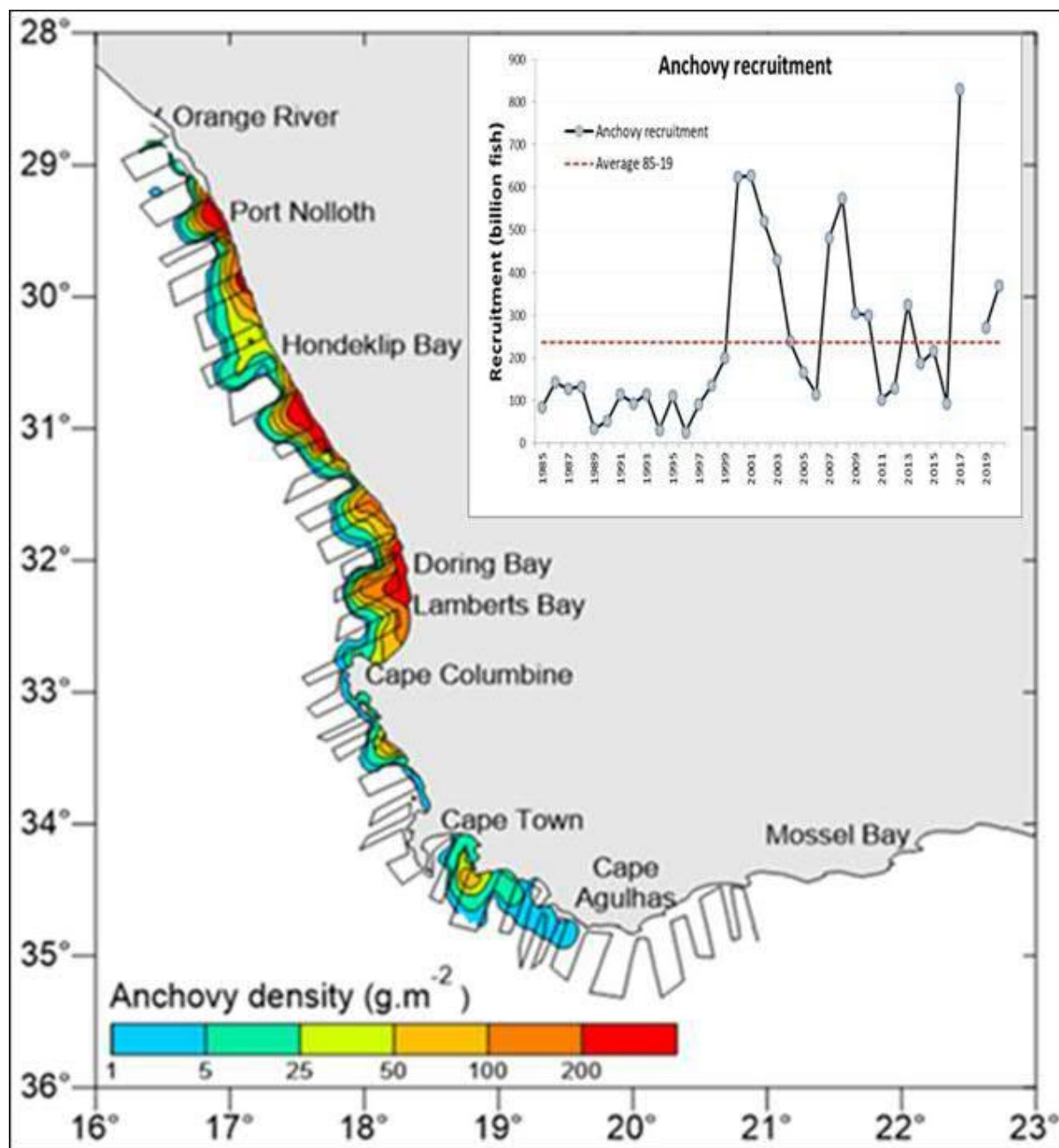


Figure 16 Recruitment survey results (May 2020) for anchovy and recruitment trend (inset). The red dotted line is the running average level of recruitment since 1985 (information and figure provided by J. Coetzee and D. Merkel of DFFE; Source: SLR 2021).

2.5.2 Tuna pole and line

The South African tuna pole and line (TPL) sector targets longfin tuna *Thunnus alalunga*, yellowfin tuna *T. albacares*, bigeye tuna *T. obesus* and skipjack tuna *Katsuwonus pelamis* seasonally between November and May. Due to the seasonality of the TPL fishery, fishers also have access to snoek *Thyrsites atun* and yellowtail *Seriola lalandi* that are also important targets of the traditional linefishery. The tuna pole fleet consists of approximately 100 vessels ranging from small outboard powered skiboats (7-9 m length) to inboard diesel-powered deck boats (6-25 m length). The reported longfin tuna catch in 2018 was 2 471 tonnes, with a wholesale value of R124 Million, or 1.2% of the total South African commercial fisheries value (Japp & Wilkinson 2021).

The commercial tuna pole fishing grounds lie between Cape Agulhas and the Orange River, but the fleet operates predominantly out of Cape Town and Hout Bay harbours and most fishing effort takes place within 100 nautical miles of these ports (particularly in the Cape Canyon area). Some effort does take place further up the west coast, although this is mostly offshore of, or to the south of concession area 14C (Figure 17). Over the period 2003-2016 there was moderate-high (average of 100-500 boat days/year) reported TPL fishing effort in the reporting grid block that partially overlaps with concession 14C (Figure 17). Furthermore, a significant amount of snoek-directed activity by the tuna pole fleet occurs inshore of the 100 m depth contour (SLR 2021). Snoek fishing activity within the area is seasonal with all fishing reported within the period April to May inclusive (SLR 2021).

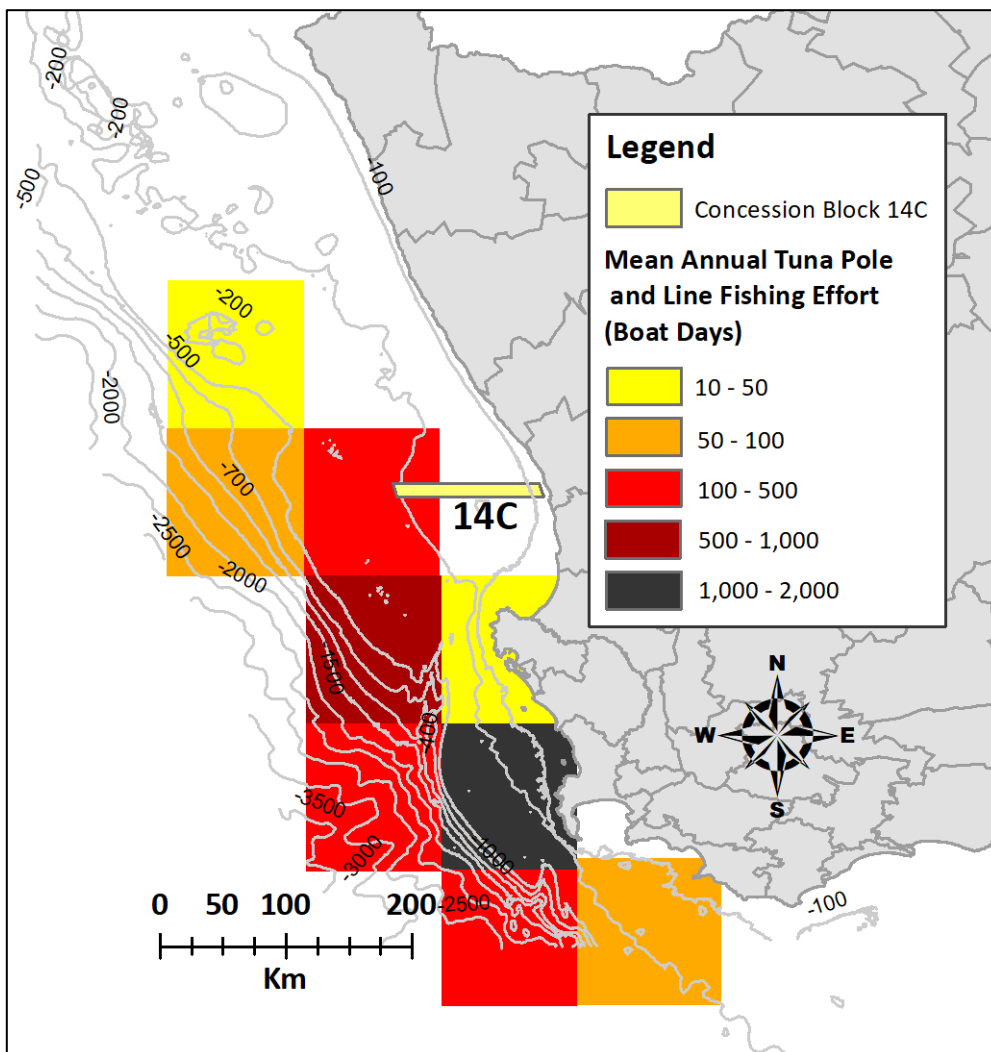


Figure 17 Mean annual tuna pole and line fishing effort (boat days) in relation to concession 14C (Source: Norman et al 2018).

2.5.3 Traditional Line fish

Catching fish with hook and line is amongst the oldest form of fishing in South Africa and can be traced back to the fishing activities of indigenous Khoi and European seafarers in the 1500s. Both linefishing

effort and catches increased substantially after the Second World War as a result of the introduction of technological advances such as reliable combustion engines, nylon line, chart plotters and echo sounders, as well as the construction of small boat harbours along the coast. In spite of technological advances over this period, declines in catch rates (in the region of 75-99%) were observed for many important linefish species during the 20th century, and are indicative of severe overexploitation. Commercial, recreational and subsistence line fishers target up to 200 different fish species, both from boats and the shore. Due to this multispecies nature of the line fisheries, there is considerable overlap in catches between the three types of line fishers, and some overlap with other sectors such as inshore net fish and demersal trawling, and this complicates management. Commercial line fishing effort peaked in the 1990s with about 3 000 registered boats (only about 700 were active commercially), whilst recreational boat fishing (currently estimated at about 4 000 vessels), shore angling (~1 million participants) and subsistence fishing (largely shore based with an estimated 25-30 000 participants), continues to grow.

A management framework that included a comprehensive suite of line fish regulations was introduced in 1985, including revised minimum size limits equal to sizes at maturity (when known), daily bag limits, closed seasons, commercial fishing bans for certain species and the capping of the commercial effort at the 1984 level. CPUE data and stock assessments conducted since the mid-1980s have revealed that, with the exception of fast-growing species such as snoek and yellowtail, most commercially exploited traditional line fishes have been depleted to dangerously low levels. Apart from reduced productivity associated with stock depletion, other setbacks, such as ecosystem alteration, loss of genetic diversity and short-term commercial extinction, were also anticipated. This suggested that the line fish management framework in place at the time was failing to provide adequate protection for line fish stocks. This led to the development of a new Line fish Management Protocol (LMP) in 1999, that uses biological reference points for species for which quantitative stock assessment data exist, or trends in catch composition and catch rate for species where stock assessment data are lacking, to determine management actions.

In an effort to rebuild depleted line fish stocks an environmental emergency in the traditional line fishery was declared in December 2000. In terms of the emergency, the Minister determined that a Total Allowable Effort (TAE) of no more than 450 vessels and 3 450 persons may fish commercially for line fish. Revised bag and size limits for commercial and recreational line fishers were implemented in 2005. The commercial line fishery was split into three regional management zones, restricting the movement of vessels from one region to the next with the long-term rights allocation. Marine protected areas are a key component of line fish management, providing research opportunities in the absence of fishing effects, whilst numerous studies have demonstrated protection of spawner biomass in these areas and potential enhancement of adjacent fisheries through export of adults and juveniles. These measures have been met with some success and improved standardized CPUE trends are apparent for some species. However, the reduction in effort and resource recovery has been somewhat undermined by effort creep (via crew exemptions and interim relief measures), illegal fishing activity and unregulated subsistence fishing in important nursery habitats such as estuaries. As of December 2020, there were 425 rights holders in the sector with 395 commercial vessels and 60 small scale (interim relief) vessels operational. With the implementation of the small-scale fisheries policy, the DFFE intends to increase the proportion of the TAE allocated to the small-scale sector from 13% to 50% to try improve economic options in poor coastal communities (although this may be at a cost to some of the existing commercial right holders who themselves are members of poor coastal communities).

Line fishers operate in shallow water (generally <100 m depth) and would potentially be negatively impacted by coastal and nearshore seismic exploration, prospecting and mining operations (particularly recreational, small scale and subsistence shore fishing). Concession area 14C is, however, relatively far offshore in water that is mostly deeper than 100 m. A spatial analysis of the reported commercial line fish catch data does show some limited overlap with traditional line fishing activity on the inner margin of the 14C concession area (Figure 18).

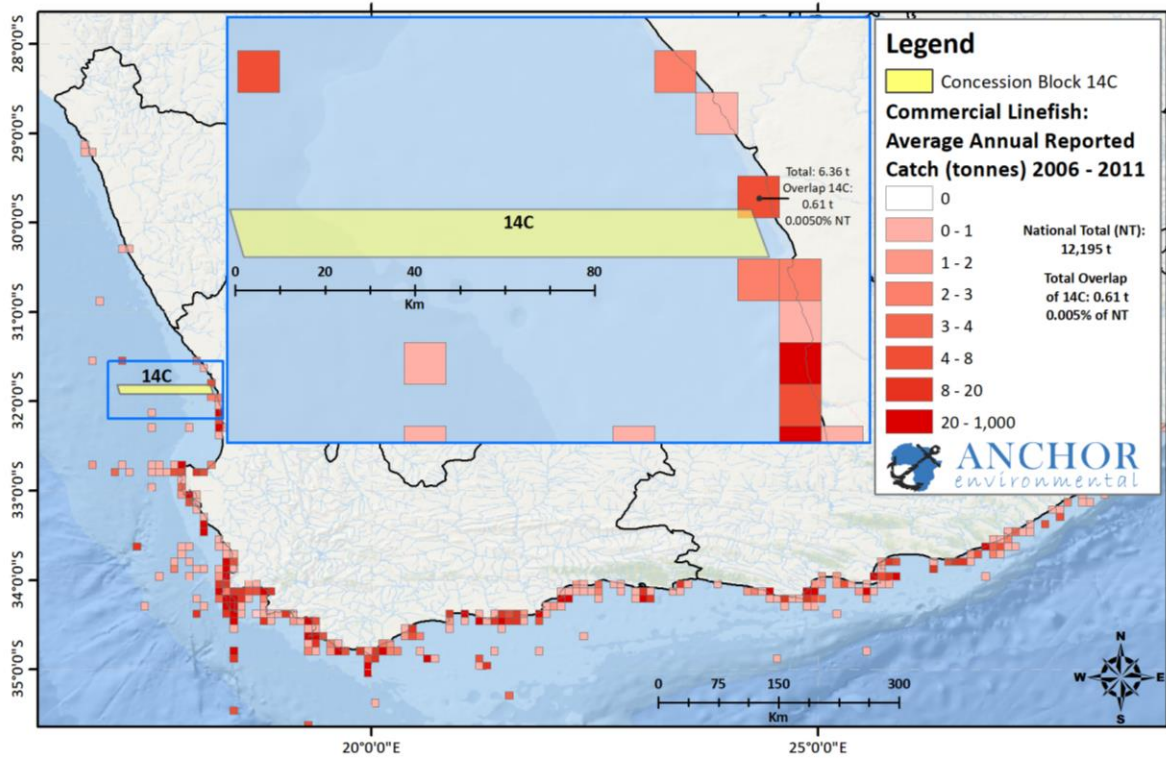


Figure 18 Reported annual commercial line fishing catch the calculated proportion of the average national total catch made within Concession Area 14C (Data source: DFFE).

3 IMPACT ASSESSMENT

Potential impacts were identified for exploration and prospecting in marine diamond mining Concession 14C. Potential impacts were assessed in terms of their nature, extent, duration, intensity, probability of occurrence, potential for mitigation, cumulative effects and overall significance (Appendix 1).

3.1 Identification of impacts

Potential impacts to the marine environment as a result of exploration and prospecting are identified based on available literature, previous EIA and monitoring reports (Lane and Carter 1999; Penney *et al.* 2007; Pulfrich 2016, 2017, 2021; Biccard *et al.* 2018; Baker and Arnott 2021) and the specialist's own knowledge. It is assumed that a vessel with dynamic positioning will be used for all survey and sampling activities and potential impacts of anchoring on the seabed are therefore not assessed. Should this not be the case the potential impacts of anchoring must be assessed, and appropriate mitigation included in a revised EMPr. Identified potential impacts include:

- Seismic disturbance to marine fauna;
- Marine megafauna collisions with survey vessels;
- Direct impact of seabed excavation and tailings disposal during drill sampling on benthic habitats e.g., soft sediments and/or reefs and associated infaunal and epifaunal communities;
- Impact on surrounding benthos and water column via fine sediment plume;
- Waste discharges during vessel operations; and
- Impacts on fisheries (and livelihoods of those who depend on these fisheries) due to exclusion zones around survey vessels and direct potential impacts on target species and supporting ecosystems.

3.1.1 Cumulative Impacts

Coastal and marine mining is well-established along South Africa's west coast between St Helena Bay and the Orange River mouth (Figure 19). There are prospecting and mining permits allocated for most of the nearshore, land based and surf zone coastal concessions between the Olifants and Orange River mouths (Figure 19). These mines are largely extracting diamondiferous gravels. In the vicinity of the 14C concession, TAD has also submitted applications for prospecting rights for concessions 14A and 11C, whilst other companies have submitted applications for prospecting rights in the adjacent concession areas (Figure 19). Between the Olifants estuary mouth and Brand se Baai, mineral sands are extracted by Tormin and Tronox mines in intertidal and land based coastal operations respectively. There are also offshore oil and gas production and prospecting licenses with additional exploration applications currently underway (Figure 19). The prospecting and exploration methods for oil and gas exploration (seismic surveys and core/drill sampling) are similar (although normally of greater intensity as the oil and gas reserves are typically deeper and located in pockets of sedimentary rock below the sea floor) to those used for offshore diamond and other mineral exploration. There has been a recent increase in applications for prospecting and exploration rights along the west coast and increased prospecting/survey activity in the short term and marine mining in the long-term is anticipated.

This means that cumulative impacts of marine prospecting and mining must be considered at a broader spatial scale in a strategic manner for each potential impact identified. Obtaining detailed information on the scale, extent, methodology (and hence intensity) of various current and pending applications is, however, not possible within the prescribed timeframes of a Basic Assessment Process for a single application (such as this one). This requires a revised strategic level Environmental Impact Assessment to assess cumulative impacts with a medium to high level of confidence. The last strategic level EIA that assessed marine and coastal diamond mining impacts in the region was a Benguela Current Large Marine Ecosystem Programme (BCLME) study undertaken over the period 2004–2007 (Penney *et al.* 2007).

It is, however, logical and reasonable, to anticipate that many of the potential impacts assessed for this project would continue together with other projects that are ongoing or scheduled to come on-line. The result is that the spatial extent of many impacts would change from “local” to “regional”, whilst the duration would change from “short-term” (<2 years) to at least “medium term” (2–15 years) or even “long-term” (>15 years, mostly reversible in the case of prospecting, but not always for mining). The intensity of impacts is anticipated to remain as they are assessed here for operations of this nature but may be higher for other sea-based mineral and energy projects in different areas with different objectives. The cumulative effect of each of the identified impacts is therefore provided in the Impact Assessment tables below using this precautionary approach (assumption of simultaneous / consecutive prospecting and mining activities in the region). These cumulative impacts are assessed “after mitigation”. The assessment of cumulative impacts has a “low confidence” rating due to the uncertainty of the timing and location of other anthropogenic activities in the region.

It is recommended that a strategic level Environmental Impact Assessment (EIA) process based on marine spatial planning principles be undertaken to assess and manage potential cumulative impacts in a holistic manner and to identify and implement regional level mitigation measures. The decision-making authority (DMRE) must take cognisance of this recommendation to do a strategic level EIA in order for Specialists and Environmental Assessment Practitioners to accurately assess cumulative impacts.

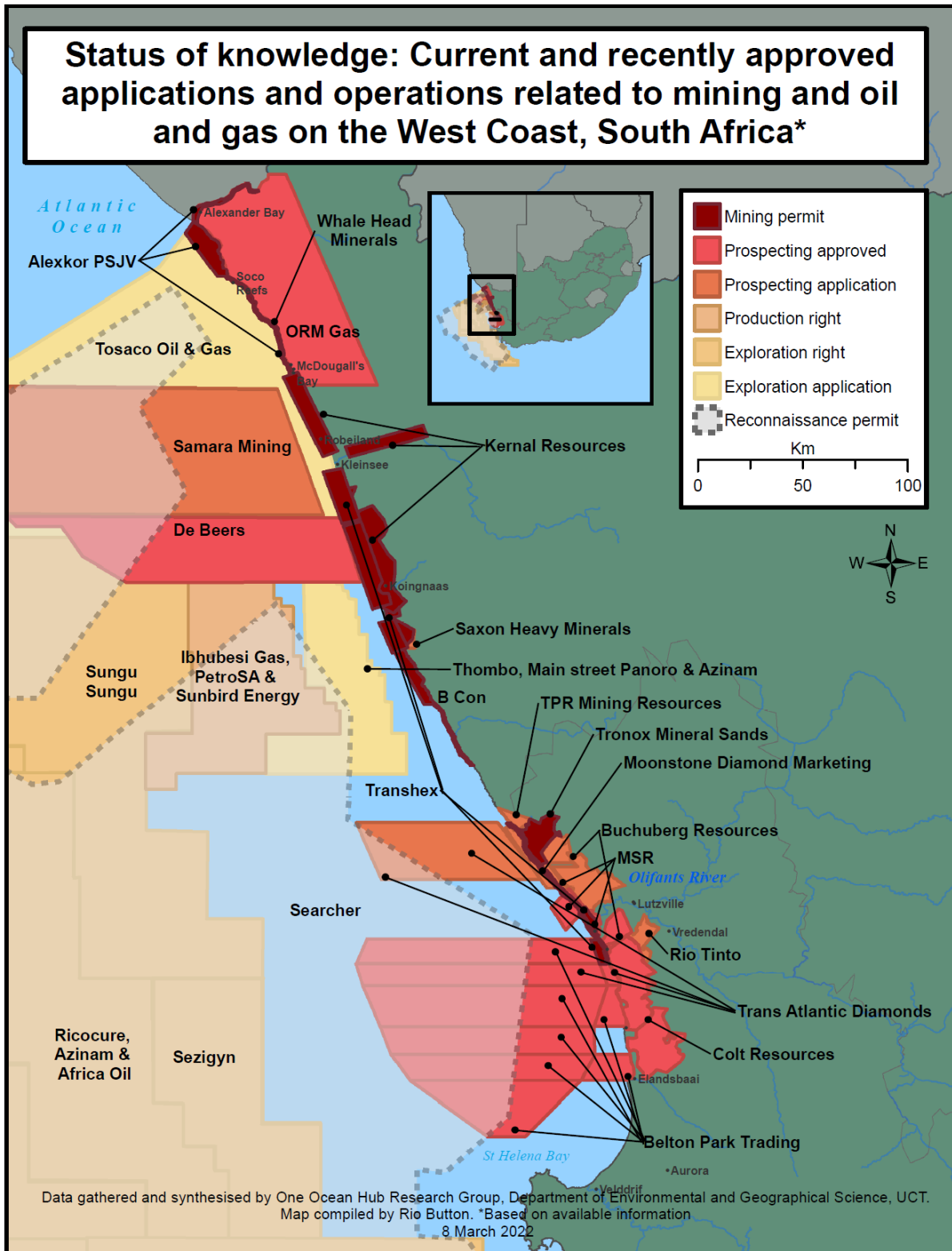


Figure 19 Extent of prospecting and mining applications and operations along South Africa’s West Coast (Source: One Ocean Hub Research Group, Department of Environmental and Geographical Science, UCT. Map compiled by Rio Button. *Based on available information 8 March 2022.

3.1.2 Seismic disturbance to marine fauna

It has become increasingly evident that noise from human activities in and around underwater environments can have an impact on marine species. The extent to which intense underwater sound might cause an adverse impact on a species is dependent upon the incident sound level, sound frequency, duration of exposure and/or repetition rate of the sound wave (Hastings and Popper, 2005). As a result, scientific interest in the hearing abilities of aquatic animal species, which may be affected by noise, has increased. These studies are primarily based on evidence from high level sources of underwater noise such as blasting or impact piling, as these sources are likely to have the greatest environmental impact.

Sounds generated by vessels in addition to the noise from seismic surveys have been related to negative impacts on marine animals (Koper and Plön 2012). These negative impacts include direct effects, such as physical injury (i.e., auditory and non-auditory), stress, perceptual interference, behavioural changes, chronic responses, and indirect effects on predator species as a consequence of a change in prey distribution or abundance due to direct effects of sound on the prey (NRC 2003; Koper and Plön 2012). The impacts associated with seismic surveys are not yet fully understood and further research is ongoing.

During prospecting, sounds and vibrations emanating from sampling tools only last a few days but can be intense. Exposure to intense sounds for even short periods of time can lead to permanent hearing damage. Concerns over these disturbing effects have been raised in international literature (Richardson *et al.* 1986; 1990; 1995; Richardson and Malme 1993; Finley *et al.* 1990; Gordon *et al.* 1992; Bauer *et al.* 1993; Maybaum 1993; Bain and Dahlheim 1994; McCauley 1994; Vincent 1996; Richardson and Würsig 1997; Gisiner 1998; Würsig *et al.* 1998; Lesage *et al.* 1999; Terhune and Verboom 1999; Au and Green 2000; McCauley *et al.* 2000; Miller *et al.* 2000; Nowacek *et al.* 2001; 2004; Nowacek and Wells 2001; Erbe 2002; Leung-Ng and Leung 2003). However, the potential effects of diamond prospecting and mining in southern Namibia on marine mammals have been reported to be minimal Findlay (1996).

It should be noted that natural sound sources are also emitted frequently from the ocean to a point where “sea noise” and biological sound sources (baleen whale calls, dolphin echolocation, shrimp snapping etc.) may even overshadow anthropogenic noise (Penney *et al.* 2007; Pulfrich 2017; Au 1993; Richardson *et al.* 1995).

Adverse impacts of underwater sound can be broadly summarised into three categories:

- Physical traumatic injury and fatality;
- Auditory injury (either permanent threshold shift (PTS) or temporary threshold shift (TTS); and
- Disturbance.

Invertebrates

Invertebrates mostly do not possess hearing organs, but many do have tactile organs or hairs that are sensitive to underwater sound pressure (Mason 2017). Some invertebrates have highly sophisticated statocysts, which resemble the ears of fishes. While there is very little published information available

about the effects of seismic noise on marine invertebrates, it has been postulated that benthic invertebrates can only hear seismic survey sounds at very close range. This implies that only surveys conducted in very shallow water will have any detrimental effects on benthic invertebrates. The overall impact of seismic disturbance to marine invertebrates in concession 14C is assessed to be INSIGNIFICANT (Table 4). No mitigation is considered necessary. For the cumulative impact assessment; the extent increases from local to regional and the duration increases from short-term to long-term (>15 years). This raises the overall consequence from very low to medium and the overall significance from insignificant to LOW. However, our confidence for this assessment decreases from medium to low (for reasons stated above).

Table 4 Seismic disturbance to invertebrates.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short-term 1	Very Low 3	Possible	INSIGNIFICANT	-ve	Medium
Best Practice:								
<ul style="list-style-type: none"> No essential or potential mitigation measures identified 								
Cumulative impact	Regional 2	Low 1	Long-term 3	Medium 6	Possible	LOW	-ve	LOW

Fish

The impacts of seismic survey noise on spawning behaviour of fish have not been quantified to date, but 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, possibly affecting recruitment to fish stocks. The Multibeam Echo Sounder (MBES) to be used in this study is a high-frequency system (frequencies in excess of 10 kHz) and it is known that fish are unable to perceive the high frequencies that characterise these sources (Popper *et al.* 2014; Barham and Mason 2021). The Topas chirp SBP falls within the mid-frequency range from Popper *et al.* (2014) (1 kHz to 10 kHz) which is also mostly inaudible to fish (Mason 2017). Some species, particularly those that possess swim bladders, can suffer serious injury, but the majority of fish are highly mobile and are able to avoid seismic noise at levels that can cause injury (Mason 2017). Popper and Schilt (2008) conclude 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 sources. Possible injury or mortality in pelagic species could occur on initiation of a sound source at full power in the immediate vicinity of fish, or where reproductive or feeding behaviour may override a flight response to seismic survey sounds. The overall impact of the use of the seismic survey equipment on fish is thus assessed to be of INSIGNIFICANT risk and no mitigation is considered necessary (Table 5). For the cumulative impact assessment; the extent increases from local to regional and the duration increases from short-term to long-term (>15 years). This raises the overall consequence from very low to medium and the overall significance from insignificant to LOW. However, our confidence for this assessment decreases from medium to low.

Table 5 Seismic disturbance to fish.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short-term 1	Very Low 3	Possible	INSIGNIFICANT	-ve	Medium
Best Practice:								
<ul style="list-style-type: none"> No essential or potential mitigation measures identified 								
Cumulative impacts	Regional 2	Low 1	Long-term 3	Medium 6	Possible	LOW	-ve	Low

Marine mammals

All marine mammals, through adaptation to the marine environment, have developed broader hearing ranges than are common to land mammals. These broader hearing ranges make them susceptible to acoustic trauma from geophysical survey activity. Such injuries are either temporary (temporary threshold shift – TTS) or permanent (permanent threshold shift – PTS). Injuries are likely to result in a reduction in foraging efficiency, reproductive potential, social cohesion and ability to detect predators (Weilgart 2007). The prevalence of geophysical survey data acquisition has increased across the globe in recent years, and this has prompted scientists to establish noise exposure criteria to predict the onset of auditory effects in marine mammals in order to avoid or mitigate for such impacts (Southall et al. 2019).

To date, extensive seismic surveys have been conducted on the continental shelf on the west and south coasts of South Africa (Branch and Branch 2018). The scientific community have voiced their concern over the potential impacts associated with these seismic surveys on various groups of marine fauna. It is known that migrating whales are frequently encountered on the west coast of southern Africa during the summer months (due to feeding activity) and encounters with odontocetes such as dusky dolphins, Heaviside’s dolphin and pilot whales are possible throughout the year. Furthermore, humpback calves are vulnerable during the southern migration which takes place during the months of September and October. The timing of seismic survey activity in concession 14C should be confined to seasons when cetaceans are scarce to ensure minimal disturbance (Gründlingh *et al.* 2006).

There is little information available on the levels of noise that would potentially result in physiological injury to cetaceans, and no permanent threshold shifts (PTS) have been recorded (Mason 2017). Available information suggests that the animal would need to be in close proximity to operating seismic equipment to suffer severe physiological injury (Koper and Plön 2012). As whales are highly mobile, it is assumed that they would avoid sound sources before such injury occurs. Observations show that responses to seismic activity varies between species with smaller odontocetes displaying the strongest avoidance response, while the responses of medium and large odontocetes (killer whales and pilot whales) were less marked (Mason 2017). Baleen whales showed fewer responses to seismic survey activity than small odontocetes, but all baleen whales showed changes in behavioural responses. McCauley *et al.* (2000b) found no obvious evidence that Humpback whales were displaced by seismic surveys and no apparent gross changes in the whale’s migratory path could be linked to seismic survey activities, although localised avoidance of survey vessels has been noted. Such

avoidance is generally considered of minimal impact in relation to the distances of migrations of the majority of whale species.

Of the proposed seismic survey activities, the Topas sub-bottom profiler system which uses shallow (35-45 kHz) and medium penetration (1-10 kHz) “Chirp” seismic pulses to map the sediment horizon could present a risk to dolphins that are known to occur in the area (mainly dusky and Heaviside’s dolphins). Heaviside’s dolphins are listed as near threatened on the IUCN red data list, are known to occur in the area, and fall into the category of mid-frequency cetaceans that could be at risk during the proposed seismic survey. Dusky dolphins (listed as “least concern” on the IUCN red data list) are also known to occur in the area and could also be at risk.

A noise modelling study (using marine mammal noise exposure criteria from Southall *et al.* (2019) that was undertaken in Greenland in 50-250 m water depth for a similar MBES and Chirp sub-bottom profiler geophysical survey system predicted worst case scenario impact ranges for HF and LF cetacean hearing groups of less than 100 m for both PTS and TTS (Barham and Mason 2021). That said, it is recommended that an Marine Mammal and Seabird Observer (MMSO) be on duty during the proposed seismic survey activities and as a precaution, the listed mitigation measures are followed. A passive acoustic monitoring (PAM) system should also be used during survey activity to detect cetaceans that could be at risk. Implementation of these mitigation measures should ensure that PTS and TTS impacts arising from the proposed seismic survey activities in concession 14C would be unlikely.

It is likely that cape fur seals *Arctocephalus pusillus pusillus* will be encountered during seismic exploration and sampling/prospecting activities in Concession 14C. Seals are highly mobile animals with a general foraging area covering the continental shelf up to depths of 120 m (approximately 220 km) offshore. In general, seals display considerable tolerance to underwater noise (Richardson *et al.* 1995). This has been confirmed by a study in Arctic Canada in which ringed seals showed only limited avoidance of seismic operations (Lee *et al.* 2005). In another study, ringed seals were shown to habituate to industrial noise (Blackwell *et al.* 2004). It is likely that seals would only suffer significant injury if they were diving directly below the vessel in close proximity to the seismic source. The likelihood of this occurring is considered very low.

Based on the above, impacts to marine mammals was assessed to be of MEDIUM risk and with the implementation of mitigation (see below) this is reduced to VERY LOW risk (Table 6) – mitigation measures are expected to reduce the intensity of the impact from high to medium. For the cumulative impact assessment; the duration increases from short-term to long-term (>15 years) and this raises the overall consequence from medium to high and the overall significance from VERY LOW to MEDIUM. However, our confidence for this assessment decreases from medium to low (for reasons stated above).

Table 6 Seismic disturbance to marine mammals

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Regional 2	High 3	Short-term 1	Medium 6	Probable	MEDIUM	-ve	Medium

Essential mitigation measures:

- A designated onboard Marine Mammal and Seabird Observer (MMSO) to ensure compliance with mitigation measures during geophysical surveying.
- MMSO to conduct pre-survey visual scans of at least 30 minutes for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses
- “Soft starts” should be carried out for equipment with source levels greater than 210 dB re 1 μ Pa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity. Where this is not possible, the equipment should be turned on and off over a 20 minute period to act as a warning signal and allow cetaceans to move away from the sound source.
- 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.
- Passive Acoustic Monitoring (PAM) must be incorporated into any survey programme and used to detect cetaceans, particularly during periods of low visibility.

With mitigation	Regional 2	Medium 2	Short term 1	Low 5	Improbable	VERY LOW	-ve	Medium
Cumulative impact	Regional 2	Medium 2	Long term 3	High 7	Improbable	MEDIUM	-ve	Low

Seabirds

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 (Mason 2017). Impacts of seismic pulses to marine birds (diving or resting on water surface) include physiological injury, behavioural avoidance of seismic survey areas and indirect impacts due to effects on prey. The African penguin *Spheniscus demersus*, which is flightless and occurs along the West Coast, is particularly susceptible to impacts from underwater noise. Due to the continuous nature of the intermittent seismic survey pulses, African penguins and other diving birds would be expected to hear the sound sources at distances where levels would not induce mortality or injury and likely avoid the approaching sound source (Mason 2017). This is supported by the findings of Pichegru *et al.* (2016) who have shown that feeding areas within 50 km of seismic surveys are completely avoided by African penguins.

Most of the impacts identified depend on the diet of the bird species concerned and the effect of seismic surveys on the diet species. For example, plunge-diving birds forage on small shoaling fish prey species relatively close to the shore (Mason 2017). Of the diving birds that occur along the coast, only the Cape gannet *Morus capensis* regularly feeds from the inshore environment as far as 100 km offshore. Other seabirds found close inshore that may be impacted along the inner margin of concession 14C include the cape cormorant, various terns and gull species. Pelagic seabirds such as albatross, petrels and shearwaters are likely to be encountered in the offshore waters of 14C and may also be impacted. The overall impact is assessed to be of LOW risk and with the implementation of mitigation (see below) is reduced to INSIGNIFICANT (Table 7). For the cumulative impact assessment; the extent increases to regional and duration increases to long-term (>15 years) and this raises the overall consequence from very low to high and the overall significance from INSIGNIFICANT to

MEDIUM. However, our confidence for this assessment decreases from medium to low (for reasons stated above).

Table 7 Seismic disturbance to seabirds.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Short-term 1	Low 5	Probable	LOW	-ve	High
Essential mitigation measures:								
<ul style="list-style-type: none"> • A designated onboard Marine Mammal and Seabird Observer (MMSO) to ensure compliance with mitigation measures during geophysical surveying • MMSO to conduct pre-survey visual scans of at least 30 minutes for the presence of feeding seabirds in the survey area • If spotted wait until all marine life (seabirds, seals, cetaceans and turtles) have cleared an area of 500 m radius of the centre of the seismic source before resuming with seismic survey (initiate soft start procedure when resuming seismic survey). • Terminate the survey, if any seabirds show affected behaviour within 500 m of the survey vessel or equipment, until they have vacated the area. • Record incidences of encounters with marine life (seabirds, turtles, seals, fish) their behaviour and response to seismic survey activity. • Suspend operations if any obvious mortalities or injuries to marine life are observed. 								
With mitigation	Local 1	Medium 2	Short term 1	Very low 4	Improbable	INSIGNIFICANT	-ve	High
Cumulative impact	Regional 2	Medium 2	Long term 3	High 7	Improbable	MEDIUM	-ve	Low

Turtles

The overlap of turtle hearing sensitivity with the higher frequencies produced by seismic survey equipment suggests that turtles may be considerably affected by seismic noise. Recent evidence suggests that turtles only detect seismic survey equipment at close range (< 10 m, possibly linked to visual rather than auditory cues) or are not sufficiently mobile to move away from approaching survey vessels (particularly if basking). Initiation of a sound source at full power in the immediate vicinity of a swimming or basking turtle could therefore result in physiological injury. Injured turtles are less mobile than other large marine fauna, and are vulnerable to both boat strikes and entanglement with seismic towed equipment. Turtles are mostly restricted to offshore pelagic waters off the west coast of South Africa and are likely to be encountered in Concession 14C. However, most incidents involve foraging turtles or turtles diving in an escape response becoming trapped by towed survey equipment which is not in the scope of works for the proposed seismic survey in Concession 14C. The overall impact is therefore assessed to be INSIGNIFICANT. Despite the low probability of impacts on turtles during the short survey duration their inability to timeously avoid an approaching survey vessel warrants a precautionary approach and required mitigation includes delayed start-ups and a 500 m buffer (Table 8). For the cumulative impact assessment; the extent increases to regional and duration

increases to long-term (>15 years) and this raises the overall consequence from very low to medium and the overall significance from INSIGNIFICANT to LOW. However, our confidence for this assessment decreases from high to low (for reasons stated above).

Table 8 Seismic disturbance to turtles.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
With and Without mitigation	Local 1	Low 1	Short-term 1	Very Low 3	Improbable	INSIGNIFICANT	-ve	High
Essential mitigation measures:								
<ul style="list-style-type: none"> • A designated onboard Marine Mammal, Turtle and Seabird Observer (MMSO) to ensure compliance with mitigation measures during geophysical surveying • MMSO to conduct pre-survey visual scans of at least 30 minutes for the presence of feeding seabirds in the survey area • If spotted wait until all marine life (seabirds, seals, cetaceans and turtles) have cleared an area of 500 m radius of the centre of the seismic source before resuming with seismic survey (initiate soft start procedure when resuming seismic survey). • Terminate the survey, if any turtles show affected behaviour within 500 m of the survey vessel or equipment, until they have vacated the area. • Record incidences of encounters with marine life (seabirds, turtles, seals, fish) their behaviour and response to seismic survey activity. • Suspend operations if any obvious mortalities or injuries to marine life are observed 								
Cumulative impacts	Regional 2	Low 1	Long-term 3	Medium 6	Improbable	LOW	-ve	Low

Mitigation Measures

Current mitigation measures for impacts to marine fauna include spatial and temporal restrictions (i.e., activity restricted to specific areas or a time of year), source based mitigation (i.e., sound containment and improvement of current equipment used), and operational mitigation where a certain protocol is followed to avoid mortalities and/or injuries to marine animals when they are encountered during survey operations. These existing mitigation measures are highly valuable for a country such as South Africa, which has a rich coastal biodiversity and is an important habitat for threatened marine species, while experiencing a rapid increase in coastal industrial developments (Koper and Plön 2012).

The following mitigation measures identified by Mason (2017) and Koper and Plön (2012) are recommended where applicable to reduce the severity of the aforementioned impacts:

- Implement “soft-starts” of at least 20 minutes duration when the SBP is deployed.
- Employ on board independent observer(s) / MMSO(s) with experience in seabird, turtle and marine mammal identification and observation techniques to carry out daylight observations.
- If surveys are to be undertaken at night, it is recommended that the vessel is fitted with Passive Acoustic Monitoring (PAM) technology. Utilise PAM technology when surveying at

night or during adverse weather conditions and thick fog (commonly encountered on the west coast of South Africa).

- Record marine mammal incidences and responses to seismic survey activity, including data on 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) along with seismic noise levels.
- Terminate acoustic survey if mass mortalities of fish are observed.
- If spotted, wait until all marine life (seabirds, seals, cetaceans and turtles) have cleared an area of 500 m radius of the centre of the seismic source before resuming with seismic survey (initiate soft start procedure when resuming seismic survey).
- Record incidences of encounters with marine life (seabirds, turtles, seals, fish) their behaviour and response to seismic survey activity.
- Suspend operations if any obvious mortalities or injuries to marine life are observed.
- Wait until all small cetaceans (<3 m in overall length) have cleared an area of 500 m radius of the seismic survey vessel before resuming with seismic survey. 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 20-minutes duration. Small cetacean behaviour during “soft starts” shall be monitored.
- Record seabird incidences and behaviour, including any attraction of predatory seabirds and incidents of feeding behaviour around the survey vessel.
- Ensure that MMSOs compile a survey close-out report incorporating all recorded data to the relevant DFFE authorities.
- Make marine mammal incidence data and seismic source output data from surveys available on request to the Marine Mammal Institute (MMI), DFFE and DMR.

3.1.3 Marine megafauna collisions with survey vessels

There is a low risk of survey vessel collisions with marine megafauna such as whales and turtles that are susceptible to “ship strikes”. Any increase in vessel traffic through habitat used by these animals can increase the risk of collision whilst the deployment of towed survey gear carries a risk of entanglement. The main causes of cetacean (mainly southern right and humpback whales) entanglement in South Africa involve static fishing gears particularly west coast and south coast rock lobster traps and long lines (Meyer *et al.* 2011). The potential for collision between cetaceans and other megafauna and the survey vessel, or entanglement in the deployed sampling equipment is directly proportional to the vessel speed and the abundance and behaviour and cetaceans in the area during the surveys. The 14C concession area is part of the natural range of several species of marine mammals including large whales such as humpback and southern right whales, but it is not considered an important aggregation site or migration route (see 2.3.3). The number of marine fauna expected to be encountered during the limited time that the survey vessel is active is therefore expected to be very low and the intensity of the impact is considered high for the individual affected animal and medium for the population as a whole. The potential impact of marine megafauna collision with the survey vessel or entanglement in sampling equipment is therefore assessed to be of VERY LOW significance and with the implementation of mitigation measures is reduced to INSIGNIFICANT (Table 9). For the cumulative impact assessment; the duration increases to long-term (>15 years) and this

raises the overall consequence from very low to medium and the overall significance from INSIGNIFICANT to LOW. However, our confidence for this assessment decreases from high to low (for reasons stated above).

Table 9 Marine megafauna collisions with survey vessels.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Regional 2	Medium 2	Short-term 1	Low 5	Possible	VERY LOW	-ve	High
Essential mitigation measures:								
<ul style="list-style-type: none"> A designated onboard Marine Mammal Observer (MMO) and vessel operator to keep watch for marine megafauna in the path of the vessel during geophysical surveying. 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. Vessel transit speed to not exceed 12 knots (22 km/hr), except within 25 km of the coast where it should be kept to less than 10 knots (18 km/hr) as well as when sensitive marine fauna are not present in the vicinity. 								
With mitigation	Regional 2	Low 1	Short term 1	Very Low 4	Improbable	INSIGNIFICANT	-ve	High
Cumulative impacts	Regional 2	Low 1	Long term 3	Medium 6	Possible	LOW	-ve	Low

3.1.4 Seabed sampling and tailings disposal

Approximately 100-200 sites will be sampled in Concession 14C using either vibracoring, gravity coring or sonic coring techniques. The diameter of core samples will be approximately 10 cm, the corers will penetrate to depths of 3–8 m and the material brought to the surface for analysis. The volume per core is calculated at 0.24 m³. The total volume for the 200 cores is calculated at 4.71 m³. The 200 cores will cover a total surface area of 1.57 m², although the core might impact a surface area slightly larger than this. The core samples do not require onboard processing (i.e., no sediment spill in the ocean) as all material collected will remain intact within core tubes which are to be analysed on land.

In addition to this, a Van Veen grab with a sampling capacity of approximately 50 kg will be used to collect baseline environmental data on sediment and benthic macrofauna at 20-50 sites. Total volume of the grab is 0.03 m³ and it will disturb an area covering approximately 0.1 m². The total area expected to be disturbed by the Van Veen grab will be approximately 5 m². Grab samples are typically washed and processed once on board. This will produce a very small sediment plume that is expected to dissipate almost immediately.

Impacts from sampling are likely to result in localised removal of benthic organisms and their habitat within the footprint of the sampling tool, which due to the relatively small size of the various coring tools, is expected to be virtually negligible. These impacts include direct habitat loss and smothering of the benthos adjacent to sampling sites associated with localised tailings discard. The samples are discrete (not contiguous), and as a result, recolonisation from adjacent undisturbed areas is possible.

Considering the available area of similar habitat on the continental shelf of the West Coast, the reduction in benthic biodiversity through sediment removal can be considered negligible.

The impact on the offshore benthos as a result of the cumulative removal of sediments from sampling is considered to be of medium intensity at a local scale (i.e., sampling locations). Full recovery is expected to take place within the short to medium term (i.e., 6 - 15 years), as the sampled areas are expected to have slow infill rates and may persist for extended periods (years). Furthermore, biomass often remains reduced for several years as long-lived species like molluscs and echinoderms need longer to re-establish the natural age and size structure of the population. It is generally accepted that offshore disturbed areas take longer to recover than those in shallow water further inshore (Figure 20). Important drivers of inshore habitat recovery are related to the exposure to dynamic physical processes such as wave action and sediment refill from river mouths (Biccard *et al.* 2020b). Hence, recovery times greatly increase with depth and distance from sources of sedimentation (the Olifants river may play a role in delivering sediment to the nearshore environment during flood events and could potentially accelerate recovery of the affected benthos).

No direct mitigation is considered necessary for seabed sampling and localised smothering of the benthos (tailings disposal). However, it is possible to implement careful planning and management of potential discharges to ensure that tailings are not discarded onto sensitive reef habitat (Penney *et al.* 2007; Pulfrich 2017). The overall consequence of this impact is considered to be low and is of LOW significance. No mitigation measures are required (Table 10). For the cumulative impact assessment; the duration increases to long-term (>15 years) and this raises the overall consequence from low to medium and the overall significance from low to medium. However, our confidence for this assessment decreases from high to low (for reasons stated above).

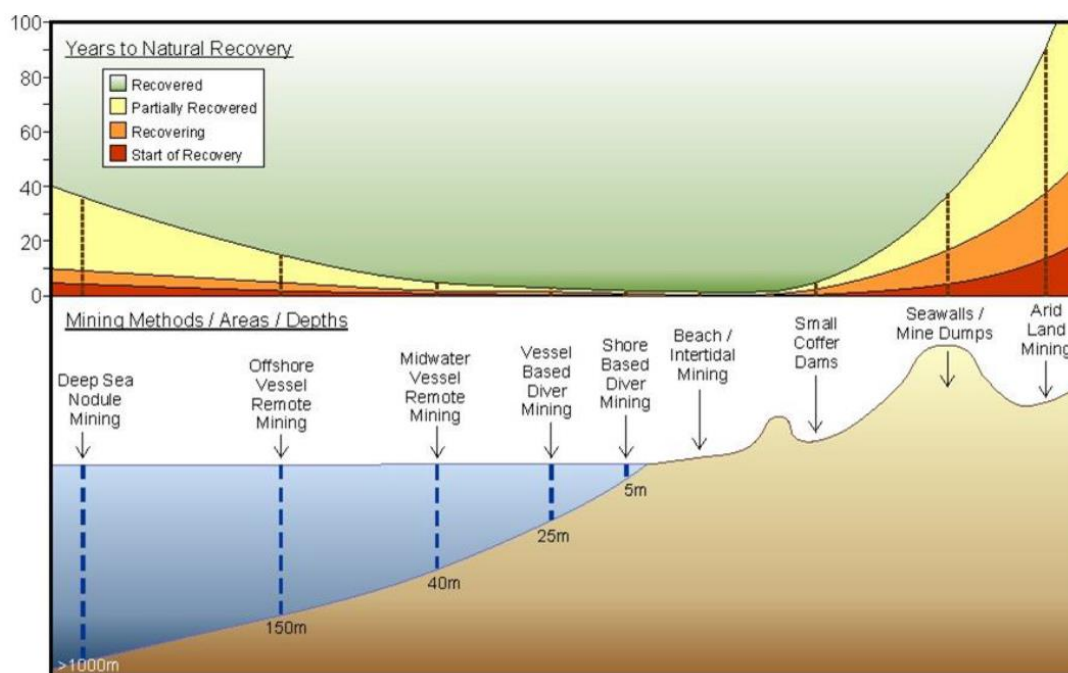


Figure 20 Maximum times to various stages of natural recovery (still impacted, recovering, partially recovered and recovered) reported in the literature for various local studies of marine mining, and relevant international studies on other seabed disturbances (Penney *et al.* 2007).

Table 10 Benthic Impacts of seabed sampling and tailings disposal.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Medium-term 2	Low 5	Definite	LOW	-ve	High
Best Practice:								
<ul style="list-style-type: none"> • Planning and management of potential discharges to ensure that tailings are not discarded onto potentially sensitive habitats • No essential or potential mitigation measures identified 								
Cumulative impacts	Local 1	Medium 2	Long-term 3	Medium 6	Possible	LOW	-ve	Low

3.1.5 Fine sediment plumes

During the sampling process, sedimentary material that has been brought to the surface will be processed onboard and unwanted material (tailings) will be discarded overboard, thereby causing sediment plumes. These plumes can affect light penetration through the water column and can adversely affect phytoplankton productivity in the water column (Johnson 1981; Poopetch 1982; Kirk 1985; Parsons *et al.* 1986a; 1986b; Monteiro 1988; O'Toole 1997; Pulfrich 2017). Suspended sediment plumes can also develop either near the seabed, or in mid-water due to the dynamic collapse and diffusion of the sediment jet following the discharge. Suspended sediment concentrations generated at the point of discharge, the extent and area over which plumes disperse, and their duration, depend largely on the proportions of silts, muds and clays in the mined sediments, as well as the sea-surface conditions during disposal. The finer sediments discharged at the surface generate a plume in the upper water column, which is dispersed away from the vessel by prevailing currents, diluting to background levels at increasing distances from the vessel.

In addition to reduced phytoplankton productivity, suspended sediments may also affect the biological responses of consumers (hatching success, larval survival, and foraging behaviour) provided they contain inorganic particles (Clarke and Wilber 2000). Although, these plumes differ in intensity and timing from natural background conditions, marine communities in the Benguela region are well adapted to such events as they are frequently exposed to naturally elevated suspended-sediment levels (Penney *et al.* 2007). Where deep-water sampling/prospecting is practiced, increased turbidity in the pelagic offshore environment as result of tailings plumes is not expected to have any significant effects on the marine biota (Penney *et al.* 2007; Pulfrich 2017). The latter statement is well supported as numerous modelling studies and aerial observations of plumes generated from mining vessels have shown that concentration of suspended sediments reduce rapidly with distance from the vessel, allowing a fairly fast settlement and dilution of fine sediment fractions (Figure 21 – Poopetch 1982; Hitchcock and Drucker 1996; Shillington and Probyn 1996; CSIR 1998; Carter and Midgley 2000). In addition, studies conducted on dredge-mining operations have recorded that water-column turbidity returns to natural background levels within a few hours after dredging has ceased (Evans 1994; Whiteside *et al.* 1995).

The 14C concession area does overlap with the west coast nursery area utilised by several commercially important fish species (particularly anchovy). However, due to the low intensity, short-term nature and very localised scale of the impact relative to the large spatial scale of the fish nursery area (most of the west coast inner shelf), the significance of any sediment plumes generated by prospecting activities on fish stock recruitment is assessed as very low.

Sampling activities in 14C will not be contiguous. This will result in a delay in time while the seabed tool is transferred to the new sampling site before additional sediment is released overboard with the next sample. Furthermore, the volumes of sediment that are expected to be collected and processed in this project are relatively small, and hence impacts on the environment are expected to be insignificant (Table 11). No direct mitigation is feasible as tailings disposal is an integral part of this sampling method. For the cumulative impact assessment, the duration increases from short term to medium term, however, the overall significance remains VERY LOW.

Table 11 Potential Impact of tailings discharge and fine sediment plumes on the pelagic habitat.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short-term 1	Very low 3	Definite	VERY LOW	-ve	High
Best Practice:								
<ul style="list-style-type: none"> No essential or potential mitigation measures identified 								
Cumulative impacts	Local 1	Low 1	Medium-term 2	Very low 4	Definite	VERY LOW	-ve	Low

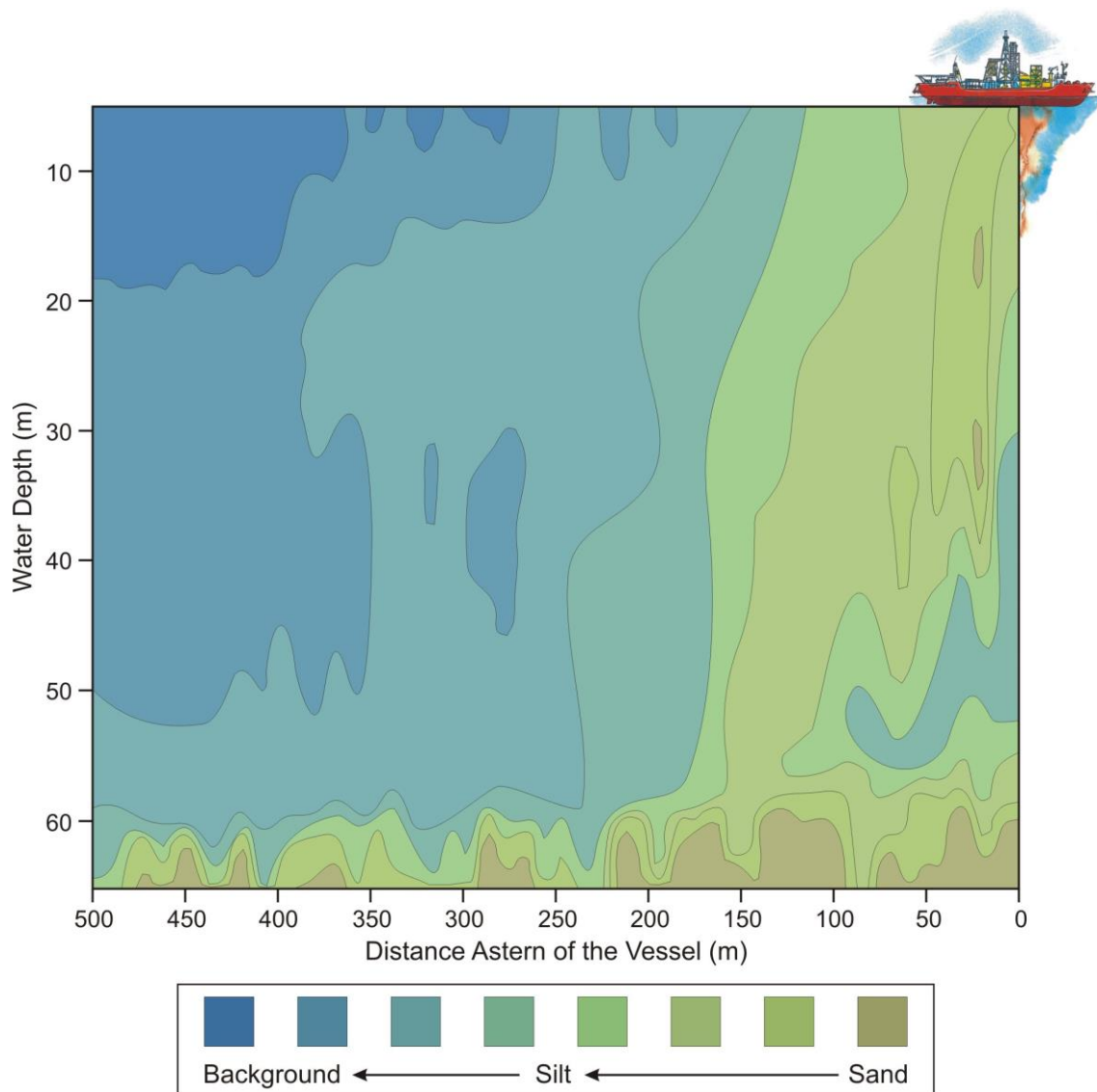


Figure 21 An example of suspended sediment plume from the MV Grand Banks operational in the Atlantic 1 MLA (Top). Acoustic Doppler Current Profiler (ADCP) longitudinal section along a tailings plume astern of a marine diamond mining vessel off southern Namibia, showing the depth and distance distribution of sediment particles of various size fractions behind the vessel (adapted from CSIR 1998; Penney *et al.* 2007).

3.1.6 Waste discharges during vessel operations

Water quality in the vicinity of exploration, sampling and associated support vessels may be impaired by various forms of waste discharged into the marine environment. During operation, normal discharges to the sea can come from a variety of sources but these are all regulated generally by onboard waste management plans which must be MARPOL compliant. The impacts on marine life depend on the properties of the waste discharged. The various kinds of waste produced at sea, their associated impacts and management protocols are outlined below.

Discharge of wastes and hydrocarbons

Vessel operators may experience accidental spills from operational machinery, which could include hydrocarbons such as hydraulic fluids, diesel, oils and/or hazardous substances. Spills of this nature are highly toxic and unless carefully managed, may pollute nearshore and coastal environments as well as damage and potentially destroy, marine organisms (wreckage of a vessel). The duration of the impact would depend on the bio-degradation of the type of waste. Solid wastes (e.g., plastics, scrap metals) may take decades or centuries to degrade. Cumulative impacts are unlikely due to the low likelihood of major accidents such as collision or wreckage. Strict waste management plans should be enforced for all operators; all deck drainage from workspaces and ballast water to be discharged must meet the MARPOL compliance level of 15 ppm oil in water. This is achieved through use of an oily-water separation system. The oily substances must be skimmed off the top of the discharge water and added to the waste (oil) lubricants and disposed of on land.

Sewage

In accordance with MARPOL, sewage effluent must not produce visible floating solids in, nor cause discolouration of the surrounding water. The treatment system must provide primary settling, chlorination and dechlorination before the treated effluent can be discharged into the sea. The discharge depth is variable, depending upon the draught of survey vessel at the time, but should not be less than 5 m below the surface.

Litter

Large numbers of marine organisms, including fish and marine mammals, are killed or injured by becoming entangled in debris (Wallace 1985), while others, including seabirds, are at risk through the ingestion of small plastic particles (Shomura and Yoshida 1985). The problem of litter entering the marine environment has escalated dramatically in recent decades, with an ever-increasing proportion of litter consisting of non-biodegradable plastic materials. Objects that are particularly harmful to marine fauna include plastic bags and bottles, pieces of rope and small plastic particles (Wehle and Coleman 1983). All reasonable measures must be implemented to ensure that no littering takes place during exploration and prospecting activities.

Food (galley) waste

Food waste may be discharged after it has been passed through a grinder in cases where the drilling unit or production facility is located more than 3 nautical miles offshore. Discharge of whole food

waste is permitted beyond 12 nautical miles offshore. The ground wastes must be capable of passing through a screen with openings <25 mm. The daily volume of discharge from a standard drilling unit is expected to be <0.5 m³ (Pulfrich 2015). This volume is not expected to be exceeded for exploration and prospecting activities in Concession 14C.

Detergents

Detergents used for washing exposed marine deck spaces are discharged overboard. The toxicity of detergents varies greatly depending on their composition, but low-toxicity, biodegradable detergents should preferably be used. Those used on work deck spaces should be collected with the deck drainage and treated as described above.

Cooling Water

Electricity on exploration, sampling and associated support vessels is typically provided by diesel-powered engines and generators, which are cooled by pumping water through a set of heat exchangers. The cooling water is then discharged overboard. Other equipment is cooled through a closed loop system, which may use chlorine as a disinfectant. Such water should be tested prior to discharge and should comply with relevant Water Quality Guidelines.

Based on the relatively small volumes of waste that can be expected, the potential impact of operational discharges from exploration and sampling/prospecting on the marine environment are of very low consequence, and the extent is likely to be limited to the immediate area around the vessel(s).

Overall, the potential impact of operational discharges on the marine environment is considered to be of VERY LOW significance. With the implementation of the stipulated mitigation measures this is reduced to INSIGNIFICANT (Table 12). For the cumulative impact assessment; the duration increases to long-term (>15 years) and this raises the overall consequence from very low to low and the overall significance from insignificant to very low. However, our confidence for this assessment decreases from high to low.

Table 12 Waste discharge during vessel operation.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Medium-term 2	Very low 4	Probable	VERY LOW	-ve	High
Best Practice:								
<ul style="list-style-type: none"> • Inform & empower all staff about sensitive marine species & suitable disposal of waste; • Ensure compliance with relevant MARPOL standards; • Develop a waste management plan using waste hierarchy; • A Shipboard Oil Pollution Emergency Plan (SOPEP) must be prepared for all vessels and should be in place at all times during operations; 								

- Deck drainage should be routed to a separate drainage system (oily water catchment system) for treatment to ensure compliance with MARPOL (15 ppm);
- All process areas should be bunded to ensure drainage water flows into the closed drainage system;
- Drip trays should be used to collect run-off from equipment that is not contained within bunded areas and the contents routed to the closed drainage system;
- Low-toxicity biodegradable detergents should be used in the cleaning of all deck spillages;
- All hydraulic systems should be adequately maintained and hydraulic hoses should be frequently inspected; and
- Spill management training should be provided, and crew members made aware of the need for thorough cleaning-up of any spillages immediately after they occur in order to minimise the volume of contaminants washing off decks.

With mitigation	Local 1	Low 1	Short term 1	Very low 3	Improbable	INSIGNIFICANT	-ve	High
Cumulative impacts	Local 1	Low 1	Long term 3	Low 5	Improbable	VERY LOW	-ve	Low

3.1.7 Impacts on fisheries

According to the International Regulations for Preventing Collisions at Sea (Colregs 1972), vessels engaged in seismic surveys are recognised as vessels limited in their ability to manoeuvre and as such, vessel engaged in other activities (such as fishing) are obliged to give way. Furthermore, the implementation of a safety (exclusion) zone around the seismic vessel will exclude any other users of the sea from these areas. In practice, this exclusion zone takes form of a moving footprint extending around the survey vessel (Mason 2017). In this case, the size of the footprint can be expected to be around 500 m in extent.

Exclusion of fishing vessels from fishing areas, possible altered behaviour of fish due to seismic activities and interference with shipping could have (indirect) socio-economic implications for the affected industries. Fisheries might be affected by target species avoiding seismic survey areas for several days after the survey has terminated or the vessel has moved on (Mason 2017). Fisheries can also be indirectly impacted should prospecting activities negatively impact fish reproduction and recruitment, e.g., impairment of egg or larval survival due to increased turbidity in the water column resulting from sediment plumes generated by sampling activities.

Fisheries sectors operating within Concession 14C that could be impacted include those listed in section 2.5 (small pelagic purse seine, tuna pole and line, and traditional linefish). Overlap with each of these sectors is shown in Figure 15, Figure 17 and Figure 18– the catches from these sectors made within the concession area 14C are all of limited significance as a proportion of the national total catch of each of these fisheries but they may be important at the individual vessel, right holder or fisher level. Due to the short-term nature and small degree of overlap of proposed prospecting in 14C with fisheries and fish nursery areas, the impact is assessed to be VERY LOW and INSIGNIFICANT with implementation of mitigation to avoid fishing seasons and inform key stakeholders from the potentially affected Small pelagic, Tuna Pole and line, and Traditional Linefish sectors (Table 13). The cumulative potential impact on fisheries due to the proposed prospecting activities within 14C in

combination with other anthropogenic activities along the west coast is assessed as LOW overall negative significance with the implementation of the same mitigation.

Table 13 Impact on fisheries.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Short-term 1	Very Low 4	Probable	VERY LOW	-ve	High
Essential mitigation measures:								
<ul style="list-style-type: none"> • Prior to survey commencement, key stakeholders (see below) should be consulted and informed of the proposed survey activity and the likely implications thereof. • Conduct the survey outside of the main fishing season in this area (i.e. Conduct prospecting during August – December, avoiding the small pelagic fishing during January-July and snoek line fishing peak during April- May). 								
With mitigation	Local 1	Medium 2	Short-term 1	Very Low 4	Possible	INSIGNIFICANT	-ve	High
Cumulative Impact with mitigation	Regional 2	Medium 2	Long-term 1	Low 5	Probable	LOW	-ve	Low

Recommended stakeholder consultation during prospecting planning and operations.

Prior to survey commencement, the following key stakeholders should be consulted and informed of the proposed survey activity (including navigational co-ordinates of the survey area, timing and duration of proposed activities) and the likely implications thereof:

- Fishing industry / associations (contactable via liason@fishsa.org):
 - SA Marine Linefish Management Association (SAMLMA);
 - South African Pelagic Fishing Industry Association (SAPFIA);
 - South African Tuna Association (SATA);
 - South African Tuna Longline Association (SATLA)
 - Large Pelagic Small Medium & Micro Enterprises Association (LPSMME)
 - Local fishing communities;
- Other associations and organs of state
 - DFFE;
 - SAMSA;
 - South African Navy Hydrographic office; and
 - Overlapping and neighbouring right holders.

These stakeholders should again be notified at the completion of surveying when the survey vessel(s) is/are off location. The operator must request, in writing, that the South African Navy Hydrographic office release Radio Navigation Warnings and Notices to Mariners throughout the survey periods. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey area, (2) an indication of the proposed timeframes of surveys and day-to-day location of the survey vessel(s), and

(3) an indication of the required safety zone(s) and the proposed safe operational limits of the survey vessel. These Notices to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.

4 CONCLUSIONS AND RECOMMENDATIONS

Anchor Environmental Consultants were requested to undertake a marine specialist study for Trans Atlantic Diamonds (Pty) Ltd who are applying for a diamond prospecting right for Concession Area 14C, offshore of the Western Cape Coast. Proposed activities include geophysical exploration and sampling/prospecting to detect the presence of palaeo-beach deposits at different submerged sea levels that occur in Concession 14C, which are known from other concessions to contain diamondiferous gravels. Seismic surveying will be conducted using a dedicated survey vessel with a hull-mounted MBES (high frequency range) and Topas sub-bottom profiler (SBP) system (mid-frequency range) collecting high-resolution acoustic data along lines 50 m to 200 m apart throughout the concession area. A description of the affected environment is provided. Habitat and biota of conservation importance were identified and mapped in relation to the proposed survey area. The likelihood of occurrence of affected marine fauna within the proposed survey area was ascertained from available literature. Important user groups such as fisheries are described and mapped in relation to the proposed survey area. Potential impacts from the proposed exploration and prospecting activities were identified. Impacts were assessed and, where possible, mitigation measures have been identified to avoid/minimise/reduce any impacts.

Assessment of potential impacts associated with the proposed activities range from medium to insignificant but with effective mitigation these are all reduced to very low, low or insignificant (Table 14). The potential impact of most concern that was assessed as Medium negative significance prior to mitigation, was seismic disturbance to marine mammals. It is known that migrating humpback and southern right whales are frequently encountered on the west coast of southern Africa and encounters with odontocetes such as dusky dolphins and Heaviside's dolphin (listed as near threatened on the IUCN red data list – Elwen *et al.* 2010) are likely throughout the year. Furthermore, humpback calves are vulnerable during the southern migration which takes place during the months of September and October.

Of the proposed seismic survey activities, the Topas sub-bottom profiler system which uses shallow (35-45 kHz) and medium penetration (1-10 kHz) "Chirp" seismic pulses to map the sediment horizon could present a risk to dusky and Heaviside's dolphins. These species are regarded as mid-frequency cetaceans (Simon Elwen *pers. comm.*) that could be at risk during the proposed seismic survey. A noise modelling study (using marine mammal noise exposure criteria from Southall *et al.* (2019) that was undertaken in Greenland in 50-250 m water depth for a similar MBES and Chirp sub-bottom profiler geophysical survey system predicted worst case scenario impact ranges for HF and LF cetacean hearing groups of less than 100 m for both PTS and TTS (Barham and Mason 2021). It is recommended that MMSOs be on duty during the proposed seismic survey activities and as a precaution, the listed mitigation measures are followed. Should seismic surveys continue into the night or during periods of low visibility (mist is frequently encountered at sea along the west coast), it is also recommended that a passive acoustic monitoring (PAM) system be used. Seismic surveying must be confined to seasons when cetaceans are scarce to ensure minimal disturbance (Gründlingh *et al.* 2006). Implementation of these mitigation measures should ensure that potential impacts on marine mammals arising from the proposed seismic survey activities in concession 14C would be unlikely.

Temporary exclusion of fishing vessels from the concession area during seismic survey and sampling/prospecting activities is also of potential concern. The historical fishing catch and effort reported by the potentially affected small pelagic, tuna pole and traditional handline sectors in the

14C concession area is of limited national importance but may well be significant at an individual vessel and right holder level. The offshore location of the 14C concession area means that impacts on local small-scale fisherman due to prospecting in this concession area are highly unlikely. Overall, the potential impacts on fisheries are assessed to be of VERY LOW negative significance. Offshore reef habitat is expected to be encountered in concession 14C (Figure 4). These reefs are considered sensitive habitat and it is recommended that they be visually assessed (by means of drop camera deployments or remotely operated underwater vehicle) during the baseline environmental survey with regular repeat surveys in the event of future mining operations in the area – offshore reefs may not be directly impacted (mined) but are at risk of being indirectly impacted by smothering from tailings disposal. These offshore rocky reefs are colonised by a range of epifauna including bryozoans, encrusting and upright sponges, solitary and colonial ascidians, sea anemones and cold-water coral colonies – the latter being slow-growing and taking many years to become established (Biccard *et al.*, 2020b). Studies undertaking assessments of prospecting and mining-related impacts on these habitats in this region are relatively new and the time taken for disturbed epifaunal communities inhabiting offshore rocky reefs to recover has not yet been determined (Biccard *et al.*, 2020b).

Table 14 Summary table of potential marine ecological and fisheries impacts associated with offshore diamond exploration activities (seismic survey and sampling/prospecting) in South African Sea Area concession 14C.

Impact	Consequence	Probability	Significance	Status	Confidence
Seismic disturbance to invertebrates No mitigation	Very low	Possible	INSIGNIFICANT	-ve	Medium
Cumulative Impact	Medium	Possible	LOW	-ve	LOW
Seismic disturbance to fish No mitigation	Very low	Possible	INSIGNIFICANT	-ve	High
Cumulative Impact	Medium	Possible	LOW	-ve	Low
Seismic disturbance to marine mammals	Medium	Probable	MEDIUM	-ve	Medium
With mitigation	Low	Improbable	VERY LOW	-ve	Medium
Cumulative Impact	High	Improbable	MEDIUM	-ve	Low
Seismic disturbance to seabirds	Low	Probable	LOW	-ve	High
With mitigation	Very low	Improbable	INSIGNIFICANT	-ve	High
Cumulative Impact	High	Improbable	MEDIUM	-ve	Low
Seismic disturbance to turtles	Very low	Improbable	INSIGNIFICANT	-ve	High

With mitigation	Very low	Improbable	INSIGNIFICANT	-ve	High
Cumulative impact	Medium	Improbable	LOW	-ve	Low
Marine megafauna collisions with survey vessels	Low	Possible	VERY LOW	-ve	High
With mitigation	Very Low	Improbable	INSIGNIFICANT	-ve	High
Cumulative impact	Medium	Possible	LOW	-ve	Low
Offshore based seabed sampling and tailings disposal No mitigation	Low	Definite	LOW	-ve	High
Cumulative impact	Medium	Possible	LOW	-ve	Low
Fine sediment plumes No mitigation	Very low	Definite	VERY LOW	-ve	High
Cumulative impact	Very low	Definite	VERY LOW	-ve	Low
Waste discharges during vessel operations	Very low	Probable	VERY LOW	-ve	High
With mitigation	Very low	Improbable	INSIGNIFICANT	-ve	High
Cumulative impact	Low	Improbable	VERY LOW	-ve	Low
Impact on fisheries	Very Low	Probable	VERY LOW	-ve	High
With mitigation	Very Low	Possible	INSIGNIFICANT	-ve	High
Cumulative Impact	Low	Probable	LOW	-ve	Low

5 REFERENCES

- Au WWL and Green M. (2000). Acoustic interaction of humpback whales and whale-watching boats. *Mar. Env. Res.* 49: 469-481.
- Au WWL. (1993). *The Sonar of Dolphins*. Springer-Verlag: New York. 277 pp.
- Bain DE and Dahlheim ME. (1994). Effects of masking noise on detection thresholds of killer whales. In: Loughlin, T.R. (Ed), *Marine Mammals and the Exxon Valdez*. 4th Edition. Academic Press, San Diego: 243-256.
- Baker R and Arnott N. (2021). Basic Assessment for a Prospecting Right Application for South African Sea Areas 4C and 5C, West Coast, South Africa. Prepared by SLR Consulting (South Africa) (Pty) Ltd for De Beers Marine (Pty) Ltd on behalf of De Beers Consolidated Mines (Pty) Ltd. SLR Project No: 720.04062.00006
- Bakun A. 1996. *Patterns in the ocean: ocean processes and marine population dynamics*. La Paz, Mexico: University of California Sea Grant Program, San Diego, California, USA, in cooperation with Centro de Investigaciones Biologicas de Noroeste.
- Barendse J, Best PB, Thornton M, Elwen SH, Rosenbaum HC, Carvalho I, Pomilla C, Collins TJQ and MA Meÿer. (2011). Transit station or destination? Attendance patterns, regional movement, and population estimate of humpback whales *Megaptera novaeangliae* off West South Africa based on photographic and genotypic matching. *African Journal of Marine Science*, 33(3): 353-373.
- Barham R and Mason T. (2021). Modelling of underwater noise from geophysical survey activity, West Greenland. Subacoustech Environmental Report No. P285R0101. 41 pp.
- Barros F, Underwood A.J and Lindegarth M. (2001). The influence of rocky reefs on structure of benthic macrofauna in nearby soft-sediments. *Estuarine, Coastal and Shelf Science* 52: 191-199.
- Bauer GB, Mobley JR and Herman LM. (1993). Responses of wintering humpback whales to vessel traffic. *J. Acoust. Soc. Am.* 94: 1848.
- Best PB, Crawford RJM & van der Elst RP. 1997. Top predators in southern Africa's marine ecosystems. *Transactions of the Royal Society of South Africa*, 52: 177-225.
- Best PB. 2007. *Whales and dolphins of the southern African subregion*. Cape Town: Cambridge University Press.
- Biccard A and Clark BM. (2014b): Zircon Roode Heuvel Mine, Northern Cape, South Africa. Marine Specialist Study and Impact Assessment. Report prepared by Anchor Environmental Consultants (AEC) for Coastal & Environmental Services.
- Biccard A and Clark BM. (2011). Marine ecology specialist study and impact assessment for upgrades to seawater intake and transfer infrastructure at the tronox namakwa sands mine. Marine Specialist Study and Impact Assessment. Report prepared by Anchor Environmental Consultants (AEC) for SRK Consulting.
- Biccard A, Gihwala K, Clark BM, Mostert B, Brown E, Hutchings K, Massie V and M Melidonis. (2018). Desktop study of the potential impacts of marine mining on marine ecosystems and marine biota in South Africa – Final report. Report prepared by Anchor Research & Monitoring (Pty) Ltd for Council for Geoscience. Report no. 1795/1.

- Biccard A, Gihwala K, Clark BM, Sedick S, Brown EA, Mostert BP, Swart C, Mtsokoba S, Tshingana B, Makhosonke A and J Dawson. (2020a). De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining Licence Area: 2018 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1807.
- Biccard A, Gihwala K, Clark BM, Sedick S, Swart C, Brown EA, Mostert BP, Dawson J, Mtsokoba S, Makhosonke A and Schmidt K. (2020b). De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining Licence Area 2019 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. AEC 1840.
- Biccard A, Hutchings K, Wright AG, Mostert BM, Sedick S and Clark BM. (2020c). The State of St Helena Bay 2020. Report No. AEC 1908/1 prepared by Anchor Environmental Consultants (Pty) Ltd for the St Helena Bay Water Quality Trust. pp 113.
- BirdLife International 2013. Marine e-Atlas: Delivering site networks for seabird conservation. Proposed IBA site 'Atlantic, Southeast 19 – Marine'. Available online: <http://54.247.127.44/marineIBAs/default.html>. Accessed 11 March 2022.
- Blackwell SB, Lawson JW and Williams MT. (2004). Tolerance by ringed seals (*Phoca hispida*) to impact pipe-driving and construction sounds at an oil production island. – *Journal of the Acoustical Society of America* 115: 2346-2357.
- Branch G and Branch M. (2018). Marine Mining. In: *The Living Shores of Southern Africa*. Struik Publishers (Pty) Ltd. 266-273.
- Branch GM and Griffiths CL. (1988). The Benguela ecosystem part V: the coastal zone. *Oceanography and Marine Biology Annual Review* 26: 395-486.
- Branch GM, Griffiths CL, Branch ML and Beckley LE. (2010). *Two Oceans: A Guide to the Marine Life of Southern Africa*. Struik Nature, Cape Town.
- Branch GM. (1981). *The Living Shores of Southern Africa*. Struik Publishers (Pty) Ltd. Cape Town.
- Brown A. (2000). Is the sandy beach isopod *Tylos granulatus* an endangered species? *South African Journal of Science* 96: 466.
- Brown AC and Mclachlan A. (2002). Sandy shore ecosystems and the threats facing them: some predictions for the year 2025. *Environmental Conservation* 29(1):1-16.
- California Coastal Commission (CCC). (2004). *Seawater Desalination and the California Coastal Act*. March 2004. (Source: <http://www.coastal.ca.gov>)
- Calliari LJ, Klein AHF, Barros FCR. (1996). Beach differentiation along the Rio Grande do Sul coastline (Southern Brazil). *Revista Chilena de Historia Natural* 69: 485-493.
- Carter RA and Midgley J. (2000). Characteristics of fine tailings plumes generated by ship-based marine diamond mining off Lüderitz: Dimensions and effects on water quality. *Proceedings of the Symposium on Co-Management of Resources off the southwestern coast of Africa, Lüderitz, Namibia, 20-24 June 2000*.
- Castro P and Huber M. (1997). Chapter 12: Life on the Continental Shelf. In: McGraw-Hill. P (ed.). *Marine Biology, Second Edition*. 260-266.

- Child MF, Roxburgh L, Do Linh San E, Raimondo D and Davies-Mostert HT. (editors). (2016). The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa. <https://www.ewt.org.za/Reddata/Order%20Cetacea.html>).
- Clark BM, Bennett BA and Lamberth SJ. (1996). Factors affecting spatial variability in seine net catches of fish in the surf-zone of False Bay, South Africa. *Marine Ecology Progress Series* 131: 17-34.
- Clark BM, Hutchings K, Biccard A, Brown E, Dawson J, Laird M, Gihwala K, Swart C, Makhosonke A, Sedick S, Turpie J and Mostert B. (2020). The State of Saldanha Bay and Langebaan Lagoon 2020, Technical Report. Report No. AEC 1876/1 prepared by Anchor Environmental Consultants (Pty) Ltd for the Saldanha Bay Water Quality Forum Trust, October 2020.
- Clark BM, Meyer WF, Ewart-Smith C, Pulfrich A and Hughes J. (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. 63.
- Cockcroft AC, van Zyl D & Hutchings L. 2008. Large-scale changes in the spatial distribution of South African West Coast lobsters: an overview. *African Journal of Marine Science*, 30: 149-159.
- Coetzee JC, van der Lingen C, Hutchings L & Fairweather TP. 2008. Has the fishery contributed to a major shift in the distribution of South African sardine? *ICES Journal of Marine Science*, 65: 1676-1688.
- Crawford RJM, Ryan PG and Williams AJ. (1991). Seabird consumption and production in the Benguela and Western Agulhas ecosystems, *South African Journal of Marine Science*, 11:1, 357-375, DOI: 10.2989/025776191784287709
- Crawford RJM, Sabarros PS, Fairweather T, Underhill LG & Wolfaardt AC. 2008a. Implications for seabirds off South Africa of a long-term change in the distribution of sardine. *African Journal of Marine Science*, 30: 177-184.
- Crawford RJM, Tree AJ, Whittington PA, Visagie J, Upfold L, Roxburg KJ, Martin AP & Dyer BM. 2008b. Recent distributional changes of seabirds in South Africa: is climate having an impact? *African Journal of Marine Science*, 30: 189-193.
- CSIR. 1998. ODM Tailings Plume Monitoring, February 1998. CSIR Report, 17 pp + Figs.
- Cury P, Bakun A, Crawford RJM, Jarre A, Quinones RA, Shannon LJ, and Verheye HM. 2000. Small pelagics in upwelling systems: patterns of interaction and structural changes in “wasp-waist” ecosystems. *ICES Journal of Marine Science* 57: 603–618.
- DEFF (Department of Environment, Forestry and Fisheries). 2020. Status of the South African marine fishery resources 2020. Cape Town: DEFF.
- DFFE, Fishing Right Register for all Commercial Fishing Sectors 2017). Downloaded from: <https://www.dalrrd.gov.za/Branches/Fisheries-Management/-Fishing-Rights-Allocation-Process-FRAP> 20 October 2021.
- Dingle RV & Hendry QB. 1984. Late Mesozoic and Tertiary sediment supply to the eastern Cape Basin (SE Atlantic) and paleo-drainage systems in southwestern Africa. *Marine Geology*, Vol. 56, pp. 13-26.
- Erbe C. (2002). Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. *Mar. Mamm. Sci.* 18: 394-418.

- Field JG and Griffiths CL. (1991). Littoral and Sublittoral Ecosystems of Southern Africa. In: A.C. Mathieson and P.H. Nienhuis (eds). Ecosystems of the World 24. Intertidal and Littoral Ecosystems. Elsevier Science Publishers, Amsterdam.
- Findlay KP. (1996). The impact of diamond mining noise on marine mammal fauna off southern Namibia. Specialist Study #10. In: Environmental Impact Report. Environmental Evaluation Unit (ed.) Impacts of deep sea diamond mining, in the Atlantic 1 Mining Licence Area in Namibia, on the natural systems of the marine environment. No. 11-96-158, University of Cape Town. Report to De Beers Marine (Pty) Ltd. 370
- Finley KJ, Miller GW, Davis RA and Greene CR. (1990). Reactions of belugas, (*Delphinapterus leucas*) and narwhals (*Monodon monoceros*) to ice-breaking ships in the Canadian high arctic. *Can. Bull. Fish. Aquat. Sci.* 224: 97-117.
- Gisiner RC. (1998). Proceedings: Workshop on the Effects of Anthropogenic Noise in the Marine Environment. Office of Naval Research.141.
- Gordon JCD, Leaper R, Hartley FG and Chappell O. (1992). Effects of whale watching vessels on the surface and underwater acoustic behaviour of sperm whales off Kaikoura, New Zealand. NZ Department of Conservation. Science and Research Series 52: 64.
- Gründlingh ML, Morant PD, van Ballegooyen RC, Badenhorst A, Gomes E, Greyling L, Guddal J, Hunter IT, Japp DW, Maartens L, Peard KR, Smith GG and Wainman CK. (2006). Environmental data requirements of maritime operations in the Benguela coastal ocean. In *Benguela: Predicting a Large Marine Ecosystem*. Eds: Shannon V, Hempel G, Malanotte-Rizzoli P, Moloney C, Woods J. Elsevier BV, Amsterdam; *Large Marine Ecosystems* 14: 357-380.
- Gurney JJ, Levinson AA & Smith HS. 1991. Marine mining of diamonds off the west coast of southern Africa: *Gems and Gemology*, v. 27, p. 206–219.
- Harris LR, Bessinger M, Dayaram A, Holness S, Kirkman S, Livingstone TC, Lombard AT, Lück-Vogel M, Pfaff M, Sink KJ, Skowno AL, Van Niekerk L. (2019). Advancing land-sea integration for ecologically meaningful coastal conservation and management. *Biological Conservation* 237, 81-89.
- Hitchcock DR and Drucker BR. (1996). Investigation of benthic and surface plumes associated with marine aggregates mining in the United Kingdom. In *the Global Ocean - towards operational oceanography*. Proc. Conf. Oceanology Int. Spearhead Publications, Surrey Conference Proceedings 2: 221-84.
- Holness S, Kirkman S, Samaai T, Wolf T, Sink K, Majiedt P, Nsiangango S, Kainge P, Kilongo K, Kathena J, Harris L, Lagabrielle E, Kirchner C, Chalmers R, Lombard M. (2014). Spatial Biodiversity Assessment and Spatial Management, including Marine Protected Areas. Final report for the Benguela Current Commission project BEH 09-01.
- Hutchings L, Beckley L E, Griffiths M H, Roberts M J, Sundby S, and C van der Lingen 2002. Spawning on the edge: spawning grounds and nursery areas around the southern African coastline. *Mar. Freshwater Res.* 53, 307–318.
- Hutchings L, van der Lingen CD, Shannon LJ, Crawford RJM, Verheye HMS, Bartholomae CH, van der Plas AK, Louw D, Kreiner A, Ostrowski M, Fidel Q, Barlow RG, Lamont T, Cotzee J, Shillington F, Veitch J, Currie JC & Monteiro PMS. 2009. The Benguela Current: An ecosystem of four components. *Progress in Oceanography* 83: 15 – 32.

- Japp, D and S. Wilkinson (2021). Environmental impact assessment for marine prospecting activities in South African sea areas 14b, 15b and 17b west coast, South Africa Fisheries Assessment prepared by Capricorn Marine Environmental for SLR and Belton Park Trading. 55p.
- Johnson SA. 1981. Estuarine dredge and fill activities: A review of impacts. *Environ. Man.* 5: 427-440.
- Karenzi N. (2014). Patterns and drivers of benthic macrofauna to support systematic conservation planning for marine unconsolidated sediment ecosystems. PhD thesis. Nelson Mandela Metropolitan University, Port Elizabeth.
- Kemper J. Underhill LG. Crawford RJM. & Kirkman SP. 2007. Revision of the conservation status of seabirds and seals breeding in the Benguela Ecosystem. In: Kirkman SP (ed.) Final Report of the BCLME (Benguela Current Large Marine Ecosystem) Project on Top Predators as Biological Indicators of Ecosystem Change in the BCLME. Avian Demography Unit, Cape Town, pp 325–342.
- Kirk JTO. (1985). Effects of suspensoids on penetration of solar radiation in aquatic ecosystems. *Hydrobiol.*, 125: 195-208.
- Koper RP and Plön S. (2012). The potential impacts of anthropogenic noise on marine animals and recommendations for research in South Africa. EWT Research and Technical Paper No. 1. Endangered Wildlife Trust, South Africa.
- Lagabriele E. (2009). Preliminary report: National Pelagic Bioregionalisation of South Africa. Cape Town: South African National Biodiversity Institute.
- Laird MC and Clark BM. (2018). Marine Environmental Impact Assessment for the Proposed Extension of Tormin Mine, West Coast, South Africa. Report no. 1743/3 prepared for SRK Consulting South Africa (Pty) Ltd by Anchor Environmental Consultants (Pty) Ltd. 69.
- Laird MC, Hutchings K, Liebau V and Clark BM. (2014). Marine Ecology Baseline Report for Proposed Abalone Aquaculture Farm at Brand-se-Baai, West Coast, South Africa. Prepared by Anchor Environmental Consultants for SRK Consulting. 37.
- Lane SB and Carter RA. (1999). Generic Environmental Management Programme for Marine Diamond Mining off the West Coast of South Africa. Marine Diamond Mines Association, Cape Town, South Africa. 6 Volumes.
- Lee K, Azetsu-Scott K, Cobanli SE, Dalziel J, Niven S, Wohlgeschaffen G, Yeats P. 2005. Overview of potential impacts from produced water discharges in Atlantic Canada. In: al. Ae (ed) Offshore oil and gas environmental effects monitoring Approaches and technologies. Batelle Press, Columbus, Ohio, p. 319-342.
- Lenanton RCJ, Robertson AI and Hansen JA. (1982). Nearshore accumulations of detached macrophytes as nursery areas for fish. *Marine Ecology Progress Series* 9: 51-57.
- Lesage V, Barrette C, Kingsley MCS and Sjare B. (1999). The effect of vessel noise on the vocal behavior of belugas in the St. Lawrence River Estuary, Canada. *Mar. Mamm. Sci.*, 15: 65-84.
- Leung-Ng S and Leung S. (2003). Behavioural response of Indo-Pacific humpback dolphin (*Sousa chinensis*) to vessel traffic. *Mar. Env. Res.* 56: 555-567.
- Levinson O. (1983) *Diamonds in the Desert*. Talelberg, Cape Town.

- MacDonald WG and Rozendaal A. (1995). The Geelwal Karoo heavy mineral deposit: a modern day beach placer. *Journal of African Earth Science* 21(1): 187-200.
- Majiedt P, Holness S, Sink K, Oosthuizen A, Chadwick P. (2013). Systematic Marine Biodiversity Plan for the West Coast of South Africa. South African National Biodiversity Institute, Cape Town.
- Mason S. (2017). Offshore Seismic Survey/s in the Orange Basin Deep Block, West Coast, South Africa. Environmental Impact Assessment. Report Prepared for Impact Africa Limited by SRK Consulting. Report Number 515843/3 PASA. Reference Number: 12/3/335 ER.
- Mate BR, Best PB, Lagerquist BA and MH Winsor. (2011). Coastal, offshore and migratory movements of South African right whales revealed by satellite telemetry. *Marine Mammal Science*, 27(3): 455-476.
- Maybaum HL. (1993). Responses of humpback whales to sonar sounds. *J. Acoust.Soc. Am.* 94: 1848-1849.
- McCauley RD, Fewtrell J, Duncan AJ, Jenner C, Jenner MN, Penrose JD, Prince RIT, Adhitya A, Murdoch J and McCabe K. (2000). Marine seismic surveys: A study of environmental implications. *APPEA Journal*: 692-706.
- McCauley RD, Fewtrell J, Duncan AJ, Jenner C, Jenner MN, Penrose JD, Prince RIT, Adhitya A, Murdoch J and McCabe K. 2000. Marine seismic surveys: A study of environmental implications. *APPEA Journal*: 692-706.
- McCauley RD. (1994). Seismic surveys. In: SWAN, J.M., NEFF, J.M. and P.C. YOUNG, (Eds.) *Environmental Implications of Offshore Oil and Gas Development in Australia - The findings of an Independent Scientific Review*. APEA, Sydney. 19-122
- McLachlan A. (1980). The definition of sandy beaches in relation to exposure: a simple rating system. *South African Journal of Science* 76: 137-139.
- Meÿer MA, Best PB, Anderson-Reade MD, Cliff G, Dudley SFJ and Kirkman SP. (2011). Trends and interventions in large whale entanglement along the South African coast. *African Journal of Marine Science* 33(3): p429–439.
- Meyer W and Clark BM. (1999). Description of the Environment of the South African West Coast Marine Diamond Mining Concession 'a'. Anchor Environmental Consultants report compiled for Sue Lane and Associates and Robin Carter for use in the compilation of Environmental Management Programmes, to be instituted by individual concession holders.
- Miller PJO, Biasson N, Samuels A and Tyack PL. 2000. Whale songs lengthen in response to sonar. *Nature* 405: 903.
- Monteiro PMS. (1998). Assessment of sediment biogeochemical characteristics in the Espirito Santo Estuary-Maputo, Bay system in order to devise a low risk dredging-disposal management plan linked to the proposed MOZAL Matola Terminal. CSIR Report No: ENV/s-C98131 A. 39.
- Mostert BP, Biccard AB, Duna OO and Clark BM. (2016). Baseline survey of the benthic marine environment in the South African diamond mining Concession areas: 1B and 1C. Report prepared for Alexkor and Placer Resource Management by Anchor Environmental Consultants. Report no. 1696/1.
- NOAA. (1998). Fact Sheet: Small Diesel Spills (500-5000 gallons) Available at: <http://response.restoration.noaa.gov/oilands/diesel.pdf>

- Norman SJ, Wilkinson SJ, Japp DW, Reed J, Sink KJ. (2018). A Review of the Spatial Management of South Africa's Offshore Fisheries. CAP Marine Environmental (Pty) Ltd., South African Biodiversity Institute.
- Nowacek DP, Johnson MP and Tyack PL. (2004). North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. Proc. R. Soc. Lond. B. 271: 227-231.
- Nowacek DP, Wells RS and Tyack PL. (2001). A platform for continuous behavioral and acoustic observation of free-ranging marine mammals: Overhead video combined with underwater audio. Mar. Mamm. Sci. 17(1): 191-199.
- Nowacek SM and Wells RS. (2001). Short term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. Mar. Mamm. Sci. 17: 673-688.
- Nowacek, DP, Broker, K, Donovan, G, Gailey, G, Racca, R, Reeves, R, Vedenev, AI, Weller, D, & B Southall, (2013). Responsible Practices for Minimizing and Monitoring Environmental Impacts of Marine Seismic Surveys with an Emphasis on Marine Mammals. Aquatic Mammals. 39. 356-377. 10.1578/AM.39.4.2013.356. NRC. (2003). Ocean noise and marine mammals. National Academy Press, Washington, DC.
- NRC. (2003). Ocean noise and marine mammals. National Academy Press, Washington, DC.
- O'Toole MJ. (1997). A baseline environmental assessment and possible impacts of exploration and mining of diamond deposits (Prospecting Grants Areas M46/3/1946, 1950) off the coast of Namibia. In: LANE, S and CMS, 1996. Environmental Assessment and Management Plan report for deep sea diamond mining in Namibia by Arena Mining (Pty) Ltd.
- Parsons TR, Kessler TA and Guanguo L. (1986a). An ecosystem model analysis of the effect of mine tailings on the euphotic zone of a pelagic ecosystem. Acta Oceanol. Sin. 5: 425-436.
- Parsons TR, Thompson P, Wu Yong, Lallo CM, Hou Shumin and Xu Huaishu. (1986b). The effect of mine tailings on the production of plankton. Acta Oceanol. Sin. 5: 417-423.
- Penney AJ, Pulfrich A, Rogers J, Steffani N & Mabile V. 2007. Data Gathering and Gap Analysis for Assessment of Cumulative Effects of Marine Diamond Mining Activities on the BCLME Region. Project: BEHP/CEA/03/02. Final Report to the BCLME mining and petroleum activities task group. March 2008. 410pp.
- Penney AJ, Pulfrich A, Rogers J, Steffani N and Mabile V. (2007). Project: BEHP/CEA/03/02: Data Gathering and Gap Analysis for Assessment of Cumulative Effects of Marine Diamond Mining Activities on the BCLME Region. Final Report to the BCLME mining and petroleum activities task group. March 2008. 410.
- Pichegru L, Nyengera R, Sutton G, Arnould J, Pistorius P. (2016). Influence of seismic surveys on African and Little Penguin behaviour. Unpublished poster presented at Birdlife Africa Conference, Kruger National Park, March 2016.
- Poopech T. (1982). Potential effects of offshore tin mining on marine ecology. Proceedings of the Working Group Meeting on environmental management in mineral resource development. Mineral Resource Development Series 49: 70-73.

- Popper AN, Hawkins AD, Fay RR, Mann D, Bartol S, Carlson T, Coombs S, Ellison WT, Gentry R, Halvorsen MB, Løkkeborg S, Rogers P, Southall BL, Zeddies D and Tavolga WN. (2014). "Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report," ASA S3/SC1.4 TR-2014 prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer and ASA Press, Cham, Switzerland.
- Pulfrich A and Branch GM. (2014). Using diamond-mined sediment discharges to test the paradigms of sandy-beach ecology. *Estuarine, Coastal and Shelf Science* 150: 165-178.
- Pulfrich A. (2002a). The Potential Effects of Increased Sediment Disposal from the Elizabeth Bay Mine on Intertidal and Subtidal Communities. Prepared by Pisces Environmental Services (Pty) Ltd for CSIR Environmentek. 103.
- Pulfrich A. (2004). Baseline Survey of Sandy Beach Macrofaunal Communities at Elizabeth Bay: Beach Monitoring Report – 2004. Prepared for NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, on behalf of CSIR Environmentek. 53.
- Pulfrich A. (2005). Survey of Intertidal and Subtidal Rocky Shore Communities at Elizabeth Bay: Intertidal and Subtidal Monitoring Report – 2005. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia. 39.
- Pulfrich A. (2006). Survey of Intertidal and Subtidal Rocky Shore Communities at Elizabeth Bay: Intertidal and Subtidal Monitoring Report – 2006. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, May 2006. 39.
- Pulfrich A. (2007). Survey of Intertidal and Subtidal Rocky Shore Communities at Elizabeth Bay: Intertidal and Subtidal Monitoring Report – 2007. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, May 2007. 64.
- Pulfrich A. (2011b). The Potential Impacts of Heavy Mineral Sands Mining on Sandy-beach and Rocky Shore Communities: Specialist Study for the Tormin EIA. PISCES Environmental Services (Pty) Ltd. 88pp.
- Pulfrich A. (2016). Environmental Impact Assessment in support of the amendment to the mining right held by the West Coast Resources (Pty) Ltd over the Namaqualand Mines, Northern Cape Province. Report prepared for Myezo Environmental Management Services.
- Pulfrich A. (2017). Amendment of Environmental Management Programmes for Mining Rights 554MRC, 10025MRC, 512MRC and 513MRC. Report prepared for SLR Environmental Consulting (Pty) Ltd.
- Pulfrich A. (2021). Proposed 3D Seismic Exploration in Block 1 off the West Coast of South Africa: Marine Faunal Specialist Assessment. Report prepared by Pisces Environmental Services (Pty) Ltd. for Environmental Impact Management Services on behalf of Tosaco Energy (Pty) Ltd. Pp 223.
- Pulfrich A. 2015. Environmental Impact Assessment for the proposed development of the Ibhusesi Gas Project. Marine Ecology Specialist Assessment. Prepared for CCA Environmental (Pty) Ltd. on behalf of Sunbird Energy (Pty) Ltd. by Pisces Environmental Services (Pty) Ltd. 156 pp.
- Pulfrich, A. (2002b). The Potential Effects of Sediments Derived from Proposed Pocket-beach Mining in the Bogenfels Licence Area, on Intertidal and Subtidal Benthic Communities. Prepared by Pisces Environmental Services (Pty) Ltd for Namdeb Diamond Corporation (Pty) Ltd. 116.

- Richardson WJ and Malme CI (1993). Man-made noise and behavioral responses. In Burns JJ, Montague JJ and Cowles CJ (eds) *The bowhead whale*. Society for Marine Mammalogy, Lawrence, Kansas. 631-700.
- Richardson WJ and Würsig B. (1997). Influences of man-made noise and other human activities on cetacean behavior. *Mar. Freshw. Behav. Physiol.* 29: 13-209.
- Richardson WJ, Greene CR, Malme CI and Thomson DH. (1995). *Marine Mammals and Noise*. Academic Press, San Diego, CA.
- Richardson WJ, Würsig B and Jr CRG. (1986). Reactions of Bowhead Whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. *J. Acoust. Soc. Am.* 79: 1117-1128.
- Richardson WJ, Würsig B and Jr CRG. (1990). Reactions of Bowhead Whales, *Balaena mysticetus*, to drilling and dredging noise in the Canadian Beaufort Sea. *Mar. Env. Res.* 29:135-160.
- Roberson LA, Lagabriele E, Lombard AT, Sink K, Livingstone T, Grantham H, Harris JM. (2017). Pelagic bioregionalisation using open-access data for better planning of marine protected area networks. *Ocean & Coastal Management*, 148: 214-230.
- Roux JP, van der Lingen CD, Gibbons MJ, Moroff NE, Shannon LJ, Anthony DM, Smith J & Cury P. 2013. Jellyfication of marine ecosystems as a likely consequence of overfishing small pelagic fishes: lessons learned from the Benguela. *Bulletin of Marine Science*, 89 (1): 249-284.
- Roy C, van der Lingen CD, Coetzee JC & Lutjeharms JRE. 2007. Abrupt environmental shift associated with changes in the distribution of Cape anchovy *Engraulis encrasicolus* spawners in the southern Benguela. *African Journal of Marine Science*, 29: 309-319.
- Scholes R, Lochner P, Schreiner G, Snyman-Van der Walt L and de Jager M. (eds.). (2016). *Shale Gas Development in the Central Karoo: A Scientific assessment of the Opportunities and Risks*, Preface. CSIR Report Number, ISBN. 13. <https://doi.org/10.1111/faf.12283>
- Shannon LV and Pillar SC. (1986). The Benguela ecosystem. 3. Plankton. In *Oceanography and Marine Bio/JKY. An Annual Review* 24. Barnes, M. (Ed.). Aberdeen; University Press: 65-170.
- Shannon LV, Ortega-Cisneros K, Lamont T, Winker H, Crawford R, Jarre A and Coll M (2020). Exploring Temporal Variability in the Southern Benguela Ecosystem Over the Past Four Decades Using a Time-Dynamic Ecosystem Model. *Front. Mar. Sci.* 7:540. doi: 10.3389/fmars.2020.00540
- Shillington FA and Probyn TA. (1996). Modelling of sediments dumped at the sea surface. In: *Impacts of deep sea diamond mining, in the Atlantic 1 Mining Licence Area in Namibia, on the natural systems of the marine environment.. Environmental Evaluation Unit (EEU) Report No. 11/96/158*. Prepared for De Beers Marine (Pty) Ltd. 315-331.
- Shillington FA, Reason CJC, Duncombe-Rae CM, Florenchie P & Penven P. 2007. Large Scale Physical Variability of the Benguela Current Large Marine Ecosystem (BCLME). In: Shannon V, Hempel G, Malanotte-Rizzoli P, Moloney C and Woods J (eds). *Benguela: Predicting a Large Marine Ecosystems series*, 14. Amsterdam: Elsevier.
- Shomura RS and Yoshida HO. (1985). Proceedings of the Workshop on the Fate and Impact of Marine Debris, 26–29 November 1984, Honolulu, Hawaii. NOAA Technical Memorandum NMFS-SWFSC-54.

- Sink K, Holness S, Harris L, Majiedt P, Atkinson L, Robinson T, Kirkman S, Hutchings L, Leslie R, Lamberth S, Kerwath S, von der Heyden S, Lombard A, Attwood C, Branch G, Fairweather T, Taljaard S, Weerts S, Cowley P, Awad A, Halpern B, Grantham H and Wolf T. (2012). National Biodiversity Assessment 2011: Technical Report. Vol. 4: Marine and Coastal Component. Pretoria: South African National Biodiversity Institute.
- SLR 2021(a). EIA for a Prospecting Right Application for Offshore Sea Concessions 14B, 15B & 17B, West Coast. Appendix 4.2 Fisheries Assessment.
- SLR 2021(b). Basic Assessment for a Prospecting Right Application for South African Sea Areas 4C and 5C, West Coast, South Africa.
- Southall BL, Finneran JJ, Reichmuth C, Nachtigall PE, Ketten DR, Bowles AE, Ellison WT, Nowacek DP and Tyack PL. (2019). Marine mammal noise expo-sure criteria: Updated scientific recommendations for residual hearing effects. *Aquatic Mammals* 45(2): 125-232.
- Souza JRB and Guanuca NM. (1994). Zonation and seasonal variation of the intertidal macrofauna of a sandy beach of Parana, Brazil. *Scientia Marina* 59(2): 103-111.
- Terhune JM and Verboom WC. (1999). Right whales and ship noise. *Mar. Mamm. Sci.* 15: 256-258.
- Van Niekerk L, Turpie JK. (eds). (2012). South African National Biodiversity Assessment 2011: Technical Report. Volume 3: Estuary Component. CSIR Report Number CSIR/NRE/ECOS/ER/2011/0045/B. Council for Scientific and Industrial Research, Stellenbosch.
- Vincent MJ. (1996). Changes in surfacing patterns of bottlenose dolphins in response to boat traffic. *Mar. Mamm. Sci.* 12: 597-602.
- Wallace N. (1985). Debris entanglement in the marine environment: a review. *Proc. of the Ninth Ann. Work. on Sea Turtle Cons. and Bio, SA.*
- Wehle DHS and Coleman FC. (1983). Plastics at sea. *Nat. Hist.* 2: 20-25.
- Weilgart LS. (2007). The impacts of anthropogenic ocean noise on cetaceans and implications for management. *Canadian Journal of Zoology* 85: 1091-1116.
- Würsig B, Lynn SK, Jefferson TA and Mullin. (1998). Behaviour of cetaceans in the northern Gulf Mexico relative to survey ships and aircraft. *Aquat. Mamm* 24: 41-50.

6 APPENDIX :1 IMPACT RATING METHODOLOGY

The significance of all potential impacts that would result from the proposed project is determined in order to assist decision-makers. The **significance** of an impact is defined as a combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The significance of each identified impact was thus rated according to the methodology set out below:

Step 1 – Determine the **consequence** rating for the impact by determining the score for each of the three criteria (A-C) listed below and then **adding** them. The rationale for assigning a specific rating, and comments on the degree to which the impact may cause irreplaceable loss of resources and be irreversible, must be included in the narrative accompanying the impact rating:

Rating	Definition of Rating	Score
A. Extent – the area over which the impact will be experienced		
Local	Confined to project or study area or part thereof (e.g. limits of the concession area)	1
Regional	The region (e.g. the whole of Namaqualand coast)	2
(Inter) national	Significantly beyond the Namaqualand coast and adjacent land areas	3
B. Intensity – the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. Duration – the time frame for which the impact will be experienced and its reversibility		
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years (state whether impact is irreversible)	3

The combined score of these three criteria corresponds to a **Consequence Rating**, as follows:

Combined Score (A+B+C)	3 – 4	5	6	7	8 – 9
Consequence Rating	Very low	Low	Medium	High	Very high

Example 1:

Extent	Intensity	Duration	Consequence
Regional 2	Medium 2	Long-term 3	High 7

Step 2 – Assess the **probability** of the impact occurring according to the following definitions:

Probability– the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

Example 2:

Extent	Intensity	Duration	Consequence	Probability
Regional 2	Medium 2	Long-term 3	High 7	Probable

Step 3 – Determine the overall **significance** of the impact as a combination of the **consequence** and **probability** ratings, as set out below:

		Probability			
		Improbable	Possible	Probable	Definite
Consequence	Very Low	INSIGNIFICANT	INSIGNIFICANT	VERY LOW	VERY LOW
	Low	VERY LOW	VERY LOW	LOW	LOW
	Medium	LOW	LOW	MEDIUM	MEDIUM
	High	MEDIUM	MEDIUM	HIGH	HIGH
	Very High	HIGH	HIGH	VERY HIGH	VERY HIGH

Example 3:

Extent	Intensity	Duration	Consequence	Probability	Significance
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH

Step 4 – Note the **status** of the impact (i.e. will the effect of the impact be negative or positive?)

Example 4:

Extent	Intensity	Duration	Consequence	Probability	Significance	Status
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	– ve

Step 5 – State the level of **confidence** in the assessment of the impact (high, medium or low).

Impacts are also considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in the table below. Depending on the data available, a higher level of confidence may be attached to the assessment of some impacts than others. For example, if the assessment is based on extrapolated data, this may reduce the confidence level to low, noting that further ground-truthing is required to improve this.

Confidence rating	
Status of impact	+ ve (beneficial) or – ve (cost)
Confidence of assessment	Low, Medium or High

Example 5:

Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	– ve	High

The significance rating of impacts is considered by decision-makers, as shown below. Note, this method does not apply to minor impacts which can be logically grouped into a single assessment.

- **INSIGNIFICANT:** the potential impact is negligible and **will not** have an influence on the decision regarding the proposed activity.
- **VERY LOW:** the potential impact is very small and **should not** have any meaningful influence on the decision regarding the proposed activity.
- **LOW:** the potential impact **may not** have any meaningful influence on the decision regarding the proposed activity.
- **MEDIUM:** the potential impact **should** influence the decision regarding the proposed activity.
- **HIGH:** the potential impact **will** affect a decision regarding the proposed activity.
- **VERY HIGH:** The proposed activity should only be approved under special circumstances.

Step 6 – Identify and describe practical **mitigation** and **optimisation** measures that can be implemented effectively to reduce or enhance the significance of the impact. Mitigation and optimisation measures must be described as either:

- **Essential:** must be implemented and are non-negotiable; and
- **Best Practice:** must be shown to have been considered and sound reasons provided by the proponent if not implemented.

Essential mitigation and optimisation measures must be inserted into the completed impact assessment table. The impact should be re-assessed with mitigation, by following Steps 1-5 again to demonstrate how the extent, intensity, duration and/or probability change after implementation of the proposed mitigation measures.

Example 6: A completed impact assessment table

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	- ve	High
Essential mitigation measures: xxxxx xxxxx								
With mitigation	Local 1	Low 1	Long-term 3	Low 5	Improbable	VERY LOW	- ve	High

Step 7 – Prepare a summary table of all impact significance ratings as follows:

Impact	Consequence	Probability	Significance	Status	Confidence
Impact 1: XXXX	Medium	Improbable	LOW	-ve	High
With Mitigation	Low	Improbable	VERY LOW		High
Impact 2: XXXX	Very Low	Definite	VERY LOW	-ve	Medium
With Mitigation:	<i>Not applicable</i>				

Indicate whether the proposed development alternatives are environmentally suitable or unsuitable in terms of the respective impacts assessed by the relevant specialist and the environmentally preferred alternative.



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