PROPOSED INSTALLATION OF THE 2AFRICA/GERA (EAST) CABLE SYSTEM, PORT ELIZABETH, EASTERN CAPE, SOUTH AFRICA

Marine Ecology Assessment

Prepared for:

ACER (Africa) Environmental Consultants

acer AFRICA

May 2021

PISCES ENVIRONMENTAL SERVICES (PTY) LTD

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Prepared by

Andrea Pulfrich
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ABBREVIATIONS and UNITS

CBA	Critical Biodiversity Area
CBD	Convention of Biological Diversity
CCA	CCA Environmental
CITES	Convention on International Trade in Endangered Species
cm	centimetres
cm/sec	centimetres per second
CMS	Centre for Marine Studies
CMS	Convention on Migratory Species
CSIR	Council for Scientific and Industrial Research
dB	decibell
DEA	Department of Environmental Affairs
E	East
EBSA	Ecologically or Biologically Significant marine Areas
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMF	Electromagnetic field
EMPr	Environmental Management Programme
ENE	east-northeast
ESA	Ecological Support Area
GIS	Global Information System
gC/m^2	grams Carbon per square metre
ha	hectares
Hz	Herz
IDZ	Industrial Development Zone
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
JNCC	Joint Nature Conservation Committee
kHz	kiloHerz
km	kilometre
km^2	square kilometre
MBES	Multibeam Echo Sounder
MPA	Marine Protected Area
m	metres
m^2	square metres
mg/m^3	milligrams per cubic metre
ml	millilitre
mm	millimetre
m/sec	metres per second
m^3/sec	cubic metres per second
NBA	National Biodiversity Assessment
NE	northeast

NNE	north-northeast
NTU	Nephelometric Turbidity Units
PIM	Particulate Inorganic Matter
POM	Particulate Organic Matter
ppt	parts per thousand
PTS	Permenent Threshold Shifts
ROV	Remotely Operated Vehicle
S	south
SANBI	South African National Biodiversity Institute
S&EIR	Scoping and Environmental Impact Report
SSW	south-southwest
SW	southwest
TSPM	Total Suspended Particulate Matter
TTS	Temporary Threshold Shift
VME	Vulnerable Marine Ecosystem
WSW	west-southwest
μg/l	micrograms per litre
μPa	micro Pascal
°C	degrees Centigrade
percent	percent
~	approximately
<	less than
>	greater than

GLOSSARY

Benthic	Referring to organisms living in, or on, the sediments of aquatic habitats (lakes, rivers, ponds, etc.).
Benthos	The sum total of organisms living in, or on, the sediments of aquatic habitats.
Benthic organisms	Organisms living in, or on, sediments of aquatic habitats.
Biodiversity	The variety of life forms, including the plants, animals and micro-organisms, the genes they contain and the ecosystems and ecological processes of which they are a part.
Biomass	The living weight of a plant or animal population, usually expressed on a unit area basis.
Biota	The sum total of the living organisms of any designated area.
Community structure	All the types of taxa present in a community and their relative abundance.
Community	An assemblage of organisms characterized by a distinctive combination of species occupying a common environment and interacting with one another.
Ecosystem	A community of plants, animals and organisms interacting with each other and with the non-living (physical and chemical) components of their environment
Environmental impact	A positive or negative environmental change (biophysical, social and/or economic) caused by human action.
Epifauna	Organisms, which live at or on the sediment surface being either attached (sessile) or capable of movement.
Habitat	The place where a population (*eg,* animal, plant, micro-organism) lives and its surroundings, both living and non-living.
Infauna	Animals of any size living within the sediment. They move freely through interstitial spaces between sedimentary particles or they build burrows or tubes.
Macrofauna	Animals >1 mm.
Macrophyte	A member of the macroscopic plant life of an area, especially of a body of water; large aquatic plant.
Meiofauna	Animals <1 mm.
Marine environment	Marine environment includes estuaries, coastal marine and nearshore zones, and open-ocean-deep-sea regions.
Pollution	The introduction of unwanted components into waters, air or soil, usually as result of human activity; *eg,* hot water in rivers, sewage in the sea, oil on land.

Population	The total number of individuals of the species or taxon.
Recruitment	The replenishment or addition of individuals of an animal or plant population through reproduction, dispersion and migration.
Sediment	Unconsolidated mineral and organic particulate material that settles to the bottom of aquatic environment.
Species	A group of organisms that resemble each other to a greater degree than members of other groups and that form a reproductively isolated group that will not produce viable offspring if bred with members of another group.
Subtidal	The zone below the low-tide level, *ie,* it is never exposed at low tide.
Surf-zone	Also referred to as the ‘breaker zone’ where water depths are less than half the wavelength of the incoming waves with the result that the orbital pattern of the waves collapses and breakers are formed.
Suspended material	Total mass of material suspended in a given volume of water, measured in mg/ℓ.
Suspended matter	Suspended material.
Suspended sediment	Unconsolidated mineral and organic particulate material that is suspended in a given volume of water, measured in mg/ℓ.
Taxon (Taxa)	Any group of organisms considered to be sufficiently distinct from other such groups to be treated as a separate unit (*eg,* species, genera, families).
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.
Turbidity	Measure of the light-scattering properties of a volume of water, usually measured in nephelometric turbidity units (NTUs).
Vulnerable	A taxon is vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

EXPERTISE AND DECLARATION OF INDEPENDENCE

This report was prepared by Dr Andrea Pulfrich of Pisces Environmental Services (Pty) Ltd. Andrea has a PhD in Fisheries Biology from the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany.

As Director of Pisces since 1998, Andrea has considerable experience in undertaking specialist environmental impact assessments, baseline and monitoring studies, and Environmental Management Programmes / Plans relating to marine diamond mining and dredging, hydrocarbon exploration and thermal/hypersaline effluents. She is member of the South African Council for Natural Scientific Professions, South African Institute of Ecologists and Environmental Scientists, and International Association of Impact Assessment (South Africa).

This specialist report was compiled on behalf of ACER (Africa) Environmental Consultants for their use in preparing a Scoping and Environmental Impact Report (S&EIR) for the proposed installation of the Port Elizabeth Branch of the ASN 2AFRICA/GERA (East) Cable System, off the South African coast. I do hereby declare that Pisces Environmental Services (Pty) Ltd is financially and otherwise independent of the Applicant and ACER.

Andrea Pulfrich

Dr Andrea Pulfrich

EXECUTIVE SUMMARY

Alcatel Submarine Networks (ASN) has been appointed as the supplier and installer of the 2AFRICA/GERA (East) Cable System. The system will be installed in phases, with the first phase entailing the installation of cable landings at Duynefontein in the Western Cape, with further branches landing at Port Elizabeth in the Eastern Cape and Amamzimtoti on the KwaZulu Natal (KZN) Coast. The cable will enter South African Territorial Waters ~22 km (12 Nm) from the coast, with the proposed Port Elizabeth landing site being the second last branch point of the cable.

This report serves as the specialist assessment to identify impacts on the Marine Benthic Environment based on the alignment selected. The study has adopted a desktop approach.

The preferred landing site at Summerstrand in Port Elizabeth is characterized by a stretch of dissipative-intermediate sandy beach. At the shore crossing, the buried subsea fibre optics cable will enter a beach manhole, from where the cable will be laid in a trench to connect to the terrestrial portion of the cable situated in the existing Cable Landing Station. Two alternative shore crossings were considered.

The continental shelf along the southeast coast is narrow, with a steep continental slope. The bathymetry drops steeply at the coast to approximately 50 m. In the region of Algoa Bay, the shelf begins to widen, with depth increasing gradually to the shelf break at a depth of 140 m off Port Elizabeth. Outside the shelf break, depth increases rapidly to more than 1,000 m (Hutchings 1994) descending into the Transkei Basin. Three submarine canyons are known off Algoa Bay of which the Sundays and Addo Canyons breach the shelf while the deeper Cannon Rocks Canyon Three submarine canyons are known off Algoa Bay with the Sundays and Addo Canyons breaching the shelf and spanning a depth range of approximately -150 m to -2 000 m. Seaward of the inner shelf sediment-wedge, the seafloor off Port Elizabeth is predominantly rocky. The cable route planning survey identified that the inshore portion of the cable comprised primarily rock outcrop (66%) and subcropping rock interspersed by areas of shallow transient sand, with fine sands dominating beyond approximately -24 m depth and coarse sediments being prevalent at depths beyond ~-28 m.

The oceanography of the Southeast Coast is almost totally dominated by the warm Agulhas Current. In the vicinity of East London, the offshore movement of the Agulhas Current creates shear edge eddies, which periodically circulate warm water inshore near Port Elizabeth resulting in rapid variation of water temperatures. During easterly wind conditions, periodic upwelling may occur near the rocky headlands, causing sharp drops in seawater temperature. Off Port Elizabeth, currents flow in a predominately southerly direction out of the Bay. Current speeds of less than 10 cm/s have been measured most frequently within the bay, although currents exceeding 20 cm/s are not uncommon.

Westerly winds predominate in winter, frequently reaching gale force strengths. During summer, easterly wind directions increase markedly resulting in similar strength/frequency of east and west winds during that season. The wave climate in Algoa Bay is predominantly from the southwest with swells of <2 m occurring approximately 80% of the time.

Biogeographically the proposed Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System falls into the Agulhas and Southwest Indian Deep Ocean ecoregion. The wide oceanic shelf provides an array of habitats and the local oceanography and temperature structure of the water column play role in accounting for high levels of biodiversity and endemicity, including the highest number of endemic fish species along the South African coast. The ecosystem threat status of the offshore benthic habitat types along most of the Southeast Coast, have been rated as 'Least Concern' , however, on the shelf and in the coastal zone along the cable route the Eastern Agulhas Bay, Agulhas Inner Shelf Mosaic, Agulhas Sandy Outer Shelf and Agulhas Coarse Sediment Shelf

Edge habitats are considered 'Vulnerable', whereas the Agulhas Sandy Mid Shelf is considered 'Near Threatened'. The intertidal beach at the shore crossing in Algoa Bay is rated as 'Least Concern'.

The coastline of Algoa Bay from Cape Padrone to the Port Elizabeth Harbour is dominated by sandy beaches. The macrofaunal communities characterising the beaches are dominated by a diversity of crustaceans, polychaete worms and bivalve molluscs. No rare or endangered species have been reported. Recent research has revealed that the near and off-shore sediment habitats within Algoa Bay harbour an extraordinary invertebrate diversity potentially including several previously undescribed taxa. Taxonomic composition highlight both Amphipod crustaceans and Polychaetes as the dominant groups in terms of abundance with Ostracods, Tanaids and cumaceans also being represented.

The intertidal and shallow subtidal reefs along the East Coast of South Africa support a wide diversity of marine flora and fauna and a relatively high percentage of endemic species. Relative to sandy habitats, reefs are scarce in Algoa Bay. The cable alignment, however, crosses both outcropping as well as subcropping rock from just beyond the beach at the shore crossing to ~2.6 km offshore. The community composition along the depth gradient of the inshore (0-30 m) cable alignment was categorised into four distinct reef biotopes and a further four sediment biotopes. Shallow water reefs were dominated by red algae and small mixed algae, while deeper reefs were characterised by ascidians, sponges and gorgonians and sand-influenced reefs by hydroids, encrusting coralline algae and large red sea fans. Off the shelf edge, the deep water habitats are thought to be characterised by a number of Vulnerable Marine Ecosystem indicator species such as sponges, soft corals and hard corals.

Benthic invertebrates further offshore include the deep-water rock lobster, and the chokka squid. The Southeast Coast ichthyofauna is diverse, comprising a mixture of temperate and tropical species. Zooplankton and ichthyoplankton abundances in the project area will reflect localised areas of higher primary productivity. As variety of pelagic fish species, including anchovy, round herring and horse mackerel, spawn east of Cape Agulhas between the shelf-edge upwelling and the cold-water ridge, ichthyoplankton abundance in inshore waters over the continental shelf is likely to be seasonally high. On the shelf, beyond the shelf break and in the offshore waters of the project area, the fish most likely to be encountered are the large migratory pelagic species, including various tunas, billfish and sharks. Five species of sea turtles occur along the Southeast Coast of which the loggerhead and leatherback turtles are likely to be the most frequently encountered in Algoa Bay. Fifteen species of seabirds breed within the South Coast region, including Cape Gannets, African Penguins, Cape Cormorants, White-breasted Cormorant, Roseate Tern, Swift Term and Kelp Gulls. The Algoa Bay Islands serve as important breeding sites for most of these species. The marine mammal fauna of the southeast coast comprises between 28 and 38 species of cetaceans (whales and dolphins) and one seal species.

There are various coastal and offshore Marine Protected Areas (MPA) in the project area although the cable route does not pass through any of these. The cable does however cross the Algoa to Amathole Ecologically and Biologically Significant Area (EBSA), which includes a number of Critical Biodiversity Areas (CBAs). Undersea cables may be compatible, subject to certain conditions, in CBAs. Algoa Bay has also been identified as a Hope Spot by Mission Blue of the Sylvia Earle Alliance. The cable route also passes through the proposed Alexandria coastal belt/Algoa Bay Islands Nature Reserve Marine Important Bird Area (IBA), specifically aimed at protecting the African Penguin, Cape Gannet, Kelp Gull, Damara Tern and Roseate Tern.

Potential impacts to the marine environment as a result of the installation and operation of the subsea cable are summarised below:

Impact	Significance (before mitigation)	Significance (after mitigation)
Geophysical Survey		
Impacts of multi-beam and sub-bottom profiling sonar on marine fauna	Very low	Very low
Cable Installation		
Disturbance and destruction of sandy beach biota during trench excavation and subsea cable installation	Low	Low
Disturbance and destruction of nearshore biota in unconsolidated sediments during trench excavation and cable installation	Low	Low
Disturbance and destruction of offshore benthic biota during cable laying	Low	Low
Disturbance and avoidance behaviour of surf-zone fish communities, shore birds and marine mammals through coastal construction noise and offshore cable installation noise	Very low	Very low
Behavioural changes and masking of biologically significant sounds in Marine Fauna due to noise from cable installation operations	Very low	Very low
Reduced physiological functioning of marine organisms due to increased turbidity in surf-zone as a result of excavations and mobilising of sediments	Very low	Very low
Other Potential Impacts		
Physical presence of the subsea cable	Low	Low
Heat, Sound, Electromagnetic fields and leaching of contaminats from thesubsea cable	Very low	Very low
Unplanned Events		
Accidental spillage or leakage of fuel, chemicals or lubricants, cement and disposal of litter may cause water or sediment contamination and/or disturbance to intertidal and subtidal biota	Medium	Low
Collisions with and Entanglement by Marine Fauna	Low	Low

Cumulative impacts were assessed to be of low to very low significance as in reality the total cumulative impacted area at any one time would be minimal, due to the natural recovery of benthic communities of unconsolidated habitats over the medium term.

Certain recommendations are put forward as how best to manage potential impacts to the marine environment of the proposed installation of the subsea cable. Although some of these are already part of standard industry practice, they are documented here for the sake of completeness. These include:

- Plan routing of proposed cable to as far as practicably possible avoid sensitive benthic habitats in the coastal and nearshore zone. This is undertaken following analysis of the geophysical data collected during the cable route survey.
- Ensure that constant monitoring for the presence of marine mammals and turtles is maintained by a ship's staff member designated as a marine mammal observer. The observation post must keep a

record of sightings, recording date, time, coordinates and approximate distance. This is particularly important should cable installation across the continental shelf be scheduled during the whale migration period (beginning of June to end of November).

- Should a cetacean become entangled in towed gear, contact the South African Whale Disentanglement Network (SAWDN) formed under the auspices of DEA to provide specialist assistance in releasing entangled animals.

For the construction phase of the proposed cable shore-crossing the recommended best-practice mitigation measures include:

- As far as practicably possible, make HDD the preferred option for the cable shore crossing, thereby avoiding damage to intertidal and shallow subtidal habitats by trenching or anchoring of the cable on the seabed.
- As far as practicable, ensure that construction activities required for subsea cable installation occur concurrently thereby minimizing the disturbance duration in the coastal and nearshore zone.
- As far as practicable, avoid cable installation within Algoa Bay during the peak squid spawning period between September and December.
- All construction activities in the coastal zone must be managed according to a strictly enforced EMPr.
- Ensure that contracted construction personnel are aware of, and adhere to, the requirements of the EMP.
- Keep heavy vehicle traffic associated with construction in the coastal zone to a minimum.
- Restrict vehicles to clearly demarcated access routes and construction areas only. These should be selected under guidance of the local municipality.
- Maintain vehicles and equipment to ensure that no oils, diesel, fuel or hydraulic fluids are spilled.
- For equipment maintained in the field, oils and lubricants must be contained and correctly disposed of off-site.
- Good housekeeping must form an integral part of any construction operations on the beach from start-up.
- Ensure regular collection and removal of refuse and litter from intertidal areas.

The following essential mitigation measures should be implemented during construction of the shore crossing:

- Obtain a vehicle access permit from DEA (Branch Oceans and Coasts) prior driving in the coastal zone.
- Restrict disturbance of the intertidal and subtidal areas to the smallest area possible. Once the shore crossing is finalised and the associated construction site is determined, the area located outside of the site should be clearly demarcated and regarded as a ‘no-go’ area.
- There is to be no vehicle maintenance or refuelling on the beach.
- Ensure that all accidental diesel and hydrocarbon spills are cleaned up accordingly.
- No mixing of concrete in the intertidal zone.
- Regularly clean up concrete spilled during construction.

- No dumping of construction materials, excess concrete or mortar in the intertidal and subtidal zones or on the sea bed.
- After completion of construction activities remove all artificial constructions or created shore modifications from above and within the intertidal zone. No accumulations of excavated intertidal sediments should be left above the high water mark, and any substantial sediment accumulations below the high water mark should be levelled.

If all environmental guidelines and appropriate management and monitoring recommendations are implemented, there is no reason why the proposed installation of the Port Elizabeth branch of the ASN 2AFRICA/GERA (East) fibre optics cable should not proceed.

1. GENERAL INTRODUCTION

The Project involves the installation and operation of a fibre optical submarine cable to provide international high-speed connectivity and reliability. Alcatel Submarine Networks (ASN) has been appointed as the supplier and installer of the 2AFRICA/GERA (East) Cable System. The system will be installed in phases, with the first phase entailing the installation of cable landings at Duynefontein in the Western Cape, with further branches landing at Port Elizabeth in the Eastern Cape and Amamzimtoti on the KwaZulu Natal (KZN) Coast. The system will connect Africa to Europe and parts of the Middle East. The 2AFRICA/GERA (East) Cable would be operated by Vodacom (Pty) Ltd as the South African landing partner. Vodacom aims to secure local permits to land the 2AFRICA/GERA (East) cable at Port Elizabeth.

Submarine telecommunications cables are important for international telecommunications networks, transporting almost 100% of transoceanic Internet traffic throughout the world (www.iscpc.org). Access to affordable international bandwidth is key to economic development in every country. Improvement in Africa's information technology infrastructure *via* telecommunications cables is expected to remove one of the current key inhibitors to development in Africa and support economic growth and opportunities on the continent.

The main 2AFRICA (East) cable trunk be located in international waters ~200 to 500 km from the shore. From the main cable, branches will run through exclusive economic zones (EEZs) and territorial waters to the landing sites in each country. The cable route will approach South African coastal waters from Mozambique and run parallel to the coastline along the East Coast of Africa in deep water. The cable will enter South African Territorial Waters ~22 km (12 Nm) from the coast, with the proposed Port Elizabeth landing site being the second last branch point of the cable. The exact position of the final section of the cable will be identified based on a combination of engineering, environmental and economic factors and will require offshore and nearshore surveying of the seabed. Two landing locations at Port Elizabeth are being considered; one at approximately 33°59'14.70"S and 25°40'21.00"E (preferred option), and the other ~300 m to the northwest at 33°59'5.97"S and 25°40'18.99"E) (alternative option).

As part of the EIA process, assessments were undertaken of the impact of the proposed Project on the South African fishing industry, shallow water reefs and rock outcrops to a depth of 30 m, offshore avifauna and marine mammals. These studies are referred to as necessary.

1.1. Scope of Work

This specialist report was compiled as a desktop study on behalf of ACER Environmental Consultants, for inclusion in the S&EIR and for developing an EMPr for the proposed installation of the subsea cable system off Port Elizabeth on the East Coast of South Africa.

The terms of reference for this study are:

- Undertake a desktop assessment of the potential impact that the 2AFRICA/GERA (East) Cable System landing at Port Elizabeth and related infrastructure will have on the Marine Benthic Environment based on the alignment selected. In this context, the specialist study should identify and discuss the following topics:

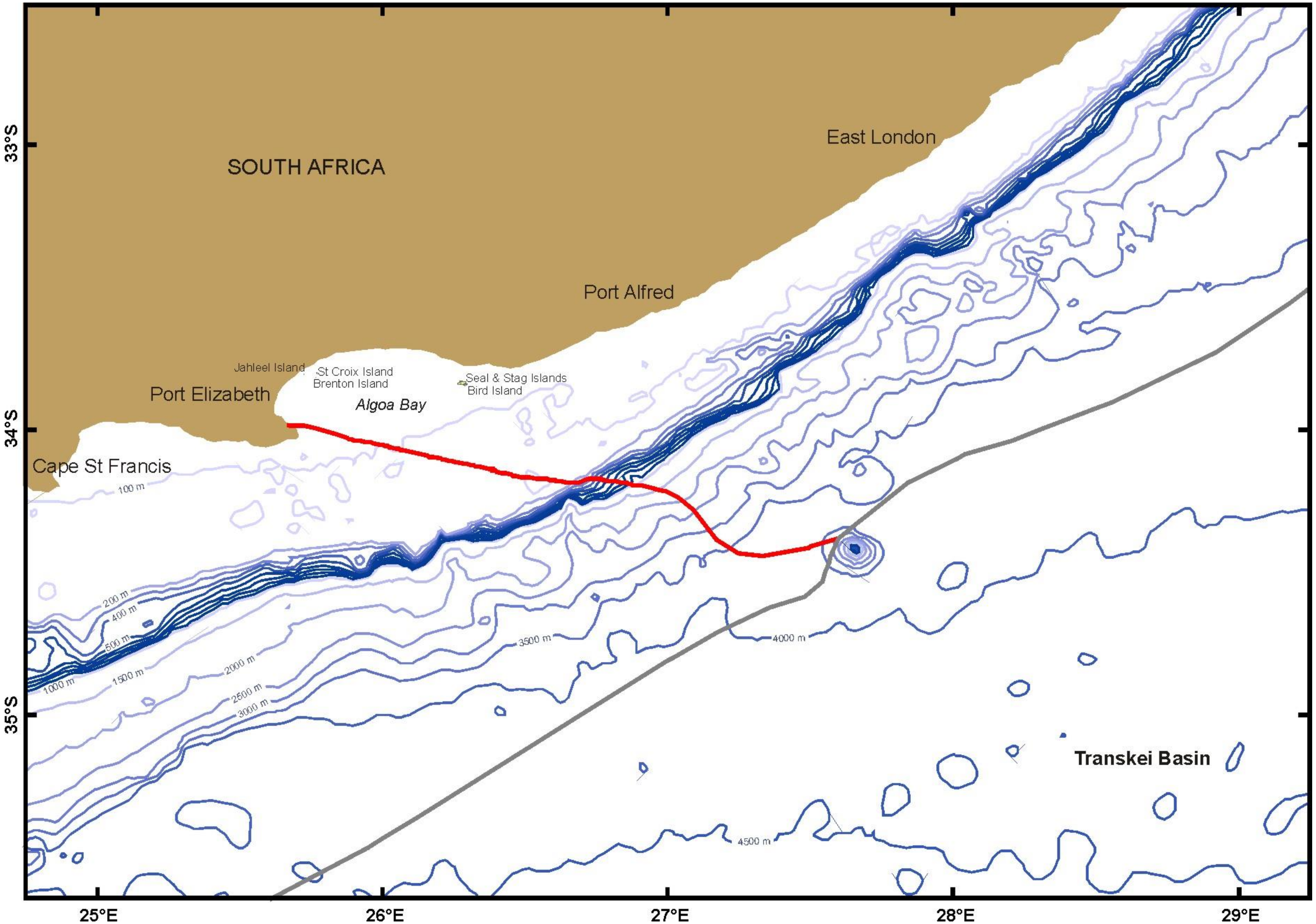


Figure 1: Map indicating proposed Port Elizabeth branch (red line) of the main trunk (grey line) of the 2AFRICA/GERA (East) Cable System in relation to bathymetry and bathymetric features off the South African East coast.

a) An introduction with a brief project overview, study approach, methodology, and assumptions and limitations.
b) A description of the marine environment of the project area, focusing on the benthic invertebrate communities based on available literature and previous experience.
c) A description of the potential impacts of the project on the benthic invertebrate fauna, followed by an assessment of the significance of these impacts using the assessment criteria provided (it must be noted that marine telecommunications cables once installed have a legislated 500 m buffer either side of the cable where no fishing/trawling or anchoring of vessels may take place).

- Provide a detailed motivation why site investigations were deemed unnecessary.
- In assessment of impacts take into account the spatial scale, intensity, duration, etc. of the impacts and include recommendations for mitigation of impacts.
- Address specific issues and concerns raised by stakeholders during the public review phase of the EIA process (an Issues and Responses Report will be provided to specialists).
- Discuss any other sensitivities and important issues from a Marine Benthic perspective that are not identified in these terms of reference.

1.2. Approach to the Study

As determined by the terms of reference, this study has adopted a 'desktop' approach. The landing site at Port Elizabeth is characterized by a stretch of dissipative-intermediate sandy beach, no different from other similar beaches in the Agulhas Bioregion, and which have been adequately described in the scientific literature. A detailed site investigation was thus not deemed necessary and no new data have been collected.

Although no protocols and formal screening tools have been developed for the marine environment as part of GNR No 320, of 20 March 2020, the approach to the study by default includes a site sensitivity verification, comprising a desktop analysis using satellite imagery of the coastal zone, as well as marine spatial information contained in the National Biodiversity Assessment: Marine Component (Sink *et al*. 2019).

All identified marine impacts are summarised, categorised and ranked in appropriate impact assessment tables, to be incorporated into the EIA Report.

1.2.1 Assumptions, Limitations and Information Gaps

As determined by the terms of reference, this study has adopted a 'desktop' approach. Consequently, the description of the natural baseline environment in the Marine Study Area is based on a review and collation of existing information and data from the scientific literature, and various internal reports. The information for the identification of potential impacts on benthic communities was drawn from various scientific publications, and information sourced from the Internet. The sources consulted are listed in the Reference chapter.

The assumptions made in this specialist assessment are:

- The study is based on the **project description made available to the specialists at the time of the commencement of the study** (cable routing, cable installation and construction approaches, *etc*.).

- Some important conclusions and associated assessments and recommendations made in this study are based on 1) the nearshore marine benthic assessment undertaken by Aquatic Ecosystem Services (Aquatic Ecosystem Services 2021), and 2) generic descriptions of cable installation processes sourced in the literature.
- Potential changes in the marine environment such as sea-level rise and/or increases in the severity and frequency of storms related to climate change are not included in the terms of reference and therefore not dealt with in this report.

Information gaps include:

- details of the benthic macrofaunal communities and potentially vulnerable species beyond the shelf break;
- details on demersal fish communities beyond the shelf break;
- information specific to the habitats and associated marine communities of the Southwest Indian Deep Ocean; and
- current information on the distribution, population sizes and trends of most pelagic seabird, turtle and cetacean species occurring in South African waters and the project area in particular.

2. DESCRIPTION OF THE PROPOSED PROJECT

2.1. Project Location

The project involves the installation and operation of a 35-mm diameter subsea fibre optic cable system, the main trunk of which will run along the African east coast from the Middle East to South Africa. Branches will split from the main trunk to landing sites located *en route*, including Somalia, Kenya, Tanzania, Madagascar and Mozambique.

The main trunk of the marine cable will be located ~200 to 500 km from the shoreline in international waters, with branch cables running to the shoreline through territorial waters to the landing site in each country. South Africa will be the southern-most point of the cable with the end station located at approximately 33°41.666'S; 18°26.387'E at Duynefontein on the West Coast and branches splitting from the main trunk at Port Elizabeth in the Eastern Cape (this assessment), and Amanzimtoti in KZN. The general alignment of the main trunck of the 2AFRICA (East) Cable System will follow the alignment of the SAFE cable from the south. Nonetheless, a detailed bathymetric and geophysical survey has be undertaken along the main trunck of the cable route, with a further survey conducted at the landing site at Port Elizabeth to determine the final alignment of the cable at the shore crossing to access the existing Telkom Limited SOC land-based infrastructure.

The preferred landing site at Summerstrand in Port Elizabeth is characterized by a stretch of dissipative-intermediate sandy beach (Figure 2). At the shore crossing, the buried subsea fibre optics cable will enter a beach manhole, from where the cable will be laid in a trench to connect to the terrestrial portion of the cable situated in the existing Cable Landing Station. Two alternative shore crossings were considered, of which Alternative 1 in the preferred option as it has less rock outcrops in the nearshore environment.

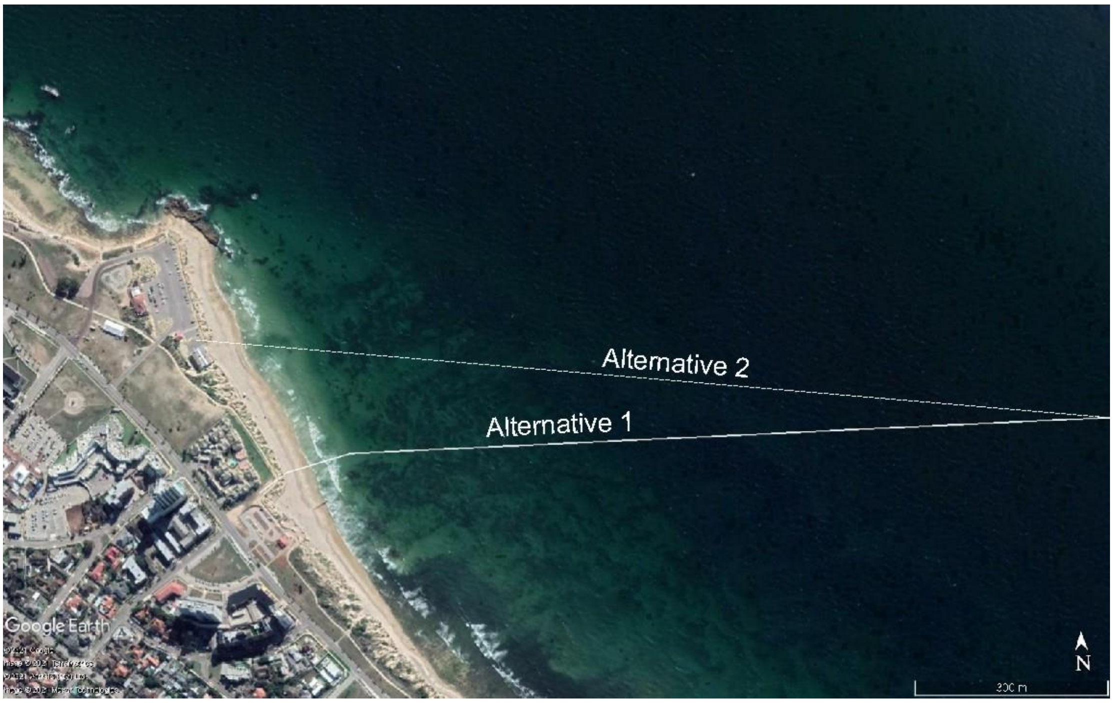


Figure 2: GoogleEarth image showing the routing of the proposed 2AFRICA/GERA (East) Cable System in shallow waters and the shore crossing alternatives at Pollok Beach, Summerstrand in Port Elizabeth.

2.2. Installation Phase

The installation of the cable would involve:

- Following a Cable Route Desktop Study, a **cable route survey** is undertaken of the offshore and nearshore seabed to provide the necessary information for detailed engineering, construction, installation and subsequent maintenance of the cable. The main objective of the survey is to define a routing that will maximise cable survivability and avoid seabed features that may pose a hazard to cable integrity or that constitute habitat of conservation interest. In water of depths less than 1,000 m, multibeam swath bathymetry, sub-bottom profiling and side scan sonar surveys are undertaken along a 500-m wide corridor along the cable route. This allows adjustment of the cable position off the centre line if required by seabed hazards. In water of depths greater than 1,000 m, only multibeam bathymetry will be acquired. All the systems are hull-mounted and no towed equipment will be used. Sound levels from the acoustic equipment would range from 190 to 240 dB re 1 μPa at 1 m.
  - swath bathymetry systems (multibeam echo sounders (MBES)) produce a digital terrain model of the seafloor (source levels of 190-220 dB re 1 μPa at 1 m);
  - sub-bottom profiler seismic systems (e.g. boomer, sparker, chirp and sleeve gun), which generate profiles beneath the seafloor to give a cross section view of the sediment layers (source levels of 200-230 dB re 1 μPa at 1 m); and
  - side-scan sonar systems, which produce acoustic intensity images of the seafloor and are used to map the different sediment textures from associated lithology of the seafloor (source levels of 190-242 dB re 1 μPa at 1 m).

  Seabed sampling and *in situ* testing of seabed physical properties, are also usually undertaken to determine the type and thickness of sediment suitable for cable burial thereby assisting in defining the most appropriate mode of burial (e.g. ploughing, jetting, horizontal directional drilling and trenching).
- A **pre-lay grapnel run**, which is conducted immediately in advance of cable installation to remove any obstacles from the path of the final subsea cable route in water depths up to 1,500 m. The operation involves the towing of one or an array of grapnels by the main cable laying vessel, or another designated vessel, along the route where burial is required. Different types of grapnels can be used depending on the seabed conditions (see Final Scoping Report for details). The grapnel is towed at a rate that ensures it maintains contact with the seabed and penetrates the seabed to a depth of 40 - 80 cm into unconsolidated sediments. As a matter of routine, the grapnel is recovered and inspected at intervals of 15-20 km along the route. Usually a single tow is made along the route, although in areas where other marine activity or seabed debris are high, additional runs may be required. Route clearance will be performed at specific locations where decommissioned cables are known to cross the ASN 2AFRICA cable route where burial is planned.
- **Subsea cable installation**, which is undertaken by a specialised cable laying vessel that places the cable on the seabed along the predetermined route. At depths exceeding 1,500 m the cable can be placed directly on the seabed without the need for burial because at these depths it is highly unlikely that the cable could be damaged by contact with bottom tending deep sea fishing gears such as trawls and dredges. At depths shallower than 1,500 m, a trench ~1.0 m deep is excavated in the unconsolidated sediments by a specialised subsea cable plough to receive the cable. The foot print of the plough is limited

to the area in which the four plough skids and the plough share, which is approximately 0.75 m wide, are in contact with the seabed. Within this width, a spoil heap of unconsolidated material exists to one side of the plough line; but the height of this is normally less than 0.25 m and will be eroded with time due to bottom currents. The plough itself is 5 - 8 m wide, with a submerged weight of 13 tonnes. The plough is designed to backfill the cable burial trench during operation. Heavier armouring around the cable is also used to provide additional protection, particularly in areas of uneaven or rocky seabed. A Remotely Operated Vehicle ROV equipped with jetting tools may be deployed to undertake post lay burial to a depth of 2 m – this is reserved for restricted areas where ploughing is ineffective or impractical.

In the littoral zone (<15 m) to the landing point on the beach, the cable will be installed through 'direct shore end operation'. This involves floating the shore end cable directly from the main cable installation vessel to the beach landing point using buoys and assisted by small boats and divers. Once water depths are too shallow for ship and plough operation, cable burial will be undertaken by divers using hand-held jets. The expected maximum width of the seabed fluidised by the jet burial is approximately 200 mm with burial to a target depth of 2.0 m. As most of the substrate at the Pollock Beach landing site in <24 m depth comprises outcropping rock, a double armoured cable will be surface laid over the reef for a distance of approximately 2 km. Conduiting or an articulated split-pipe may be used to maximise cable security and protection. The cable will be anchored in place by using pins or clamps to attach the cable to the underlying rocky substrates to prevent movement.

- The **shore-crossing** of the cable segment from the low water mark to the beach man hole will involve trenching of the beach sediments to a target depth of 2 m below the beach level, or until bedrock is reached. If rock substrate is encountered at sediment depths shallower than 2 m rock trenching will be undertaken to a water depth of approximately 0.5 – 1 m to bury the cable. Rock trenching will involve the excavation of a trench in the rock to a depth of approximately 30 cm allowing for the cable to be installed below the natural rock profile. Once installed the excavated channel will be backfilled with the rock cuttings and mixed with a cement suitable for the marine environment. By backfilling the rock trench to its original rock profile, the cable will be suitably protected from exposure should storm events result in sand deflation on the beach and the exposure of the underlying rock shelves. Beyond 1 m water depth, the cable will be protected by articulated pipes and will be pinned to outcropping reefs in the shallow water environment. Installation and burial of the sea earth plate and earth cable (System Earth) below the beach water table will also be required. The beach excavation will typically be carried out using tracked backhoe diggers and hand tools.

  If the substrate is unsuitable for trenching, Horizontal Directional Drilling (HDD) may be required to install the cable through the shallow water environment (1-2 m depth below the low water mark of the sea), underneath the beach and coastal dune cordon. HDD involves the drilling of an undersea pilot hole from the land to the sea. All cuttings and drilling fluids would be removed on the landward side for disposal. Following drilling of the pilot borehole to a predetermined offshore location, the borehole would be enlarged with a reamer and the cable pulled back through the borehole (i.e. from the offshore location onto land). Intertidal and shallow subtidal habitats would thus not be affected at all as the borehole would pass well below the seabed before surfacing out of the seabed at an offshore location.

Table 1: Summary of Cable Installation Activities revalent to the marine environment.

Conditions/Environment	Installation Method
Water depth >1,500 m	No burial, cable surface laid without armouring.
Water depth < 1,500 m	Ploughing from the subsea cable lay vessel to a target water depth of 15 m with Post Lay Burial to a depth of 1 m reserved for areas where ploughing is ineffective or impractical.
Littoral zone	Trench excavation using diver-operated hand-held jets. . The subsea cable is generally protected by clamping additional pipe sections around it (articulated pipe or uraduct protection). In areas of hard seabed and high wave energy, the split pipes may be pinned to the seabed to prevent movement. Where possible, Existing anchor sites will be used.
Beach landing	Trenching above the High Water Mark (HWM) to achieve burial to 2 m depth

2.3. Operations

Once installed and operational the subsea cable will not require routine maintenance, although cable repair may be required as a result of physical damage (either anthropogenic or natural) or failure. To effect repairs on deep sea cables, the damaged subsea cable is cut at the seabed and each end separately brought to the surface, whereupon a new section is spliced in. Dedicated repair ships are on standby to respond to any emergency repairs.

2.4. Decommissioning

The subsea cable is expected to be operational for at least 25 years. Options for decommissioning of the system at the end of the Project's lifetime include retirement in place, or removal and salvage. Decommissioning would involve demolition, recovery and removal of terrestrial components (if they are not re-used for new cables or another purpose).

The subsea cable is likely to be left in place, as per current global industry practice. This is done in accordance with a Decommissioning Plan, details of which will be provided in the EIA Report.

3. DESCRIPTION OF THE BASELINE MARINE ENVIRONMENT

The descriptions of the physical and biological environments along the South African Southeast Coast focus primarily on the area between Cape St Francis and East London, where the cable will cross onto the continental shelf and make landfall. As the eastern boundary of the South Coast is considered to lie at Cape Padrone (CCA & CMS 2001), the project area will be referred to as the Southeast Copast as the offshore portions of the cable routing would fall within the East Coast. Descriptions of the physical and biological environments along the cable route along the East Coast will be generic only as information on the biotic components of the deep ocean beyond the shelf break is largely unknown. The purpose of this environmental description is to provide the marine baseline environmental context within which the proposed Subsea cable will be installed. The summaries presented below are based on information gleaned from CCA and CMS (2001) and more recent scientific studies undertaken in the general area.

3.1. Geophysical Characteristics

3.1.1 Bathymetry

The orientation of the coastline along the Southeast Coast is relatively uniform, and north-northeast trending. The continental shelf along the southeast coast is narrow, with a steep continental slope. The bathymetry drops steeply at the coast to approximately 50 m. In the region of Algoa Bay, the shelf begins to widen, with depth increasing gradually to the shelf break at a depth of 140 m off Port Elizabeth, 130 m off Cape St Francis, and 300 m south of Cape Agulhas (Birch & Rogers 1973). Outside the shelf break, depth increases rapidly to more than 1,000 m (Hutchings 1994) descending into the Transkei Basin (Figure 1). Three submarine canyons are known off Algoa Bay with the Sundays and Addo Canyons breaching the shelf and spanning a depth range of approximately -150 m to -2 000 m. The deeper Cannon Rocks Canyon, off the Boesmans Estuary east of Port Elizabeth, is confined to the slope. Further canyons are reported further north off Port St. Johns and Port Edward where the continental margin descends into the Natal Valley (Sink *et al.* 2012, 2019).

The substratum types and ecosystem types in the project area are illustrated in Figure 4 and Figure 4, respectively. Seaward of the inner shelf sediment-wedge, the seafloor off Port Elizabeth is predominantly rocky (Birch & Rogers 1973; Schumann 1998). Mud patches occur inshore east of Cape Infanta, but the majority of unconsolidated sediment is sand to muddy sand (Birch & Rogers 1973). Offshore of the shelf break, benthic habitats are dominated by Southwest Indian Upper and Lower Bathyal unconsolidated sediments, with the deeper portions of the project area comprising sediments of the Southwest Indian Unclassified Abyss (Sink *et al.* 2019) (Figure 3).

The cable route planning survey undertaken by Fugro (2020) identified that the inshore portion of the cable at depths <-30 m comprised primarily rock outcrop (66%) and subcropping rock interspersed by areas of shallow transient sand (25%), with fine sands dominating beyond approximately -24 m depth and coarse sediments being prevalent at depths beyond ~-28 m (6%) (Fugro 2020).

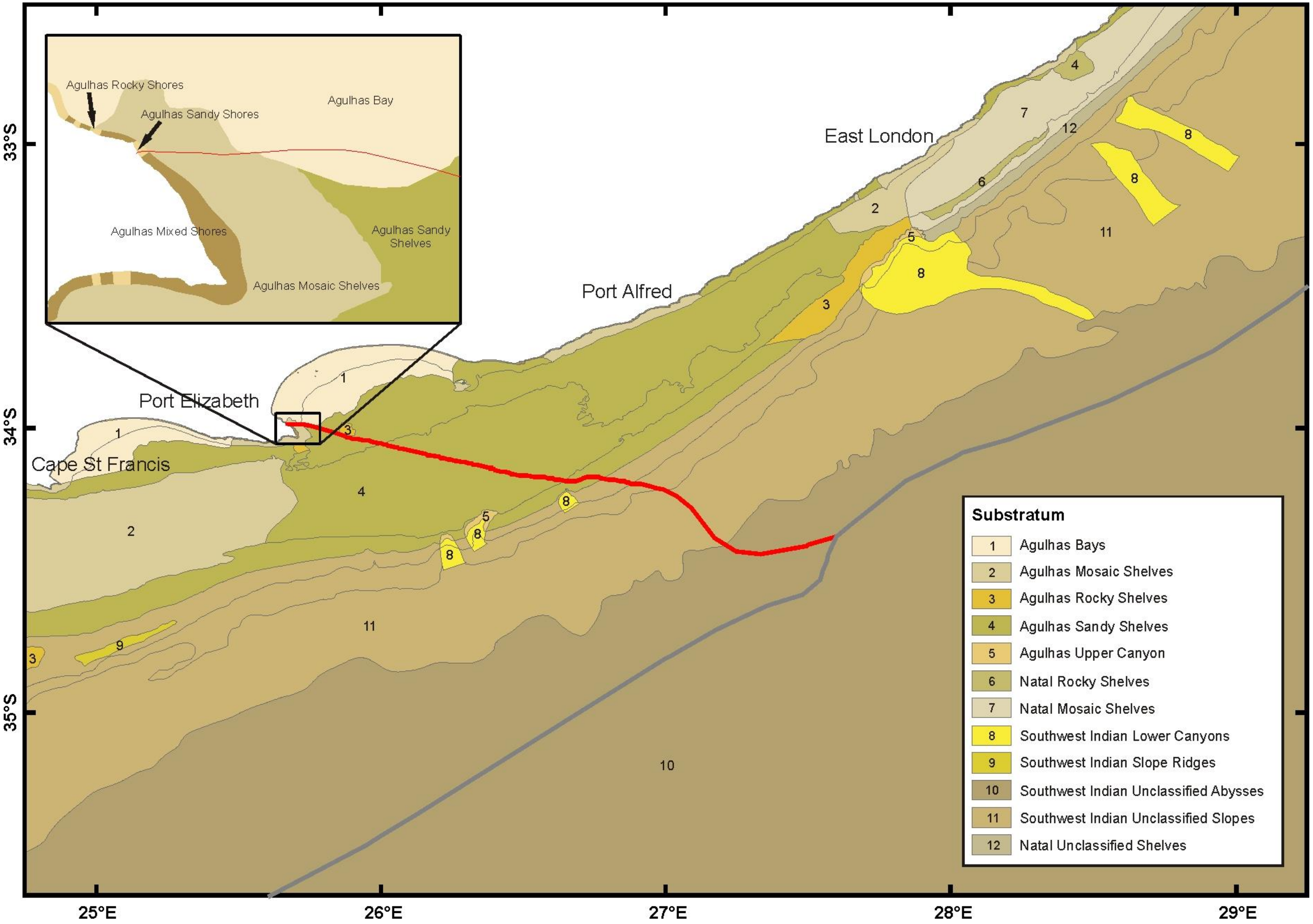


Figure 3: The proposed Port Elizabeth branch (red line) of the main trunk (grey line) of the 2AFRICA/GERA (East) Cable System in relation to coastal and offshore benthic habitat types off the South African Southeast Coast (adapted from Sink *et al*. 2019).

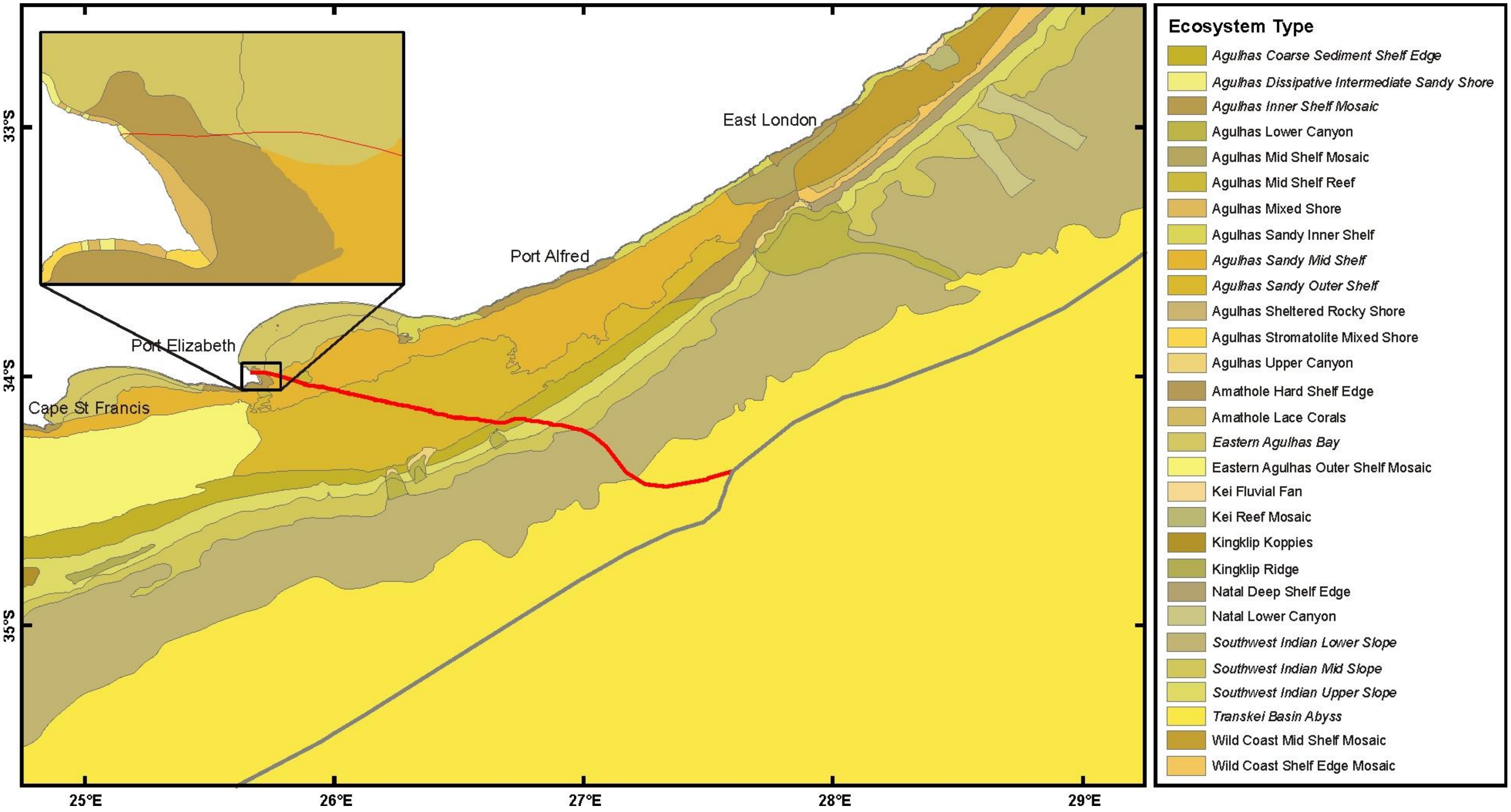


Figure 4: The proposed Port Elizabeth branch (red line) of the main trunk (grey line) of the 2AFRICA/GERA (East) Cable System in relation to the distribution of ecosystem types along the Southeast Coast (adapted from Sink *et al*. 2019). Those ecosystem types affected by the cable are indicated in italics.

3.1.2 Water Masses and Circulation

The oceanography of the Southeast Coast is almost totally dominated by the warm Agulhas Current (Figure 5). The current forms between 25° and 30° S, its main source coming from recirculation in a South-West Indian Ocean subgyre. Further contributions to the Agulhas Current come from the Mozambique Current and the East Madagascar Current in the form of eddies that act as important perturbations to the flow (Lutjeharms 2006). It flows southwards at a rapid rate following the shelf edge along the East Coast, before retroflecting between 16° and 20° E (Shannon 1985). It is a well-defined and intense jet some 100 km wide and 2,300 m deep (Schumann 1998; Bryden *et al.* 2005). Current speeds of 2.5 m/sec or more and water transport rates of over 60×10^6 m^3/sec have been recorded (Pearce *et al.* 1978; Gründlingh 1980).

Where it meets the northern part of the Tugela Bank near Cape St Lucia, the inertia of the Agulhas Current carries it into deep water. This generates instability in the current (Gill & Schumann 1979) resulting in meanders and eddies (Pearce *et al.* 1978). South of Durban, the continental shelf again narrows and the Agulhas Current re-attaches itself as a relatively stable trajectory to the coast, until off Port Edward it is so close inshore that the inshore edge (signified by a temperature front) is rarely discernible (Pearce 1977a). At Port St Johns, however, there exists a semi-permanent eddy, which results in a northward-flowing coastal current and the movement of cooler water up the continental slope onto the centre of the very narrow shelf (Roberts *et al.* 2010). Further south, when the Agulhas Current reaches the wider Agulhas Bank, where the continental slopes are weaker, it starts to exhibit large meanders, with cross shelf dimensions of approximately 130 km, which move downstream at approximately 20 km per day (Lutjeharms 2006). It may also shed eddies, which travel at around 20 cm/sec and advect onto the Agulhas Bank (Swart & Largier 1987; Penven *et al.* 2001). After detaching from the shelf edge at 15° E, the Agulhas Current retroflects and flows eastwards as the Agulhas Return Current to follow the Subtropical Convergence (Schumann 1998; Lutjeharms 2006) (Figure 5).

Currents over the inner and mid-shelf (to depths of 160 m) are weak and variable, with velocities along the eastern half of the South Coast ranging from 25 - 75 cm/sec mid-shelf and 10 - 40 cm/sec nearshore. In common with other western boundary currents, a northward (equator-ward) undercurrent — termed the Agulhas Undercurrent — is found on the continental slope of the East Coast at depths of between 800 m and 3,000 m (Beal & Bryden 1997). The offshore movement of the Agulhas Current in the vicinity of East London creates shear edge eddies, which periodically circulate warm water inshore near Port Elizabeth resulting in rapid variation of water temperatures (Boyd *et al.* 1992; Boyd & Shillington 1994). During easterly wind conditions, periodic upwelling may occur near the rocky headlands, causing sharp drops in seawater temperature. Bottom water shows a persistent westward movement, although short-term current reversals may occur (Swart & Largier 1987; Boyd & Shillington 1994; CCA & CSIR 1998). Temperature and current dynamics within Algoa Bay are therefore complex and vary over small spatial scales. Current speeds of less than 10 cm/s have been measured most frequently within the bay, although currents exceeding 20 cm/s are not uncommon. Off Port Elizabeth, currents flow in a predominately southerly direction out of the Bay.

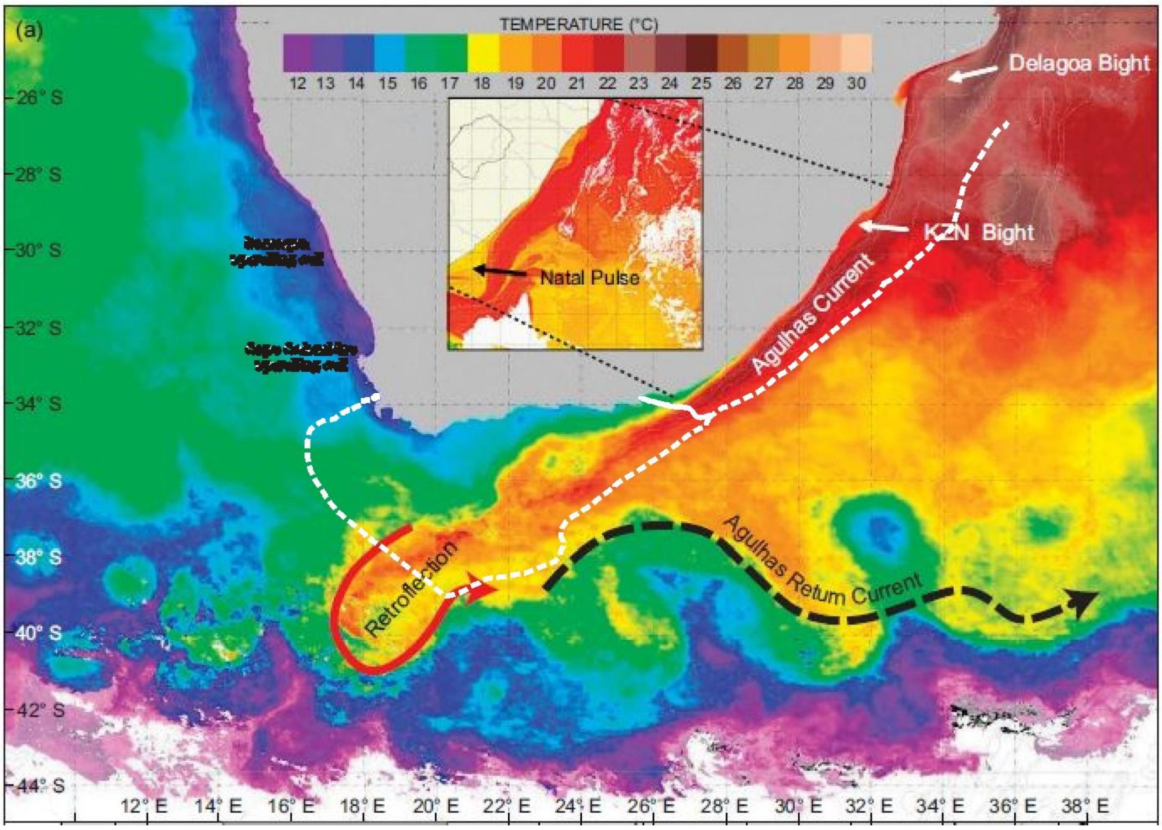


Figure 5: The predominance of the Agulhas current in the oceanography of the East Coast (adapted from Roberts *et al*. 2010). The proposed Port Elizabeth branch (white line) of the main trunk (dashed line) of the 2AFRICA/GERA (East) Cable System is shown.

As part of the benthic ecology study undertaken as part of the EIA for the Algoa Bay Aquaculture Development Zone (ADZ) (Hutchings *et al*. 2013; Dawson *et al*. 2019) an Acoustic-Doppler Current Profiler (ADCP) was deployed ~3 km offshore of the proposed cable landing site from February to June 2013 to quantify the wave climate (wave height and period) and currents at various depths in the water column. Results indicated that currents were strongest and flowed in a predominately southerly (SE-SW) direction (Figure 6). Currents, however, flowed in all directions at times, with relatively strong flows (>15 cm/sec) towards the North and North West at nearly all depths for 20-30% (cumulative frequency) of the time. Westerly and easterly flowing currents were rare, and occurred approximately 6% of the time. Current velocities in the lower water column (>-15 m) exceeded 10 cm/sec for 34-43% of the time, while those shallower than -10 m exceeded 10 cm/sec for more than 50% of the time and reached a maximum velocity of 62 cm/sec.

As the Agulhas Current originates in the equatorial region of the western Indian Ocean its waters are typically blue and clear, with low nutrient levels and a low frequency of chlorophyll fronts. The surface waters over most of the project area are a mix of Tropical Surface Water (originating in the South Equatorial Current) and Subtropical Surface Water (originating from the mid-latitude Indian Ocean). The surface waters of the Agulhas Current may be over 25°C in summer and 21°C in winter and have lower salinities than the Equatorial Indian Ocean, South Indian Ocean Central water masses found below. Surface water characteristics, however, vary due to insolation and mixing

(Schumann 1998). South Indian Ocean Central Water of 14°C and a salinity of 35.3 ppt occurs below the surface water layers at between 150 - 800 m depth. The deeper waters comprise, from shallowest to deepest, Antarctic Intermediate Water, North Indian Deep Water, North Atlantic Deep Water and Antarctic Bottom Water. Sub-tropical Surface Water of between 15 and 20°C often intrudes into the Agulhas Current at depths of 150 - 200 m from the east (Schumann 1998).

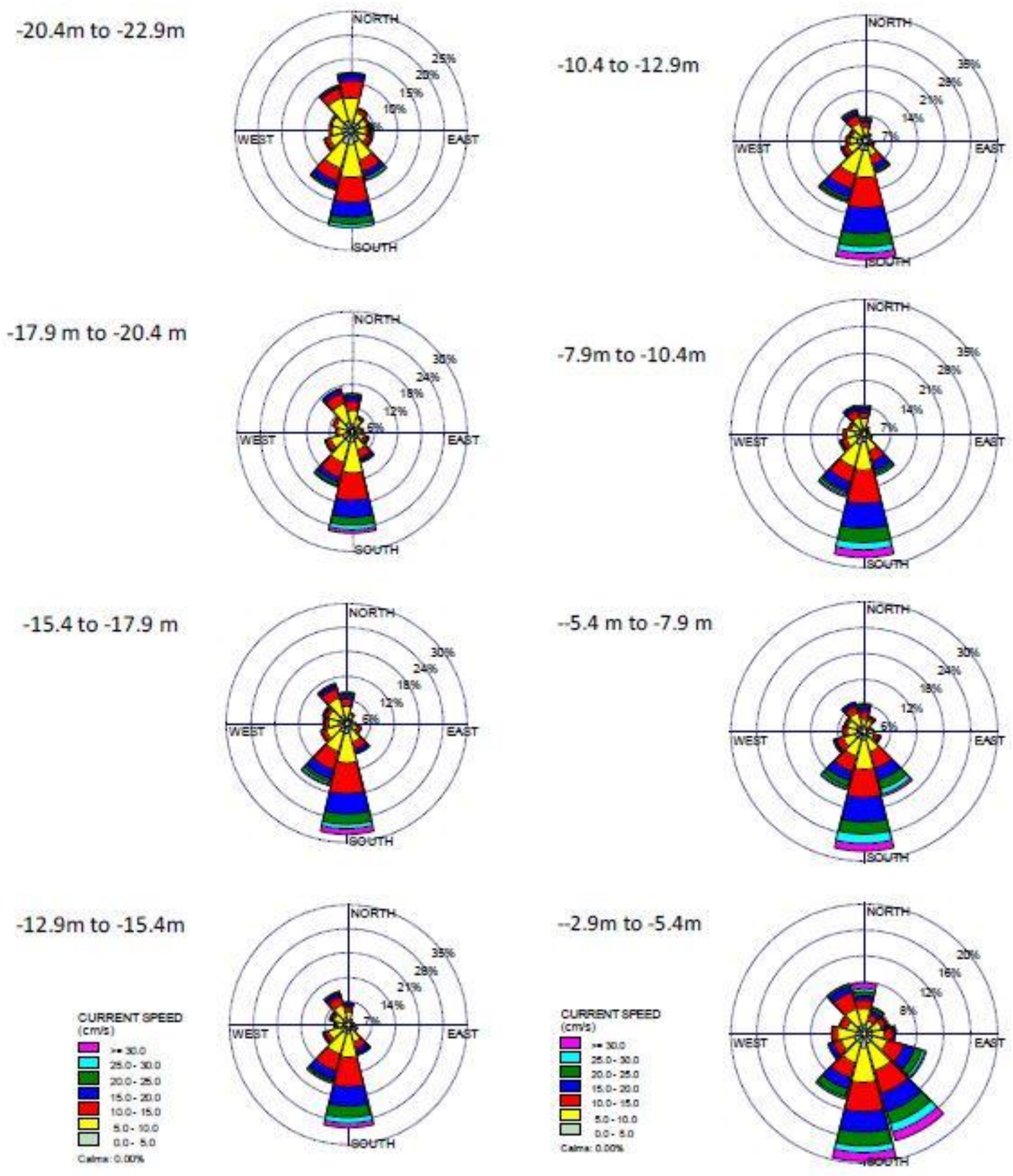


Figure 6: Current roses showing the directions and speeds of currents measured at the Algoa 1 ADZ site during 2 February – 11 June 2013 within different depth strata (from Hutchings *et al*. 2013).

Seasonal variation in temperatures is limited to the upper 50 m of the water column (Gründlingh 1987), increasing offshore towards the core waters of the Agulhas Current. Inshore, waters are warmest during autumn, with warm water tongues found off Cape Recife (near Port Elizabeth) from January to March, and Knysna from October to January and during August. Warm water also tends to bulge towards Knysna between April and July and during September (Christensen 1980).

At the inner boundary of the Agulhas current, cold bottom water is advected onto the Agulhas Bank *via* shelf-edge upwelling (Schumann 1998). This process is primarily due to frictional interactions between the Agulhas Current and bottom topography (Hutchings 1994), and is most intense at the eastern boundary of the South Coast, where the cold bottom layer breaks the surface (Figure 8). The core of the upwelling lies at Port Alfred but can extend from the eastern edge of Algoa Bay to Mbashe on the Transkei Coast (Lutjeharms *et al.* 2000). This upwelling has been associated with large meanders in the Agulhas Current (Jackson *et al.* 2012; Goshen *et al.* 2015; Malan *et al.* 2018). Such shelf-edge upwelling largely defines the strong thermocline and halocline topography that typically develops between the cold bottom water and the sun warmed surface layer during spring (September to November), summer (December to February) and autumn (March to May). A cool ridge of upwelled water extends in a north-east (NE) – south-west (SW) direction over the mid-shelf regions between the shelf-edge upwelling and inshore waters close to the coast (Swart & Largier 1987; Boyd & Shillington 1994; Schumann 1998). The ridge has its 'base' at the coast between Cape Seal (Robberg Peninsula) and Cape St Francis and appears to be most prominent under south-east wind conditions, which cause coastal upwelling in the Knysna region (Walker 1986; Boyd & Shillington 1994; Jury 1994). As easterly winds dominate in the spring-autumn period the cool water ridge is a semi-permanent feature during much of the year. Inshore of the cool water ridge, the thermoclines may be disrupted by coastal upwelling on the lee side of capes under easterly wind conditions (Schumann *et al.* 1982; Walker 1986; Schumann 1998). Such upwelling usually begins at the prominent capes and progresses westwards (Schumann *et al.* 1982; Schumann *et al.* 1988), and can result in temperature changes of up to 8° C within a few hours (Hutchings 1994).

More site specific data of temperature variations throughout the water column at a sampling site ~3 km offshore of the proposed beach landing site is presented in Hutchings *et al.* (2013), who found that vertical movement of the thermocline at this site took place during late summer-autumn, moving as shallow as 5 m from the surface during late March 2013, with a ~5°C drop in temperature over a 12 hour period. Temperature variations became more pronounced with depth, and varied seasonally, but with little fluctuation after April.

3.1.3 Winds and Swells

Along the Eastern Cape, westerly winds predominate in winter, frequently reaching gale force strengths. During summer, easterly wind directions increase markedly resulting in roughly similar strength/frequency of east and west winds during that season (Jury 1994). The strongest winds are observed at capes, including Infanta, Robberg and Cape Recife (Jury & Diab 1989). Calm periods are most common in autumn (CCA & CSIR 1998). At Cape Recife, the winds have a variable west south-westerly component, with the highest frequency of south westerly wind speeds greater than 10.5 m/sec occurring during September and October (Cliff 2013).

The wave climate in Algoa Bay is predominantly from the southwest with swells of <2 m occurring approximately 80% of the time (MacLachlan 1983) (Figure 8). Only a small percentage of waves from the southwest exede 3 m; these are generated by storms in the Southern Ocean. Most of Algoa Bay is protected from these swells by the rocky headland at Cape Recife, although some degree of refraction does occur (Goschen & Schumann 2011). Maximum recorded wave heights along the surf zone of Algoa Bay reached 6 m (MacLachlan 1983), with higher wave heights dominating during winter (CSIR 1987).

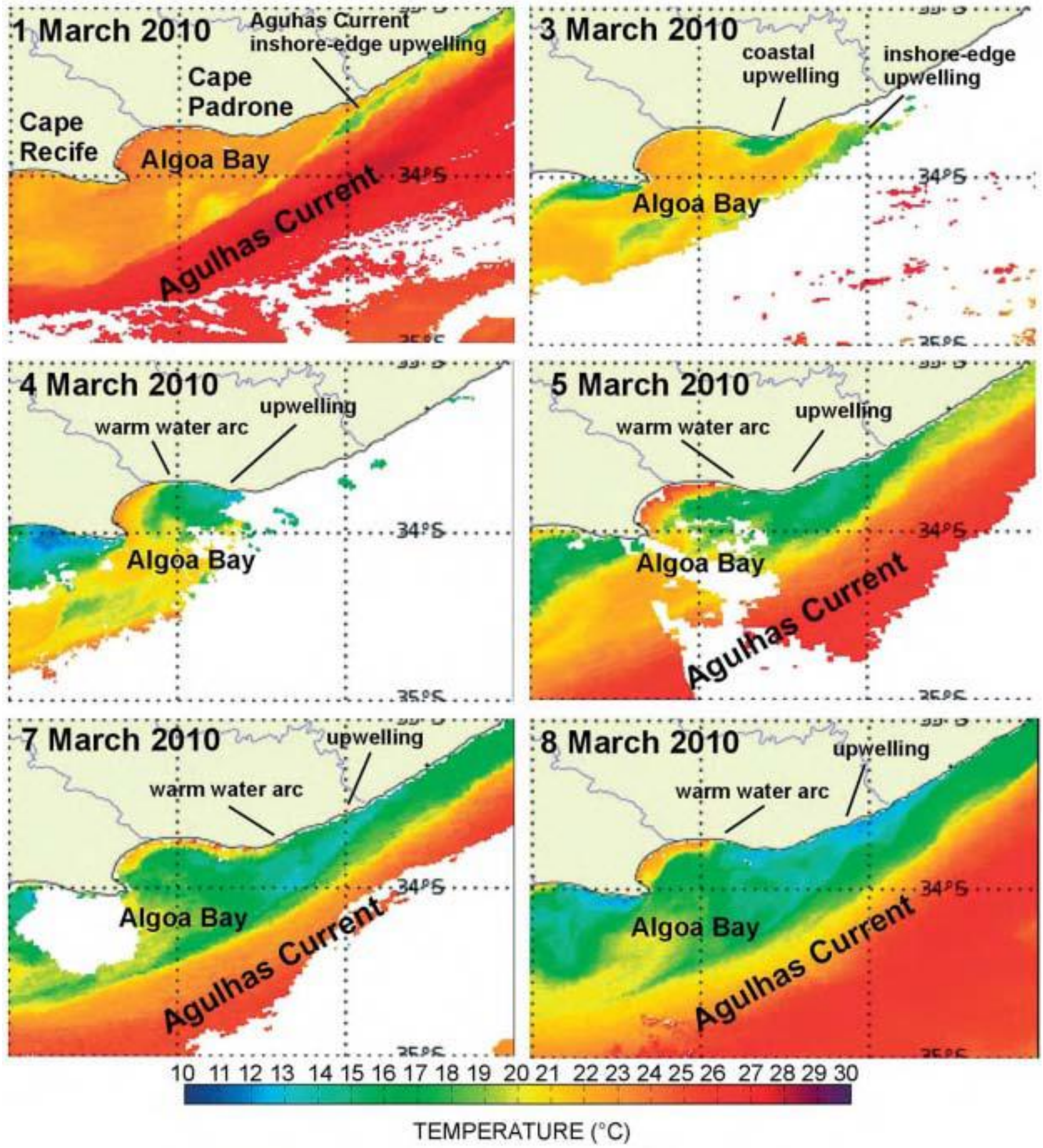


Figure 7: Satellite imagery of sea surface temperature between 1 and 8 March 2010 showing an upwelling event. Cool water first emerges at Woody Cape/ Cape Padrone and expands into Algoa Bay (Source: Hutchings *et al*. 2013).

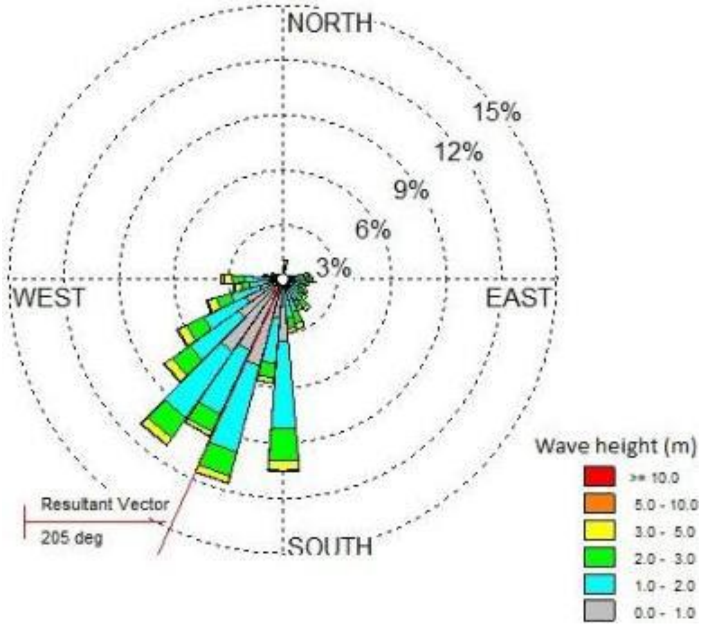


Figure 8: Wave rose showing the direction, proportion and magnitude of waves experienced offshore of the St. Francis- Algoa Bay region (Source: SADCO Voluntary Observing Ships for a 30-year period).

3.1.4 Tides

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

3.1.5 Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) can be divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. On the Agulhas Bank, seasonal microphyte production associated with upwelling events, both inshore and along the shelf edge, will play an important role in determining the concentrations of POM. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. The PIM loading in nearshore waters is strongly related to natural riverine inputs and resuspension and bedload transport of seabed sediments. Within Algoa Bay, turbidity levels in surface waters are typically low throughout the year (<10 NTU), indicative of clear water. Elevated turbidity has, however, been detected nearer the seabed where values exceeded 10 NTU and at time reach 25 NTU (Laird *et al*. 2016).

A feature of continental shelf waters off the South Coast is the benthic nepheloid layer (Zoutendyk & Duvenage 1989; Dorfler 2002). This layer can be up to 10 m thick and may have TSPM values of up to 38 mg/ℓ. It is usually located below the thermocline at a depth of between 20 m and 30 m (Zoutendyk & Duvenage 1989). Initially thought to be associated with the mud belts on the inner Agulhas Bank near Mossel Bay, the nepheloid layer has recently been found associated with the

Cape St Francis and Cape Infanta areas (Dorfler 2002) (Figure 9), as well as at about 150 m depth on the continental slope between Knysna and Cape St Francis (Jackson *et al*. 2012). Although thought to originate from detrital fallout from surface waters, Zoutendyk & Duvenage (1989) reported that POM contributed <10% of the TSPM in the turbid layer. The dynamics of the nepheloid layer are complex, and appear to be driven by a combination of wind, waves and currents. Turbidity events, however, not only occur during upwelling but also in isothermal conditions, with down-welling and turbidity being correlated in deeper waters (Dorfler 2002). The benthic nepheloid layer plays a significant role in the benthic community structure of nearshore reefs (Zoutendyk & Duvenage 1989) and is thought to influence the spawning success of squid in Eastern Cape inshore waters (Dorfler 2002).

Offshore of the continental shelf the oceanic surface waters are clear and background concentrations are typically <1 mg/ℓ (Emery *et al*. 1973).

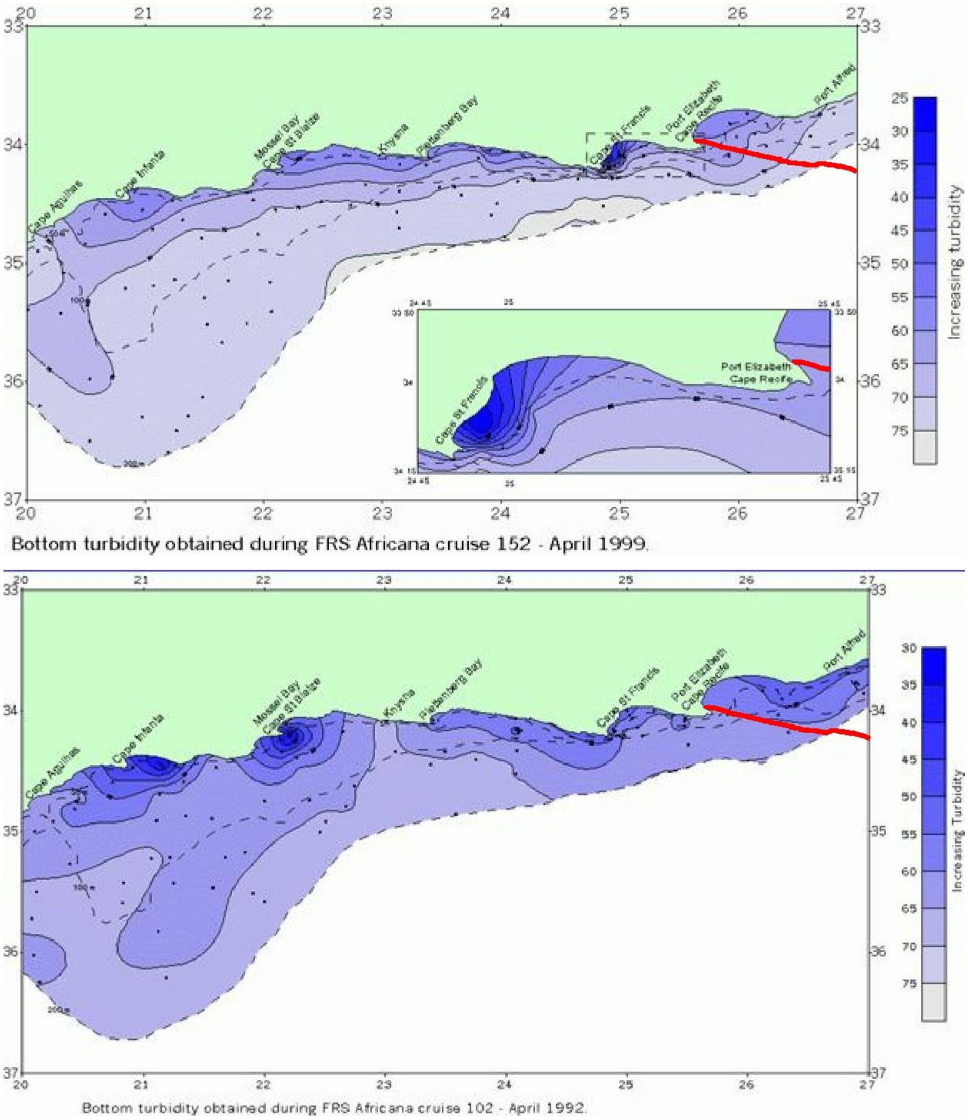


Figure 9: The proposed Port Elizabeth branch (red line) in relation to in relation to benthic turbidity events on the Eastern Agulhas Bank in April 1992 (bottom) and April 1999 (top) (adapted from Dorfler 2002). The turbidity scales are in Nephelometric Turbidity Units (NTU).

3.2. The Biological Environment

Biogeographically the proposed Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System falls into the Agulhas and Southwest Indian Deep Ocean ecoregion (Figure 10) (Sink *et al*. 2019). For about half of its length, the cable will be located on the shelf in waters <200 m depth, dropping down the shelf edge to connect to the main trunk in beyond the shelf break of ~3,000 m. The seabed communities on the continental shelf off Algoa Bay lie within the Agulhas photic, sub-photic and continental slope bioregion, which extend from the shore to the shelf edge. Where the cable passes from the upper and lower continental slope to the abyssal deepsea, it lies within the Southwest Indian Deep Ocean ecoregion. The wide oceanic shelf provides an array of habitats and the local oceanography and temperature structure of the water column play role in accounting for high levels of biodiversity and endemicity, including the highest number of endemic fish species along the South African coast (Turpie *et al*. 2000; Lombard *et al*. 2004; Sink *et al*. 2019).

The biota of nearshore marine habitats on the Southeast Coast are relatively robust, being naturally adapted to an extremely dynamic environment where biophysical disturbances are commonplace. Communities within this region are largely ubiquitous, particular only to substrate type (i.e. hard vs. soft bottom), exposure to wave action, or water depth. Habitats specific to the study area include:

- Sandy intertidal and subtidal substrates,
- Intertidal rocky shores and subtidal reefs, and
- The water body

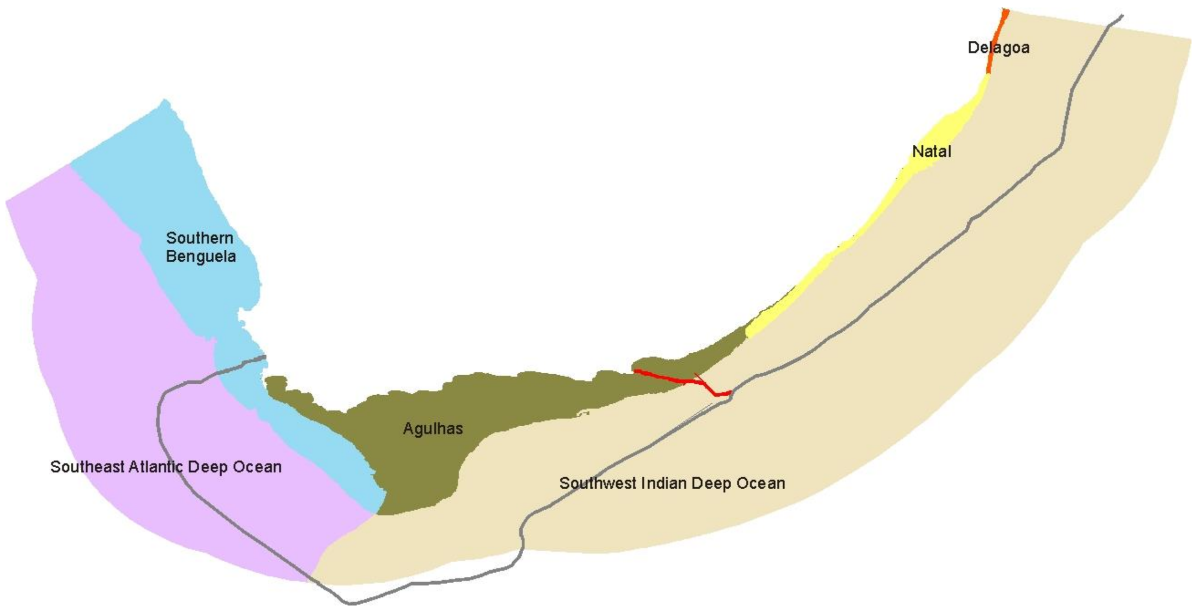


Figure 10: The proposed Port Elizabeth branch (red line) of the main trunk (black line) of the 2AFRICA/GERA (East) Cable System in relation to the South African inshore and offshore ecoregions (adapted from Sink *et al*. 2019).

The biological communities of these environments consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). No rare or endangered species have been recorded (Awad *et al*. 2002). The biological communities 'typical' of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species, which may be affected by the proposed Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System routing. This description is supplemented by the comprehensive investigation of macrobenthic communities within and adjacent to the cable servitude within the nearshore (0-30 m) undertaken by Aquatic Ecosystem Services (2021). In this survey a drop camera system was used to obtain imagery of the seafloor at 50 m intervals along the proposed cable alignment, with additional sites in 5 m depth strata across outcropping rock (reef), subcropping rock and soft substrate being assessed to gain understanding of the benthic biotopes present with the study area. Sixty-six sites were assessed along the cable alignment and additional 30 sites assessed adjacent to the servitude. A point intercept method was use to quantify benthic community structure.

Due to limited opportunities for sampling, information on the pelagic and demersal communities of the continental slope, lower bathyal and abyss are very poorly known (Lesley *et al*. 2000; Griffiths *et al*. 2010), with only 2% of all existing benthic samples in South Africa having been collected in water deeper than 1,000 m (Griffiths *et al*. 2010). The shelf on the South Coast has been moderately well sampled, with most sample collected by dredging. Consequently, much of the information on the baseline environment provided below relates to the continental shelf (<200 m) regions, which fall within the Agulhas Ecoregion.

The benthic habitats of South Africa were mapped as part of the 2018 National Biodiversity Assessment (Sink *et al*. 2019) to develop assessments of the ecosystem threat status and ecosystem protection level. The benthic ecosystem types were subsequently mapped (see Figure 3 and Figure **4**) and assigned an ecosystem threat status based on their level of protection (Figure 11).

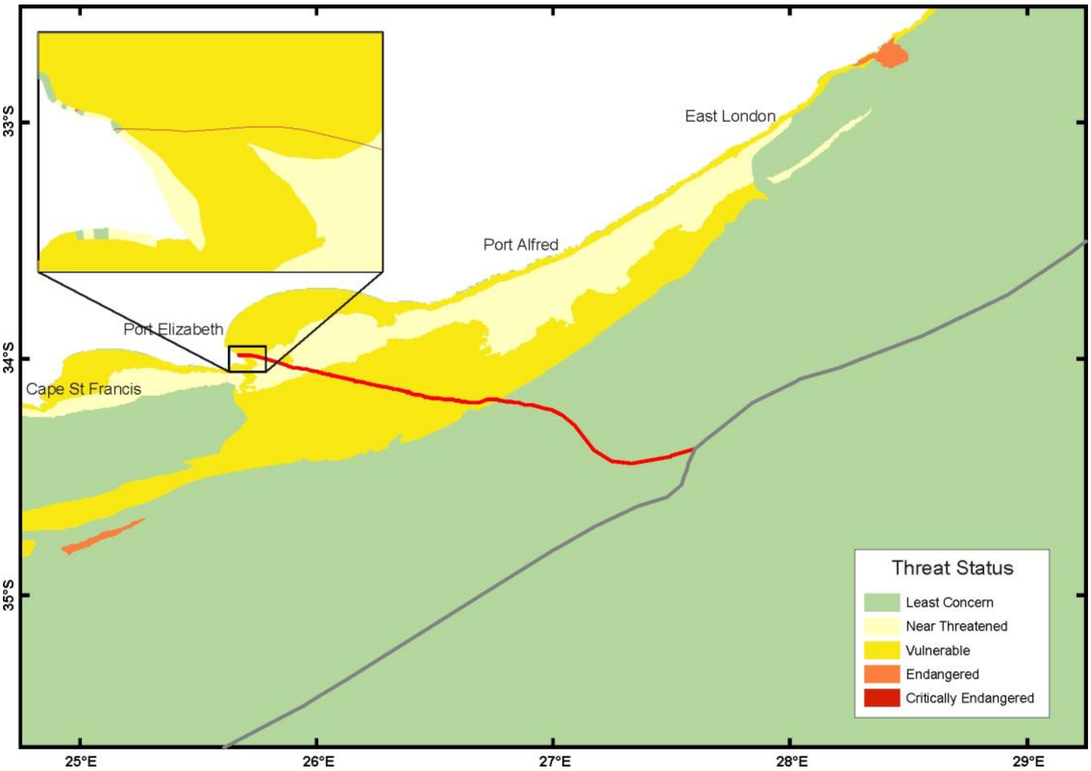


Figure 11: The proposed Port Elizabeth branch (red line) of the main trunk (black line) of the 2AFRICA/GERA (East) Cable System in relation to the ecosystem threat status for coastal and offshore benthic habitat types (adapted from Sink *et al*. 2019). The insert provides details of the threat status of intertidal habitas at the cable shore crossing.

The ecosystem threat status of the offshore benthic habitat types along most of the Southeast Coast, have been rated as 'Least Concern' reflecting the great extent of these habitats within the South African EEZ (Sink *et al*. 2012) (Figure 11). However, on the shelf and in the coastal zone of the project area, the Eastern Agulhas Bay, Agulhas Inner Shelf Mosaic, Agulhas Sandy Outer Shelf and Agulhas Coarse Sediment Shelf Edge habitats through which the cable crosses are considered 'Vulnerable', whereas the Agulhas Sandy Mid Shelf is considered 'Near Threatened'. The intertidal beach at the shore crossing in Algoa Bay is rated as 'Least Concern'.

3.2.1 Sandy Substrate Habitats and Biota

The benthic biota of soft bottom substrates constitutes invertebrates that live on, or burrow within, the sediments, and are generally divided into megafauna (>10 cm), macrofauna (animals >1 mm) and meiofauna (<1 mm).

Intertidal Sandy Beaches

The coastline of Algoa Bay from Cape Padrone to the Port Elizabeth Harbour is dominated by sandy beaches. The faunal community composition of sandy beaches is largely dependent on the interaction of wave energy, beach slope and sand particle size (beach morphodynamics). There are three general morphodynamic beach types: dissipative, reflective and intermediate beaches (McLachlan *et al*. 1993). Dissipative beaches are wide and flat with fine sands and high wave energy. Waves start to break far from the shore in a series of spilling breakers that 'dissipate' their energy across a broad surf zone. This generates slow swashes with long periods, resulting in less turbulent conditions on the gently sloping beach face. These beaches usually harbour the richest intertidal faunal communities. Reflective beaches have low wave energy, are coarse grained (>500 µm sand) and have narrow and steep intertidal beach faces. The relative absence of a surf zone causes the waves to break directly on the shore causing a high turnover of sand. The result is depauperate faunal communities. Intermediate beach conditions exist between these extremes and have a very variable species composition (McLachlan *et al*. 1993, Jaramillo *et al*. 1995, Soares 2003). This variability is mainly attributable to the amount and quality of food available. Virtually all the beaches in Algoa Bay are classified as dissipative-intermediate sandy shores comprised of dune and medium-grained marine sands. Considerable small-scale spatial and temporal variability in the physical state can, however, occur and beaches and their associated macrofaunal communities should therefore be viewed as extremely dynamic. Within a biogeographic province, the macrofaunal communities of sandy beaches are generally ubiquitous. As the study area falls within the transition zone between the South and East Coasts, invertebrate macrofauna representing both regions can occur.

The beach and surf-zones together are considered a functional ecosystem, which interacts with the terrestrial environment through the movement of sand, and with the nearshore through the activity of rip currents (McLachlan *et al*. 1981; McLachlan *et al*. 1984; Talbot 1986). In this semi-enclosed ecosystem, surf-zone phytoplankton are the producers, macrofauna the consumers and the interstitial meiofauna the decomposers.

Numerous methods of classifying beach zonation have been proposed, based either on physical or biological criteria. The general scheme proposed by Branch & Griffiths (1988) is used below (Figure

12), supplemented by data from publications on Eastern Cape sandy beach biota (e.g. Wooldridge *et al*. 1981; Bursey & Wooldridge 2002; Harris 2012).

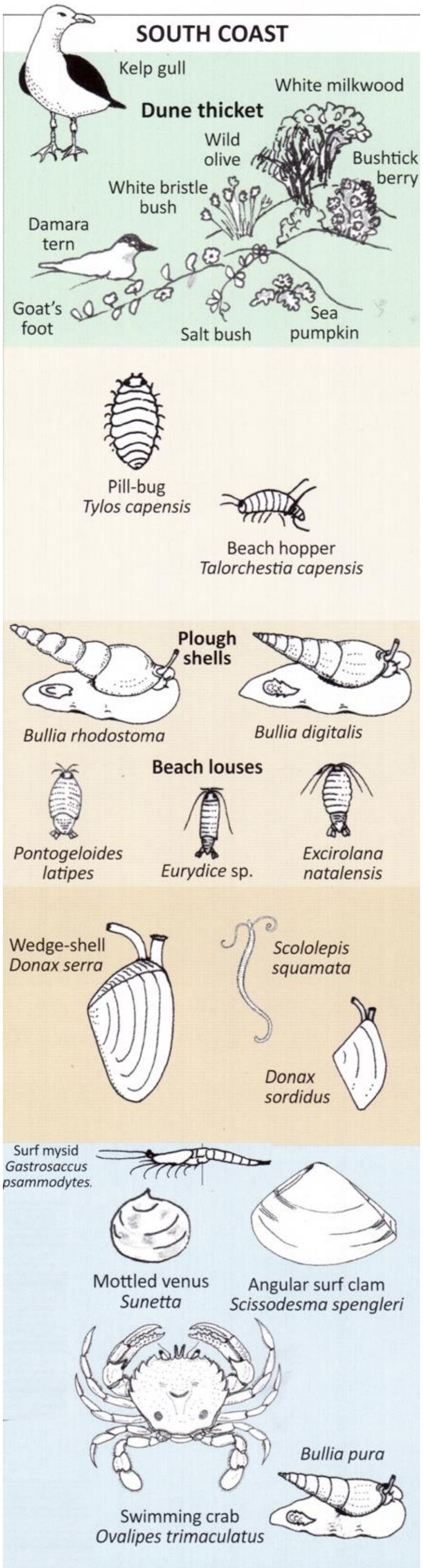


Figure 12: Schematic representation of the Southeast Coast intertidal zonation on sandy beaches (adapted from Branch & Branch 2018).

The high shore between the base of the dunes and the high water mark is typically dominated by the semi-terrestrial isopod *Tylos capensis* and the beach hopper *Talorchestia capensis*. Scavenging whelks such as *Bullia rhodostoma* are common in the midshore zone while *B. pura* and *B. digitalis* occur in the surf zone (McLachlan 1977), feeding on almost any carion cast up on the shore. Several cirolanid isopod species occur across the intertidal moisture gradient (De Ruyck *et al.* 1992) with the genus *Eurydice* being the most common from the midshore and extending into the low shore.

The isopods *Pontegeloides latipes* and *Excirolana natalensis* occur in lower numbers above mid-tidal level extending also into the lowshore. The nemertean worm *Cerebratulus* sp. and polychaete *Nephtys* sp. are typical of the mid- and lowshore, extending into the surf-zone.

In the lowshore, the macrofauna is dominated by the filter feeding sand mussel *Donax serra*, with the smaller *D. sordidus* dominating the surf-zone (McLachlan & Bate 1984). Sand mussels in the region are thought to dependent largely on *Anaulus* and consequently reach their highest biomasses where *Anaulus* blooms are most frequent. Sand mussels are key organisms in the foodwebs and are preyed on by a variety of animals including gulls, oystercatchers, crabs, sandsharks, rays and fish. The surf-zone swimming crab *Ovalipes punctatus*, is an important invertebrate predator on Eastern Cape beaches, feeding predominantly on *Donax* and *Bullia* (Du Preez 1984). Seawards of the breaker zone, the scavenging polychaete worm *Goniadopsis incerta* is abundant (McLachlan & Bate 1984). The bentho-pelagic mysid *Gastrosaccus psammodytes* is most abundant in the swash and surf-zone of sandy beaches and occurs in densities of up to 55 individuals/m^2, forming an important link between the primary food supply and higher levels of the macrofaunal foodweb (Wooldridge 1983; Wooldridge *et al.* 1997).

Meiofaunal organisms (<1 mm in size), which occur within the sediment, are dominated by nematodes (38%) and harpacticoid copepods (38%), with turbellarians (10%), mystacocarids (6%), archiannelids (3%), oligochaetes (2%) and other minor groups (3%) constituting the rest (McLachlan *et al.* 1981). Nematodes dominate where the sand is finer and the oxygen level lower, while harpacticoid copepods prefer coarser well-drained sands.

A number of fish species occur in and just beyond the surf zone, namely galjoen (*Dichistius capensis*) and white steenbras (*Lithognathus lithognathus*), which swim over submerged beaches at high tide and feed on small crabs and macrofauna (Branch & Branch 2018). Elf (*Pomatomus saltatrix*), leervis (*Lichia amia*), sand shark (*Rhinobatos annulatus*) and white sea catfish (*Galeichthys feliceps*), are some of the characteristic species that favour the sandy surf-zone.

Nearshore and Offshore unconsolidated habitats

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

The meiobenthos includes the smaller species such as nematode worms, flat worms, harpacticoid copepods, ostracods and gastrotriches. Some of the meiofauna are adept at burrowing while others live in the interstitial spaces between the sand grains.

Recent research within Algoa Bay has revealed that the Bay harbours an extraordinary invertebrate diversity potentially including several previously undescribed taxa (Dorrington *et al*. 2018). Similarly, a study investigating the natural variation in the community structure and spatial distribution of benthic macrofauna assemblages and sediment quality within Algoa Bay reported a high overall species count of 187 species from 137 different genera (Masikane 2011). The benthic ecology study undertaken as part of the EIA for the Algoa Bay Aquaculture Development Zone (ADZ) (Dawson *et al*. 2019) sampled unconsolidated sediments between 21.3 m and 39.7 m depth 3 km offshore of the proposed cable landing site (Figure 13). Sediments comprised primarily medium to very coarse sands ranging in mean particle sizes from 383 μm to 1,341 μm. Gravel contributed ~10% to the composition of the sediments with a small contribution by mud (<63 μm). Off King's Beach, sediments are similarly dominated by medium to coarse sands, with contributions by fine and very fine sand varying between about 30 – 45% (Masikane 2011). The percentage of total organic content ranged from 2.27 to 5.04% in the Algoa 1 area, but reached an average of only ~1.6% off King's Beach (Masikane 2011).

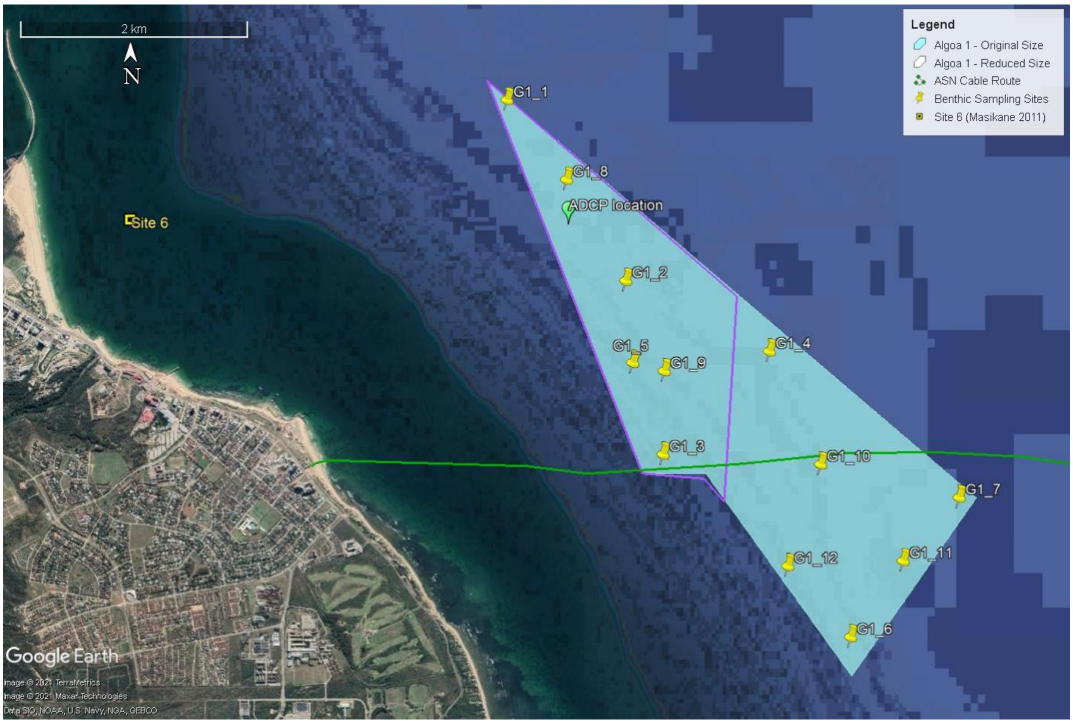
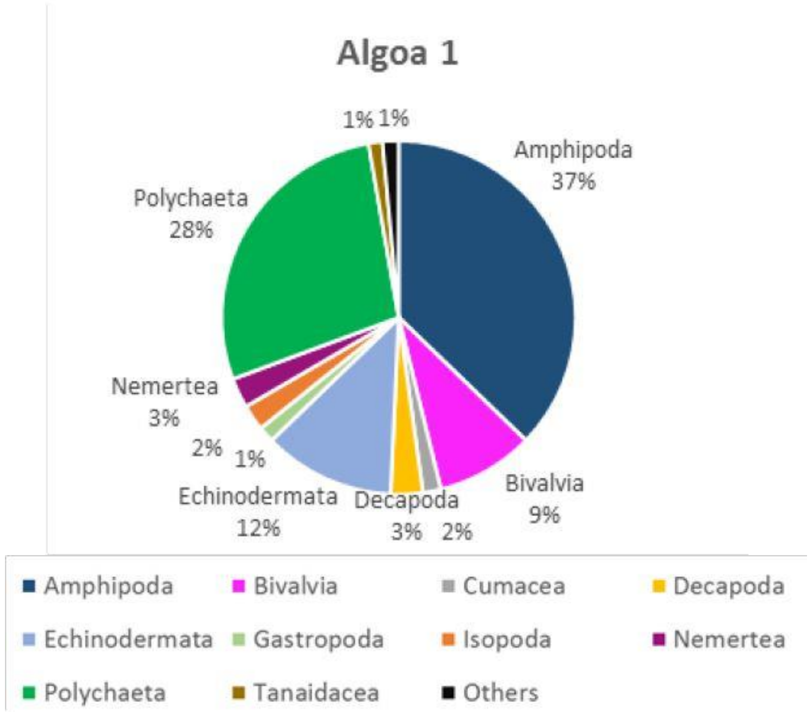


Figure 13: Proposed landing site of the Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System in relation to the original proposed Algoa 1 ADZ, the reduced-size ADZ option, the location of the benthic macrofaunal sampling sites and the location of the ADCP (Source: Anchor Environmental Consultants). Site 6 off King's Beach sampled by Masikane (2011) is also shown.

Taxonomic composition within the Algoa 1 area highlighted both Amphipoda and Polychaeta as the dominant groups in terms of abundance (Figure 14a) (Dawson *et al*. 2019). This reflected the results reported for nearby Site 6 by Masikane (2011), where amphipods and polychaetes were similarly dominant contributing over 50% to the total abundance (Figure 14b), with Ostracods, Tanaids and cumaceans also being represented. Masikane (2011) reported an exceptionally rich macrofaunal diversity in Algoa Bay comprising 187 species from 137 different genera. Figure 15 provides some examples of macrofauna found in Algoa Bay (Hutchings *et al*. 2019)

A.



B.

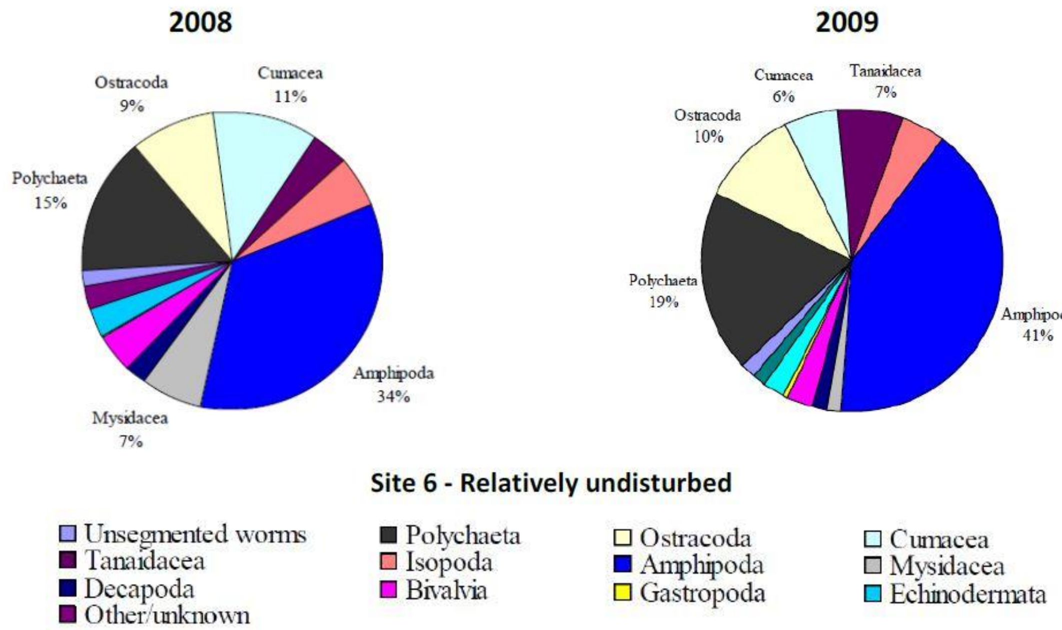


Figure 14: Taxonomic composition and most abundant groups for the community assemblages at A) Algoa 1 precinct of the ADZ (Dawson *et al*. 2019), and B) at Site 6 off King's Beach (Masikane 2011). Other is a combination of smaller, least abundant or rare groups, including Anthozoa, Cephalochordata, Hydrozoa, Ostracoda, Pennatulacea, Polyplacophora, Scleractinia and Turbellaria. Decapoda were represented by brachyuran and anomuran crabs, shrimps and prawns.

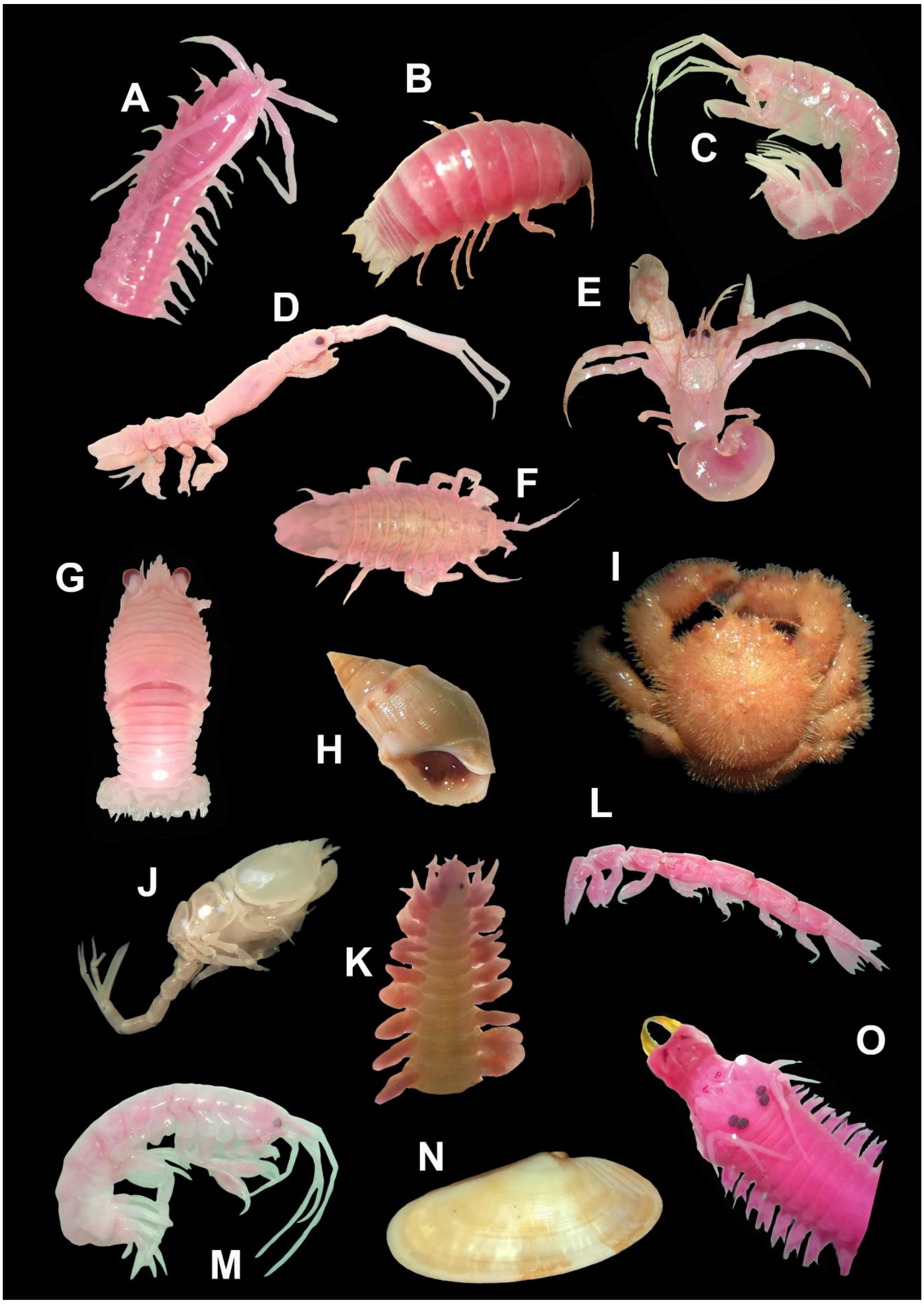


Figure 15: Examples of benthic macrofaunal species found in Algoa Bay: A – *Onuphis geophiliformis* (Polychaeta); B – *Cirolana sulcate* (Isopoda); C – *Ceradocus rubromaculatu* (Amphipoda); D – *Neastacilla mediterranea* (Isopoda); E – *Diogenes costatus* (Decapoda); F: *Synidotea hirtipes* (Isopoda), G – *Galathea intermedia* (Decapoda); H – *Bullia annulata* (Gastropoda); I – *Dromidae* sp (Decapoda); J – *Ostracoda* sp (Ostracoda); K - *Protomystides capensis* (Polychaeta); L: *Leptanthura laevigata* (Isopoda) M – *Austromaera bruzelii* (Amphipoda); N – *Donax burnupi* (Bivalvia); *Nereis sp* (Polychaeta) (Source: Hutchings *et al*. 2019).

Further north off East London, a benthic ecology study undertaken off West Bank (Bickerton & Blair 1999; Monteiro *et al*. 2001) similarly identified a high species diversity for macrofauna (total of 144 species) and meiofauna (39 taxa) in offshore sediments Macrofaunal communities were characterised by polychaetes, crustaceans (of which amphipods, cumaceans and isopods were the dominant types), echinoderms and molluscs, and showed a general trend of increasing benthic macrofaunal abundance and species diversity with increase in water depth. The meiofauna was dominated by nematodes, with gastrotrichs, harpacticoid copepods and flatworms (turbellaria) also being major contributors.

Subtidal trawl and dredge surveys conducted on soft bottom habitats from Mossel Bay to Cape Padrone likewise recorded high diversities of polychaetes (56 species of bristle worms), gastropods (53 species of snails), ophiuroids (9 species of brittle star) and mysids (4 species of shrimps) (Wallace *et al*. 1984). Benthic macrofaunal samples collected during a pilot survey offshore of Cape Recife, identified a total of eleven species including three species of amphipod (*Griffithsius latipes*, *Urothoe pinnata* and *Colomastigidae pusilla*), four species of isopod (all belonging to the genus *Cirolana*), two species of polychaete (*Ophelia* sp. and *Pectiniaria* sp.), as well as a species of sea cucumber and a species of brittle star (*Amphipholis squata*).

3.2.2 Rocky Shores and Subtidal Reefs

The intertidal and shallow subtidal reefs along the East Coast of South Africa support a wide diversity of marine flora and fauna and a relatively high percentage of endemic species (Turpie *et al*. 2000; Awad *et al*. 2002).

On the Southeast Coast, rocky intertidal shores can be divided into five zones on the basis of their characteristic biological communities: The Littorina, Upper Balanoid, Lower Balanoid, Cochlear and the Infratidal Zones. The general scheme proposed by Branch & Branch (2018) is used below (Figure **16**), supplemented by data from publications on Eastern Cape rocky shores (Beckley 1988; Seagrief 1988; Lubke & Seagrief 1998; Wooldridge & Coetzee 1998). Tolerance to the physical stresses associated with life on the intertidal, as well as biological interactions such as herbivory, competition and predation interact to produce these five zones.

Supralittoral fringe or Littorina zone - The uppermost part of the shore is the supralittoral fringe, which is the part of the shore that is most exposed to air, perhaps having more in common with the terrestrial environment. The supralittoral is characterised by low species diversity, with the tiny periwinkle *Afrolittorina knysnaensis*, and the red alga *Porphyra capensis* constituting the most common macroscopic life. Sheltering under rocks on the high-shore is the common shore crab *Cyclograpsus punctatus*.

Upper Mid-littoral or Upper Balanoid zone - The upper mid-littoral is characterised by the limpets *Scutellastra granularis* and *S. oculus*. The gastropods *Oxystele variegata*, *Nucella dubia*, and *Helcion pectunculus* are variably present, as are low densities of the barnacles *Tetraclita serrata*, *Octomeris angulosa* and *Chthamalus dentatus*. Flora is best represented by the green algae *Ulva* spp. and the knobbly *Iyangaria stellate*.

Lower Mid-littoral or Lower Balanoid zone - Toward the lower shore, biological communities are determined by exposure to wave action. On sheltered and moderately exposed shores, a diversity of algae abounds with a variable representation of: green algae – *Ulva* spp, *Codium* spp.; brown

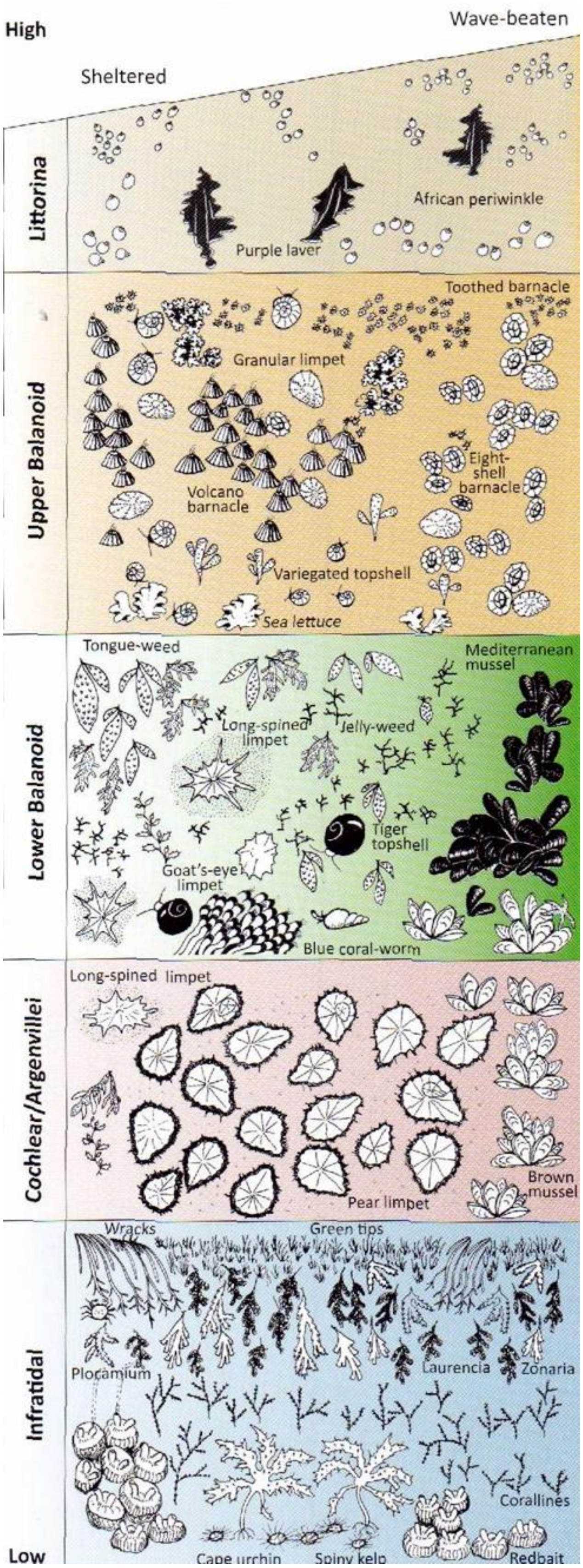


Figure 16: Schematic representation of the South Coast intertidal zonation on rocky shores (adapted from Branch & Branch 2018).

algae – *Splachnidium rugosum*; and red algae – *Aeodes orbitosa*, *Mazzaella (=Iridaea) capensis*, *Gigartina polycarpa* (=*radula*), *Sarcothalia* (=*Gigartina*) *stiriata*, and *Gelidium pristoides*. The gastropods *Scutellastra longicosta, Oxystele sinensis* and *O. tigrina*, as well as scavenging whelks (*Burnupena* spp.) and anemones occur interspersed among the algae. Filter-feeders are represented primarily by the brown mussel *Perna perna*.

Cochlear zone – this zone, named after the limpet *S. cochlear* is characteristic of the South coast occurring as a dense band of limpets at the low tide mark. These limpets can reach densities up to 2,600 per m^2 thereby preventing algae from establishing and restricting juvenile limpets to the backs of adults.

Sublittoral fringe - The sublittoral fringe typically supports dense colonies of red bait Pyura stolonifera, and thick stands of algae including articulated corallines, species of *Hypnea*, *Plocamium* and *Laurencia*. In wave exposed areas *Bifurcaria brassicaeformis* and *Ecklonia biruncinata* abound, whereas on more sheltered shores the urchin *Parechinus angulosus* cover the rocks. In areas dominated by urchins, foliose algae are virtually absent, leaving only the grazer-resistant encrusting coralline *Lithothamnion*. Some of these species extend into the subtidal below.

Relative to sandy habitats, reefs are scarce in Algoa Bay (Figure 17) (Bremner 1991; Chalmers 2012; Truter 2019). The cable alignment, however, crosses both outcropping as well as subcropping rock from just beyond the beach at the shore crossing to ~2.6 km offshore, at which point sandy substrate becomes the dominant seabed type (Fugro 2020). A previous study by Chalmer (2012) also identified that a large proportion of the inshore coastal region between Bird Rock (near the Landing Site) and Cape Recife point comprises hard reef substrata.

On shallow subtidal reefs (<10 m), algae, grazers and filter feeders are the most prolific fauna. Dominant algae comprise primarily red foliose species, especially *Plocamium s*pp (Seagrief 1988; Porter *et al*. 2012). The ascidian *Pyura stolonifera* is also abundant (Beckley 1988), and Cape oysters are prevalent particularly in areas prone to periodic sanding. Abalone *Haliotis midae* are an important species occurring on shallow, algal-dominated subtidal reefs. On deeper reefs the large predatory whelk *Charonia lampas* is also frequently encountered (Porter *et al*. 2012.

Marine benthic reef communities are strongly influenced by depth with a change from algal dominated to ascidian, porifera or bryozoan dominated communities with increasing depth (Heyns 2015; Parker-Nance 2021). Paker-Nance (2021) distinguished four distinct biotopes at the White Sands Long-Term Ecosystem Research Station (LTER), which is located some 350 m to 1,000 m from the proposed nearshore routing of the cable. These are summarised briefly below:

- **Biotope I** situated in the inshore areas (depth range of 4.6 to 7.6m), is characterised by low, flat, sand veneered reef (69.6%) with fine sand (21.1%), predominantly supports *Hypnea tenuis*.
- **Biotope II** is located between 5.8 m and 13.6 m in the western section and consists of numerous stabilised pebbles and cobbles on or between the largely rocky substrate (83.6%), with only small patches of sand. The biotic community is dominated by articulated coralline algae and hydroid tufts with encrusting coralline algae covering the pebbles and small cobbles.
- **Biotope III** lies between 12.3 m to 17.2 m depth in the eastern section and is characterised by large stable cobbles and boulders interspersed with gravel. It supports biota consisting of encrusting sponge, various sea fans and articulated and encrusting coralline algae.

- **Biotope IV** is the deepest of the biotopes (17.5 to 20.5 m), comprising mostly low to medium profile reef characterised by small overgrown outcrops, with fine sediment with shell fragment being a prominent component. The reef is typically encrusted with sponge, with sea fans and the crinoids present in crevices.

The community composition along the depth gradient of the inshore (0-30 m) cable alignment was investigated by Aquatic Ecosystem Services (2021), who identified four distinct reef biotopes and a further four sediment biotopes. Reef Biotope A comprised small mixed algae with larger algal species contributing to the structure. Reef Biotope B was dominated by the red alga *Plocamium corallorhiza*, wheras Reef Biotope C, located in deeper water was characterised by ascidians, sponges and gorgonians. Reef Biotope D comprised low profile patch reef with a sand veneer and included hydroids, encrusting coralline algae and large red sea fans. Details of the percentage contribution of the dominant taxa and the species recorded within the reef biotopes are provided in Aquatic Ecosystem Services (2021). The soft biotopes occurred in deeper water and were characterised by fine sand and shell fragments (Biotope E), with cnidarians (Biotope F), infaunal burrows (Biotope G) and shells and pebbles (Biotope H). Of the biotopes identified, Biotope D was the dominant reef biotope contributing 25% to the total 58% classified as reef, and Biotope F was the most abundant soft sediment biotope contributing 26% to the substrate composition along the cable route. The study conducted along the ASN fibre optic cable route from the landing site at Pollock Beach to 30 m depth identified a total of 172 benthic reef species, comprising 58 sponge, 18 cnidarians, 7 bryozoans, 2 echinoderms, 55 ascidians and 32 species of macro-algae. This is in contrast with the 322 macro benthic reef species identified in the adjacent White Sands LTER, where biodiversity was reported to be much higher comprising 93 species of sponge, 43 species of cnidarians, 25 species of bryozoans, 2 echinoderms, 116 ascidians and 43 macro-algae. No species were identified along the cable route that had a distribution limited to the study area. The reader is referred to the report by Aquatic Ecosystem Services (2021) for further detail.

The Agulhas Inshore Reef and Agulhas Inshore Hard Ground benthic habitats, identified by Sink *et al.* (2012), lie at depths between 5 m and 30 m, and extend from the Mbashe River (east of East London) to Cape Point. The reefs are considered to be warm temperate reefs, which have a more heterogeneous community structure when compared with those in the Southwestern Cape and KZN inshore regions. Classified as 'Critically endangered', and 'Vulnerable', respectively in the 2011 National Biodiversity Assessment (NBA) (Sink *et al.* 2012), these habitats were renamed Agulhas Mosaic Shelves and Agulhas Rocky Shelves in the 2018 NBA and given a threat status of 'Vulnerable' (Sink *et al.* 2019).

Deeper reefs below 10 m are characterised by exceptionally high levels of diversity and dominated by many species of filter feeders, particularly colonial ascidians, sponges, sea fans, soft corals, hydroids and bryozoans (Wooldridge & Coetzee 1998) (Figure 18 and Figure 19). Sponges and ascidians are especially diverse on subtidal reefs in the region and are particularly poorly studied. Sea fans (*Leptogorgia palma, Eunicella albicans, E. papillosa* and *E. tricoronata*) are common in the area as is the purple soft coral *Alcyonium fauri*. Bryozoans become more abundant with depth due to their fragile structure as do feather stars, two species of which, namely *Comanthus wahlbergi* and *Tropiometra carinata* occur in the area.

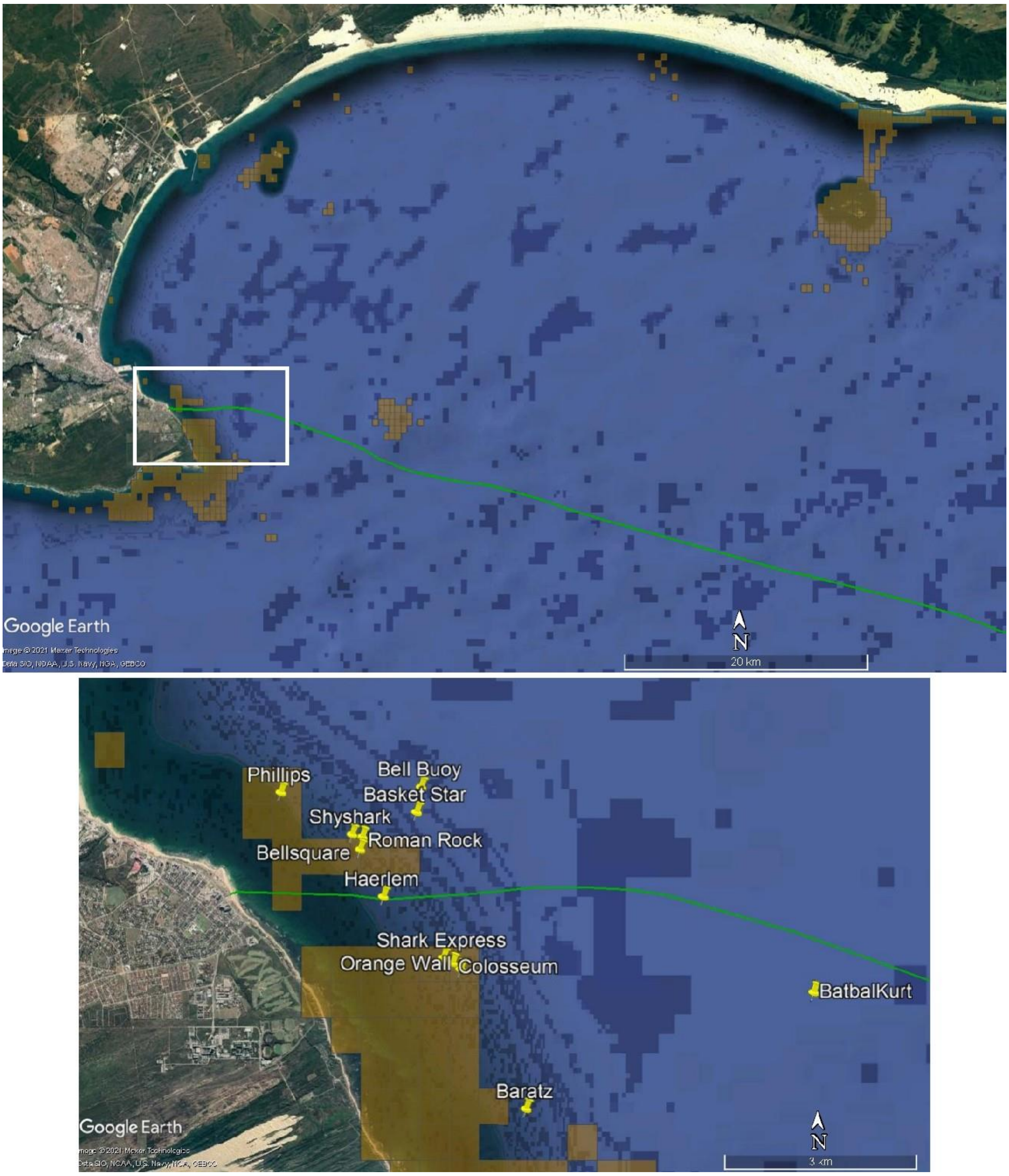


Figure 17: Proposed landing site of the Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System in relation to confirmed reef areas (brown) within Algoa Bay (Chalmers 2021). Insert provides details of reef distribution at the shore crossing as well as popular dive sites in the area.

Reef structure in the vicinity of the cable routing appears to be diverse. *Haerlem* is a navy frigate, scuttled in 1987 to form an artificial reef. She lies at a depth of 21 m between the Bell Buoy and Cape Recife and has become inhabited by shy sharks, nudibranchs, soft corals and a variety of fish. Basket Star is a flat reef at a depth of 25-29 m, which protrudes 1-1.5 m above the ocean floor and is home to a thriving reef community dominated by basket starfish and soft coral. In contrast, Bell

Buoy, Shyshark Reef and Orange Wall are pinnacle reefs comprising gullies and pinnacles with an abundance of fish, soft corals, feather stars, starfish, sea fans and anemones. Roman Rock (also known as Shark Alley) is home to an abundance of red roman fish and ragged-tooth sharks, whereas Phillips Reef is densely populated with sea fans, sponges and soft corals, and a diversity of fish (www.prodive.co.za).

In particular, the islands in Algoa Bay form ecological distinct subtidal habitats, containing many endemic species of invertebrates and seaweeds.

Figure 18: A typical subtidal reefs and their associated communities found in the Algoa Bay area (Source: Hutchings *et al*. 2019; www.prodive.co.za).

The concept of a 'Vulnerable Marine Ecosystem' (VME) centres upon the presence of distinct, diverse benthic assemblages that are limited and fragmented in their spatial extent, and dominated (in terms of biomass and/or spatial cover) by rare, endangered or endemic component species that are physically fragile and vulnerable to damage (or structural/biological alteration) by human activities (Parker *et al*. 2009; Auster *et al*. 2011; Hansen *et al*. 2013). As the component species of VMEs typically exhibit traits of slow growth, late maturity, low fecundity, unpredictable recruitment and high longevity, VMEs are characterised by sensitivity to changes in environmental conditions and slow recovery from damage (FAO 2009).

VMEs are known to be associated with higher biodiversity levels and indicator species that add structural complexity, resulting in greater species abundance, richness, biomass and diversity compared to surrounding uniform seabed habitats (Buhl-Mortensen *et al*. 2010; Hogg *et al*. 2010; Barrio Froján *et al*. 2012; Beazley *et al*. 2013, 2015). Compared to the surrounding deep-sea environment, VMEs typically form biological hotspots with a distinct, abundant and diverse fauna, many species of which remain unidentified. Levels of endemism on VMEs are also relatively high compared to the deep sea. The coral frameworks offer refugia for a great variety of invertebrates and fish (including commercially important species) within, or in association with, the living and dead coral framework thereby creating spatially fragmented areas of high biological diversity. The skeletal remains of Scleractinia coral rubble and Hexactinellid poriferans can also represent another important deep-sea habitat, acting to stabilise seafloor sediments allowing for colonisation by distinct infaunal taxa that show elevated abundance and biomass in such localised habitats (Bett & Rice 1992; Raes & Vanreusel 2005; Beazley *et al*. 2013; Ashford *et al*. 2019).

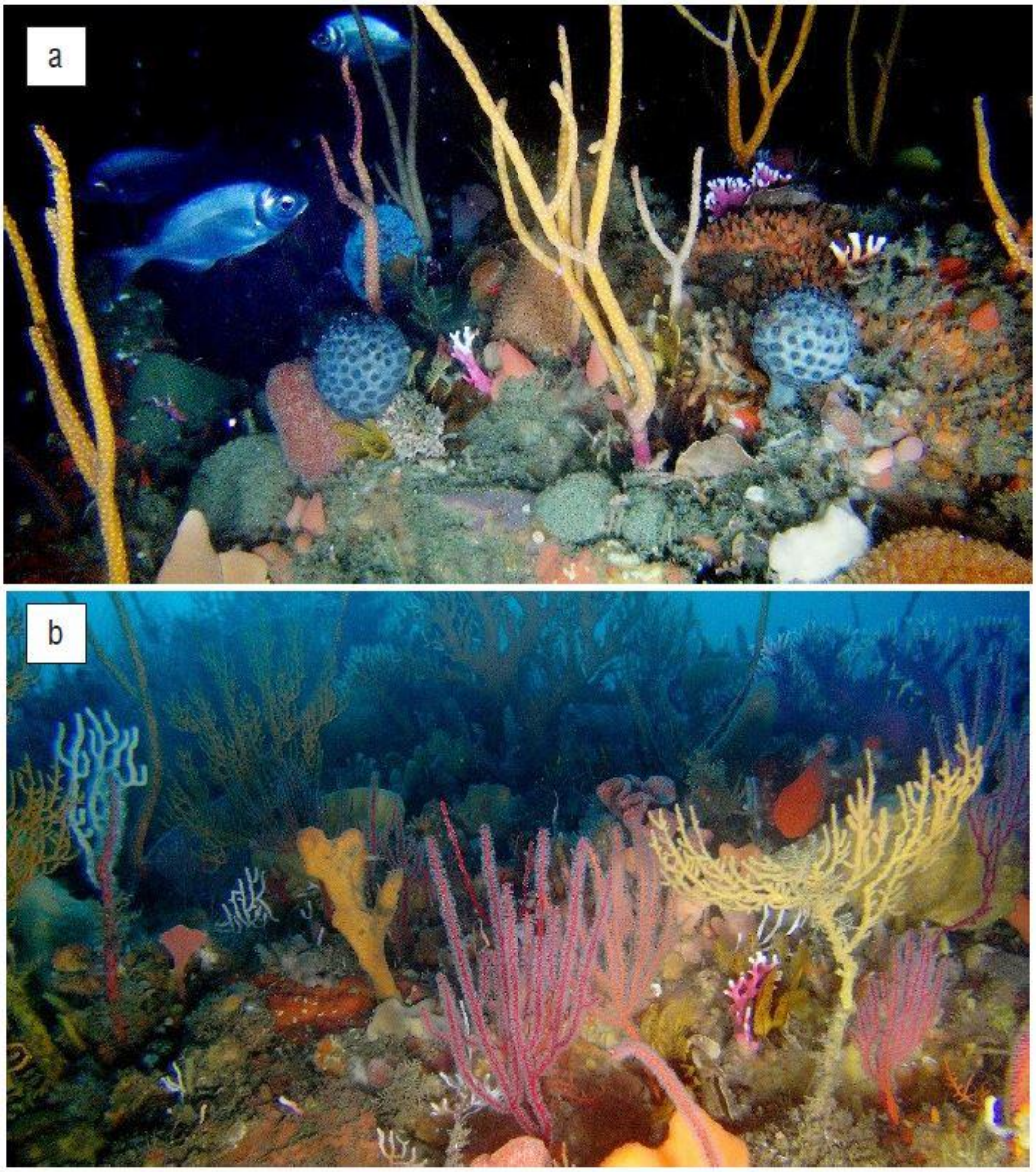


Figure 19: Benthic habitats in deeper water in Algoa Bay (a) Evan's Peak reef and (b) Riy Banks reef (Source: Dorrington *et al*. 2018).

VMEs are also thought to contribute toward the long-term viability of a stock through providing an important source of habitat for commercial species (Pham *et al*. 2015; Ashford *et al*. 2019). They can provide a wide range of ecosystem services ranging from provision of aggregation- and spawning sites to providing shelter from predation and adverse hydrological conditions (Husebø & Nøttestad *et al.* 2002; Krieger & Wing 2002; Tissot *et al.* 2006; Baillon *et al.* 2012; Pham *et al.* 2015). Indicator taxa for VMEs are also known to provide increased access to food sources, both directly to associated benthic fauna, and indirectly to other pelagic species such as fish and other predators due to the high abundance and biomass of associated fauna (Krieger & Wing 2002; Husebø & Nøttestad *et al.* 2002; Buhl-Mortensen *et al.* 2010; Hogg *et al.* 2010; Auster *et al.* 2011).

VME frameworks are typically elevated from the seabed, increasing turbulence and raising supply of suspended particles to suspension feeders (Krieger & Wing 2002; Buhl-Mortensen & Mortensen 2005; Buhl-Mortensen *et al.* 2010). Poriferans and cold-water corals further provide a strong link between pelagic and benthic food webs (Pile & Young 2006., Cathalot *et al.* 2015). VMEs are increasingly being recognised as providers of important ecosystem services due to associated increased biodiversity and levels of ecosystem functioning (Ashford *et al.* 2019).

The deep water habitats on the Agulhas Bank are thought to be characterised by a number of VME indicator species such as sponges, soft corals and hard corals. The distribution of 22 potential VME indicator taxa for the South African EEZ were recently mapped Figure 4.3), with those from the eastern Agulhas Bank listed in Table 2 (Atkinson & Sink 2018; Sink *et al.* 2019).

The Deep Secrets Offshore Research survey undertaken by the NRF and ACEP in 2016 provided further insight into potential VMEs off the eastern portion of the South Coast. A key feature mapped during this expedition was the rocky ridge off Port Elizabeth, which has come to be known as Kingklip Ridge and Kingklip Koppies. The feature spans a broad depth range of -150 to -800 m with a rocky feature rising to form a long narrow ridge 530 m wide and approximately 40 km long. The crest and edges of the northern end of the feature hosted reef-forming Scleractinia corals. However, much of the coral was broken, with evidence of recent and past (6 months) mortality. Some of the coral rubble areas were colonised by deep-water soft corals and brisingid sea stars (Sink *et al.* 2016, cited in Sink *et al.* 2019). In addition, a number of urchins characteristic of sandy habitats on the Agulhas shelf edge and slopes were recorded as well as a diversity of crabs, cerianthid tube anemone and various Foraminifera, as well as various starfish, basket stars, brittlestars and crinoids (Sink *et al.* 2016, cited in Sink *et al.* 2019). The dominant octocoral *Thouarella* was present in rocky areas, with the presence of several associates (brittlestar, scale worm) and fish eggs and larvae within these bottebrush corals.

The proposed Port Elizabeth Branch of the 2AFRICA/GERA (East) Cable System lies well to the north of this reef feature. The Kingklip Ridge and Kingklip Koppies ecosystems have been included in the Kingklip Corals Ecologically and Biologically Significant Marine Area (EBSA).

Nonetheless, as very few areas of the continental slope off the Southeast coast have been biologically surveyed, our understanding of the invertebrate fauna of the sub-photic zone is relatively poor (Gibbons *et al.* 1999) and the conservation status of the majority of invertebrates in this bioregion is not known. To date there have been no studies examining connectivity between slope, plateau or abyssal ecosystems in South Africa and there is thus limited knowledge on the benthic biodiversity of all three of these broad ecosystem groups in South African waters (Sink *et al.* 2019). There is no quantitative data describing bathyal ecosystems in South Africa and hence limited understanding of ecosystem functioning and sensitivity (Anderson & Hulley 2000). No description can therefore be provided for benthic macrofaunal communities beyond the shelf break along the proposed cable routing. However, with little sea floor topography and hard substrate, such areas are likely to offer minimal habitat diversity or niches for animals to occupy. Detritus-feeding crustaceans, holothurians and echinoderms tend to be the dominant epi-benthic organisms of such habitats. The 2018 National Biodiversity Assessment for the marine environment (Sink *et al*. 2019) points out that very few national IUCN Red List assessments have been conducted for marine invertebrate species to date owing to inadequate taxonomic knowledge, limited distribution data, a lack of systematic surveys and limited capacity to advance species red listing for these groups.

Table 2: Potential VME species from the eastern Agulhas Bank and shelf edge (Atkinson & Sink 2018).

Phylum	Name	Common Name
Porifera	*Rossella* cf. *antarctica*	Glass sponge
Cnidaria	*Melithaea* spp.	Colourful sea fan
	Thouarella spp.	Bottlebrush sea fan
Family: Isididae	?	Bamboo coral
	Anthoptilum grandiflorum	Large sea pen*
	Lophelia pertusa	Reef-building cold water coral
	Solenosmilia cf. *variabilis*	Thicket coral
	Goniocorella dumosa	Fine bridge coral
	Cladopsammia spp.	Right angled coral
	Eguchipsammia spp.	Right angled coral
	Enallopsammia	Zigzag coral
	Stylaster nobilis	Noble coral
	Stylaster spp.	Fine-branching hydrocoral
	Errina spp.	Red Hydrocoral
	Errinopsis cf. spp.	Fenestrate hydrocoral
	Inferiolabiata cf. spp.	Spiny lace coral
Bryozoa	*Adeonella* spp.	Sabre bryozoan
	Aspidstoma sp.	Pore-plated bryozoan
	Phidoloporidae spp.	Honeycomb false lace coral
Hemichordata	*Cephalodiscus gilchristi*	Agar animal

3.2.3 Benthic Invertebrates

Information on offshore invertebrates occurring along the coast of the project area is sparse. The deep-water rock lobster (*Palinurus gilchristi*) occurs on rocky substrate in depths of 90 - 170 m between Cape Agulhas and southern KZN (Figure 20, left). Larvae drift southwards in the Agulhas Current, settling in the south of the Agulhas Bank before migrating northwards again against the current to the adult grounds (Branch *et al*. 2014). The species is fished commercially along the southern Cape Coast between the Agulhas Bank and East London, with the main fishing grounds being in the 100 – 200 m depth range south of Cape Agulhas on the Agulhas Bank, and off Cape St Francis, Cape Recife and Bird Island.

Other deep-water crustaceans that may occur in the proposed survey area are the shovel-nosed crayfish (*Scyllarides elisabethae*), which occurs primarily on gravelly seabed at depths of around 150 m, although it is sometimes found in shallower water. Its distribution range extends from Cape Point to Maputo. Other rock lobster species occurring in shallower waters on the South and East Coasts include the West Coast rock lobster (*Jasus lalandii*), East Coast rock lobster (*Panulirus homarus*), Longlegged spiny lobster (*Panulirus longipes*), the ornate spiny lobster (*Panulirus ornatus*) and the painted spiny lobster (*Panulirus versicolor*), all of which are typically associated with shallow-water reefs, although the West Coast lobster has been recorded at depths of 120 m (Branch *et al*. 2014).

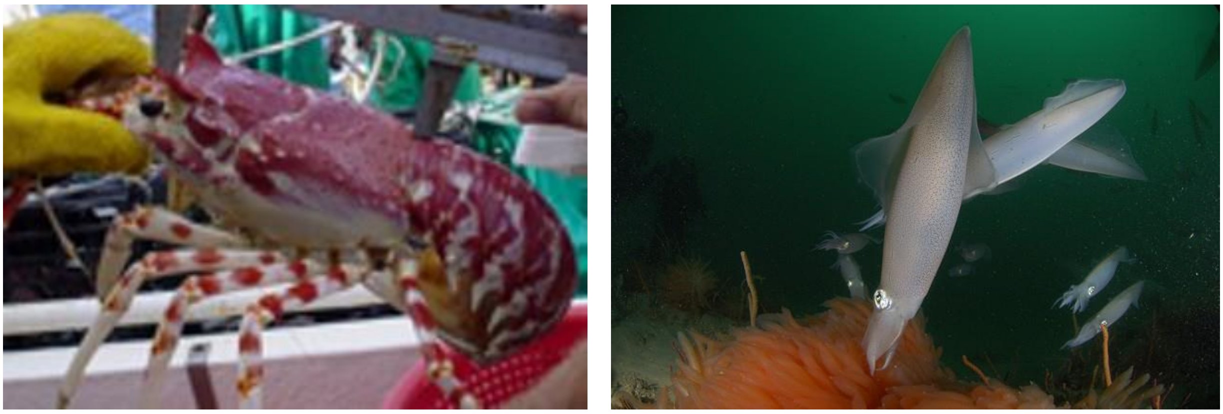


Figure 20: The South Coast rock lobster (*Palinurus gilchristi*) occurs in deep water (left) and the chokka squid (*Loligo vulgaris reynaudii*) spawn in nearshore areas off the South Coast (right) (photos: www.mpa.wwf.org.za; Steve Kirkman).

Forty-five species of cephalopods have been recorded on the Agulhas Bank and the shelf break off the South Coast, the majority of which are cuttlefish (Lipinski 1992; Augustyn *et al*. 1995; Atkinson & Sink 2018). Most of the cephalopod resource is distributed on the mid-shelf with *Sepia australis* being most abundant at depths between 60-190 m, whereas *S. hieronis* densities were higher at depths between 110-250 m. *Rossia enigmatica* occurs more commonly on the edge of the shelf to depths of 500 m. Biomass of these species was generally higher in the summer than in winter. Cuttlefish are largely epi-benthic and occur on mud and fine sediments in association with their major prey item; mantis shrimps (Augustyn *et al*. 1995). They form an important food item for demersal fish.

The squid (*Loligo vulgaris reynaudii*) (Figure 20, right) occurs extensively on the Agulhas Bank out to the shelf edge (500 m depth contour) increasing in abundance towards the eastern boundary of the South Coast, especially between Plettenberg Bay and Algoa Bay (Augustyn 1990; Sauer *et al*. 1992; Augustyn *et al*. 1994). Adults are normally distributed in waters >100 m, except along the eastern half of the South Coast where they also occur inshore, forming dense spawning aggregations at depths between 20 - 130 m (Augustyn 1990; Roberts *et al*. 2012; Downey 2014). The most important spawning grounds are between Plettenberg Bay and Algoa Bay (Augustyn 1990), these having been linked to specific spawning habitat requirements (Roberts & Sauer 1994; Roberts 2005). Spawning aggregations are a seasonal occurrence, reaching a peak between September and December

(Augustyn *et al*. 1992). Spawning is thought to be triggered by upwelling events (Downey *et al*. 2010; Roberts 1998) or possibly a rapid temperature change (Schön *et al*. 2002). Eggs are typically laid on sand and low relief reefs in large and sheltered bays, with environmental conditions playing an important role in the migration of the adults into the spawning areas. Following passive and active planktonic phases, juveniles move offshore, dispersing over the shelf over the full range of their distribution (southern Namibia to East London), eventually returning as adults to their spawning grounds (Augustyn *et al*. 1992). The species is fished commercially along the inshore regions of the southern Cape Coast, with annual catches varying considerably (Roberts & Sauer 1994).

The extent of the known inshore spawning grounds between Plettenberg Bay and Algoa Bay was estimated at approximately 90 km^2 (Sauer *et al*. 1992). The southern portion of the original Algoa 1 precinct (2010-2014) partially overlapped by approximately 1 km^2 with a known squid spawning area. The proposed route of the Port Elizabeth branch passes ~400 m to the north of this area at its closest point.

3.2.4 Demersal fish

The ichthyofauna of the Southeast Coast is diverse, comprising a mixture of temperate and tropical species. As a transition zone between the Agulhas and Benguela current systems, the South Coast ichthyofauna includes many species also occurring along the West and/or East Coasts.

The varied habitat of rocky reefs and soft-bottom substrates off the Southeast coast supports a high diversity of Teleosts (bony fish) and Chondrichthyans (cartilaginous fish) associated with the inshore and shelf waters, many of which are endemic to Southern Africa (Smale *et al*. 1994). In particular, there is a high diversity of endemic sparid species along the South Coast (Smale *et al*. 1994) (Figure **21**), some of which utilise the protected bays as spawning and nursery areas (Wallace *et al*. 1984; Buxton 1990; Smale *et al*. 1994) or undertake spawning migrations eastwards up the coast into KZN waters. Those species that undertake migrations along the South and East Coasts include Red Steenbras (*Petrus rupestris)*, White Steenbras (*Lithognathus lithognathus*) (summer), Seventy-four (*Polysteganus undulosus*), Silver Kob (*Argyrosomus inodorus*), Geelbek (*Atractoscion aequidens*), leervis (*Lichia amia*) and Elf (*Pomatomus saltatrix*)(winter). Spawning of the majority of species endemic to the area occurs in spring and summer.

Characteristic fishes found on the deeper reefs of the eastern Agulhas Bank and off Algoa Bay include Panga (*Pterogymnus laniarius*), Piggy grunter (*Pomadasys olivaceum*), Santer (*Cheimerius nufar*), Carpenter (*Argyrozona argyrozona*), Fransmadam (*Boopsoidea inornata*), Red Roman (*Chrysoblephus laticeps*), Red Stumpnose (*Chrysoblephus gibbiceps*), Dageraad (*Chrysoblephus cristiceps*), Yellowbelly Rockcod (*Epinephelus marginatus*), Steentjie (*Spondyliosoma emarginatum*) and White Musselcracker (*Sparadon durbanensis*) (Smale & Buxton 1998; Chalmers 2012).

The Cape hake (*Merluccius capensis*), is distributed widely on the continental shelf along the Eastern Cape and onto the Agulhas Bank, while the deep-water hake (*Merluccius paradoxus*) is found further offshore in deeper water (Boyd *et al*. 1992; Hutchings 1994). The nursery grounds for both species are located off the west coast and fish move southwards onto the Agulhas Bank as they grow. Juveniles of both species occur throughout the water column in shallower water than the adults. Kingklip (*Genypterus capensis*) is also an important demersal species, with adults distributed in deeper waters along the coast west of Algoa Bay, especially on rocky substrate (Japp *et al*. 1994). Juveniles occur inshore along the entire South Coast. The Agulhas or East Coast sole (*Austroglossus pectoralis*) inhabits inshore muddy seabed (<125 m) on the shelf between Cape Agulhas and Algoa Bay (Boyd *et al*. 1992).

Figure 21: The Inshore and offshore reefs support a wide diversity of teleost species including musselcracker (left) and red stumpnose (right) (photos: http://spearfishingsa.co.za, www.easterncapescubadiving.co.za).

Furthermore, a wide variety of chondrichthyans occur in nearshore waters along the Eastern Cape, including the Ragged-tooth shark (*Odontaspis Taurus*), Bronze whaler (*Carcharhinus brachyurus*), Dusky shark (*Carcharhinus obscures*), St Joseph shark (*Callorhincus capensis*) and Soupfin shark (*Galeorhinus galeus*).

Information on other demersal fish and megabenthic invertebrates beyond the shelf break is lacking and no description of these communities can be can be provided for the project area.

3.2.5 The Water Column

Plankton

The nutrient-poor characteristics of the Agulhas Current water are reflected in comparatively low primary productivity on the continental shelf of the Southeast Coast, with mean *chlorophyll a* concentrations averaging between 1 - 2 mg/m^3 over the whole year in the top 30 m of the water column. *Chlorophyll a* concentrations vary seasonally, being minimal in winter and summer (<1 – 2 mg/m^3), and maximal (2 - 4 mg/m^3) in spring and autumn (Brown 1992). In the area off Port Elizabeth and East London, phytoplankton concentrations are usually higher than further west, comprising predominantly large cells (Hutchings 1994). Further offshore throughout the project area, the pelagic environment is characterised by very low productivity, with the low variability in water-column temperature resulting in very low frequency of chlorophyll fronts. On the South Coast, lower concentrations are partly due to nutrient limitation due to the strong summer thermoclines or light limitations due to deep mixing in winter (Probyn *et al*. 1994), but if the thermocline falls within the 1% light depth, phytoplankton biomass can increase dramatically, with sub-surface chlorophyll concentration maxima often being in excess of 10 mg/m^3 (Carter *et al*.

1987; Hutchings 1994). Chlorophyll concentrations can also be high where upwelling occurs at the coast (Probyn *et al*. 1994).

There is also a microflora component associated with beaches, namely microphytobenthos and phytoplankton, which are present both in the sand and the surf. The bays along the South Coast and the shoreline between Port Elizabeth and East London are reported to have a comparatively high diversity of microflora (Harris 2012).

A major ecological feature of the surf-zone along much of the Eastern Cape Coast is the regular occurrence of visible accumulations of the diatom, *Anaulus australi*s, which in some areas accounts for 95% of the primary production and is the basic food source in the surf-zone and adjacent beach (Campbell 1987; Wooldridge *et al*. 1997), fuelling three distinct food chains, one associated with the interstitial system (meiofauna), the microbial food chain and the macroscopic food chain (Brown & McLachlan 1994). Other diatom species such as *Aulacodiscus kittoni, Sroederella* sp., *Asterionella* sp., *Thalassiothrix* sp. and *Navicula* sp. also occur.

Zooplankton and ichthyoplankton abundances in the project area will reflect localised areas of higher primary productivity (Oliff 1973; Probyn *et al*. 1994). Continental shelf waters support greater and more variable concentrations of zooplankton biomass than offshore waters (Beckley & Van Ballegooyen 1992), with species composition varying seasonally (Carter & Schleyer 1988). Copepods represent the dominant species group (Carter & Schleyer 1988), but chaetognaths are also abundant (Schleyer 1985). On the South Coast, zooplankton communities have comparatively high species diversity (De Decker 1984). Biomass of mesozooplankton increases from west (~0.5-~1.0 gC/m^2) to east (~1.0-~2.0 gC/m^2), mirroring the eastward increase in *chlorophyll a* concentrations, peaking on the central and eastern Agulhas Bank during summer in association with the subsurface ridge of cool upwelled water. Standing stocks of mesozooplankton (>200 µm) along the eastern half of the South Coast ranges from 3 – 6 gC/m^2, and is dominated by the calanoid copepod *Calanus aghulensis*, which associates with shallow thermoclines and the mid-shelf cool water ridge (Verheye *et al*. 1994). This species may contribute up to 85% of copepod biomass in the region, and is an important food source for pelagic fishes (Peterson *et al*. 1992).

The surf-zone zooplankton is dominated by large motile crustaceans. The surf shrimp *Macropetasma africana* is associated with diatom accumulations inside the surf-zone (Romer 1986). The mysid *Mesopodopsis wooldridgei* forms dense swarms out to approximately 10–20 m depths and migrates inshore to just behind the breaker line at night to feed on phytoplankton (Wooldridge 1983; Webb 1986). This mysid is probably instrumental in transporting primary production from the surf-zone into the shallow and deeper subtidal regions. Swarming mysids are important in the surf-zone food web as they consitute a major prey species for various surf-zone and pelagic fish (Cornew *et al*. 1992; Verheye *et al*. 1994). Other members of the surf-zone zooplankton community are siphonophores, chaetognaths, ostracods, copepods, isopods, amphipods and decapod larvae (Romer 1986). Macrozooplankton (>1,600 µm) standing stocks are estimated to be 0.079 gC/m^2 between Cape Agulhas and Cape Recife (Verheye, unpublished data).

The inshore area of the Agulhas Bank, especially between the cool water ridge and the shore, serve as an important nursery area for numerous linefish species. Adults undertake spawning migrations along the South Coast into KZN waters during the winter months (Van der Elst 1976, 1981; Griffiths 1987; Garret 1988; Beckley & van Ballegooyen 1992). Following spawning during spring and summer (November to April), the eggs and larvae are dispersed southwards by the Agulhas Current, with juveniles occurring on the inshore Agulhas Bank (Van der Elst 1976, 1981; Garret 1988). In the case of the carpenter, a high proportion of the reproductive output comes from the central Agulhas Bank and the Tsitsikamma Marine Protected Area (MPA) Section of the Garden Route National Park, and two separate nursery grounds appear to exist, one near Port Elizabeth and a second off the deep reefs off Cape Agulhas, with older fish spreading eastwards and westwards (van der Lingen *et al.* 2006).

A variety of pelagic fish species, including anchovy, round herring and horse mackerel, spawn east of Cape Agulhas between the shelf-edge upwelling and the cold-water ridge (Crawford 1980; Hutchings 1994; Roel & Armstrong 1991; Hutchings *et al.* 2003) (Figure 22). The eggs and larvae spawned in this area are thought to largely remain on the Agulhas Bank, although some may be carried to the West Coast or be lost to the Agulhas Current retroflection (Hutchings 1994; Duncombe Rae *et al.* 1992; Hutchings *et al.* 2003). Pilchards also spawn on the Agulhas Bank during spring and summer (Crawford 1980), with adults moving eastwards and northwards after spawning. After the 'sardine run' in June and July (see later), pilchard eggs occur in inshore waters along the Eastern Cape and the southern KZN coast (Anders 1975; Connell 1996). There is also recent evidence for winter (June-July) spawning of sardines on the central Agulhas Bank in patches of high concentrations of phytoplankton (van der Lingen *et al.* 2006). The sardine and other clupeid eggs persist in inshore waters throughout winter – spring, before disappearing in early summer as the shoals break up and move northwards and further offshore (Connell 2010). Anchovy (*Engraulis japonicus*) eggs have also been reported in the water column during December extending from Port Elizabeth eastwards to as far north as St Lucia in KZN (Anders 1975). Demersal species that spawn along the South Coast include the cape hakes and kingklip. Spawning of the shallow-water hake occurs primarily over the shelf (<200 m) whereas that by the deep-water hake occurs off the shelf. Similarly, kingklip spawn in an isolated area off the shelf edge to the south of St Francis and Algoa Bays, (Shelton 1986; Hutchings 1994) (Figure 22). Squid (*Loligo* spp.) spawn principally in the inshore waters (<50 m) between Knysna and Port Elizabeth, with larvae and juveniles spreading westwards. Their distribution and abundance is highly erratic and linked to temperature, turbidity, and currents (Augustyn *et al.* 1994).

Ichthyoplankton abundance in inshore waters over the continental shelf (<200 m) is thus likely to be seasonally high. Larval concentrations vary between 0.005 and 4.576 larvae/m^3 decreasing rapidly with distance offshore (Beckley & Van Ballegooyen 1992). In the offshore portion of the project area, ichthyoplankton abundance is, however, expected to be low.

Harmful Algal Blooms (HABs)

As the upwelling events in Algoa Bay are generally relatively weak and short lived, the proliferation of harmful algal blooms (HABs) was, until recently, not known to occur. Between December 2013 and March 2014, however, a large and persistent harmful algal bloom of *Lingulodinium polyedrum* formed within Algoa Bay and spread along the east coast as far as Wilderness (Bornman 2014). The intensity of the bloom caused waters to turn a dramatic red colour and to display spectacular phosphorescence at night (Figure 23). Fuerthermore, in December 2015 several red tide blooms were sampled in Algoa Bay and St Francis Bay confirming that the HAB-forming dinoflagellate, *Lingulodinium polyedrum*, was again present in Algoa Bay. *Lingulodinium polyedrum* produces yessotoxins that have been proven to be toxic to mice and may accumulate in bivalves, although human toxicity is not known (Bornman 2014). This species irritates the gills of fish, interfering with respiration, and has caused fish kills in several places within Algoa Bay (Bornman 2014). *Lingulodinium polyedrum* has previously been documented as cysts in marine sediments collected from the area, suggesting that it was not a recent introduction and that the bloom was likely triggered by a combination of favourable environmental conditions.

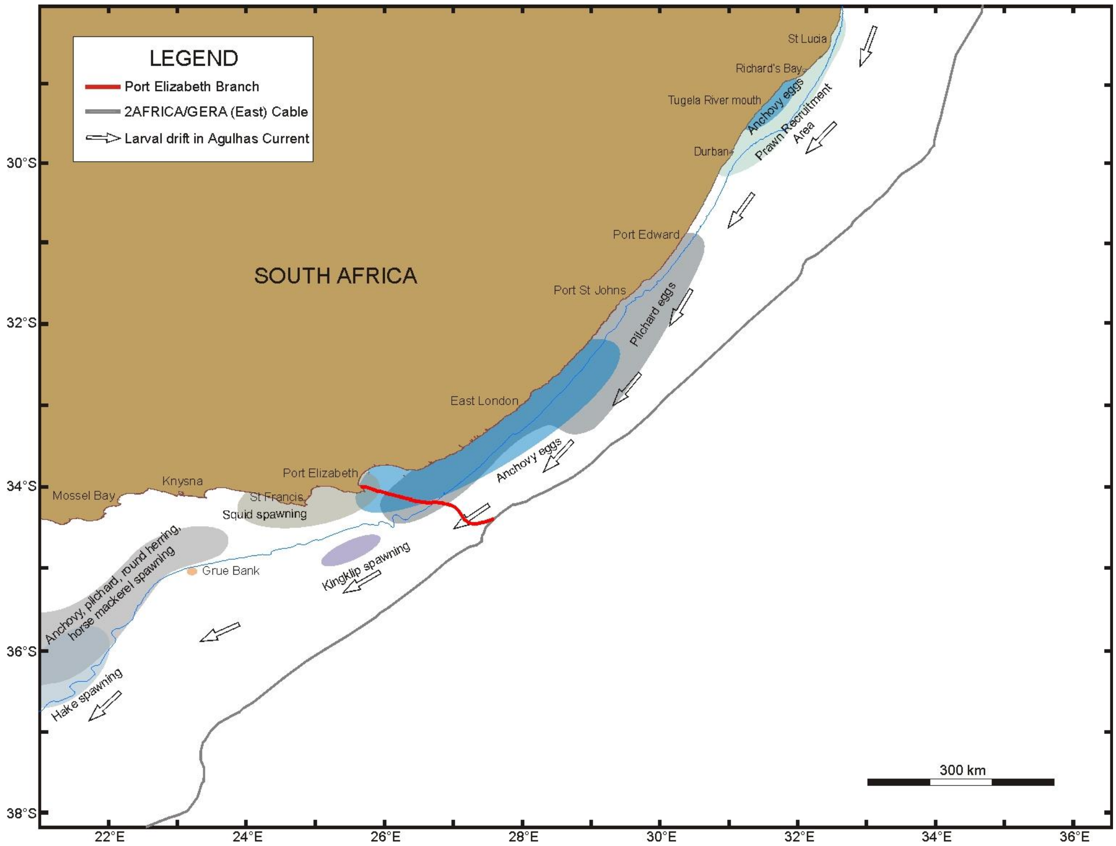


Figure 22: The proposed Port Elizabeth branch (red line) of the main trunk (black line) of the 2AFRICA/GERA (East) Cable System in relation to important pelagic and demersal fish, and squid spawning areas (after Anders 1975; Crawford *et al*. 1987; Hutchings 1994). The 200 m depth contour is also shown.

Figure 23: Harmful Algal bloom in Algoa Bay caused by Lingulodinium polyedrum during summer 2013-2014 (Source: Laird *et al*. 2016).

Pelagic Invertebrates

The giant squid *Architeuthis* sp. is a deep-dwelling species usually found near continental and island slopes all around the world's oceans (Figure 24). This deep-water species could thus potentially occur along the offshore portions of the Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System beyond the 1,000 m depth contour. Growing to in excess of 10 m in length, it is the principal prey of the sperm whale, and is also taken by beaked whaled, pilot whales, elephant seals and sleeper sharks. Nothing is known of their vertical distribution, but data from trawled specimens and sperm whale diving behaviour suggest they may span a depth range of 300 – 1,000 m.

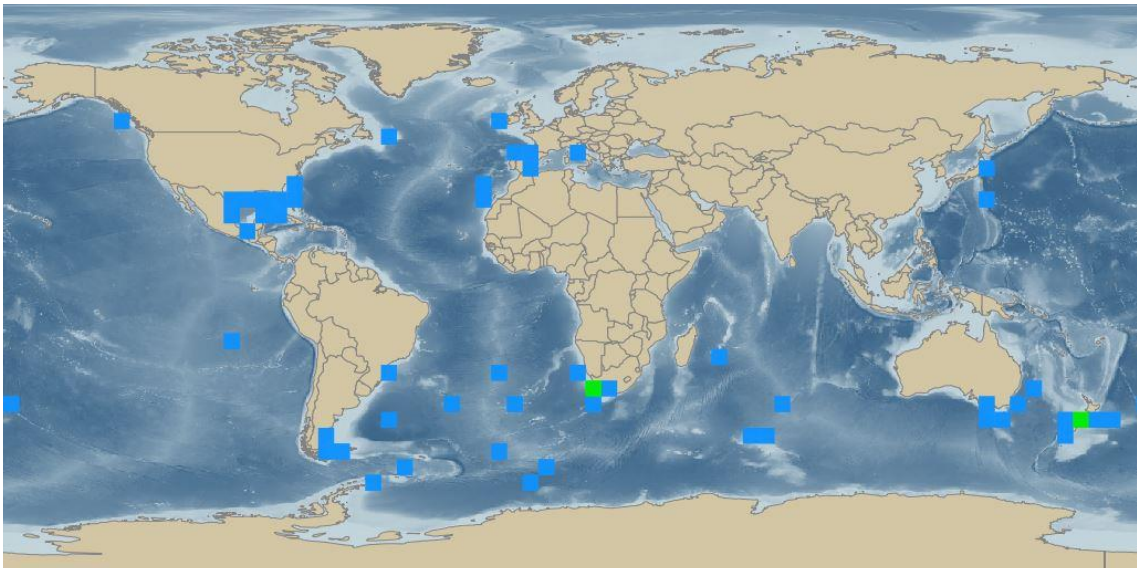


Figure 24: Distribution of the giant squid (http://iobis.org). Blue squares <5 records, green squares 5-10 records.

Pelagic Fish

Small pelagic shoaling species occurring along the Eastern Cape include anchovy (*Engraulis encrasicolus*), pilchard (*Sardinops sagax*) (Figure 25, left), round herring (*Etrumeus japonicas*), chub mackerel (*Scomber japonicas*) and horse mackerel (*Trachurus trachurus capensis*) (Figure 25, right). Anchovies are usually located between the cool upwelling ridge and the Agulhas Current (Hutchings 1994). Having spawned intensively in an area around the 200 m depth contour between Mossel Bay and Plettenberg Bay between October and January, most adults move inshore and eastwards ahead of warm Agulhas Current water. Round herring juveniles similarly occur inshore along the South Coast, but move offshore with age (Roel *et al*. 1994; Hutchings 1994).

Pilchards are typically found in water between 14°C and 20°C. Spawning occurs on the Agulhas Bank during spring and summer (Crawford 1980), with recruits being found inshore along the South Coast (Hutchings 1994). The shift in the distributions of anchovy and sardine to the south and east during the 1990s and early 2000s was attributed to improved conditions for spawning by these species to the east of Cape Agulhas (van der Lingen *et al*. 2005; 2006; Roy *et al*. 2007; Coetzee *et al*. 2008). Winter (June-July) spawning of sardines on the central Agulhas Bank in patches of high concentrations of phytoplankton (van der Lingen *et al*. 2006) was evidence that the Agulhas Bank served as a refuge for pilchard under low population levels, and therefore vital for the persistence of the species (CCA & CSIR 1998). In late summer and during winter, the penetration of northerly-flowing cooler water along the Eastern Cape coast effectively expands the suitable habitat available for this species, resulting in a 'leakage' of large shoals northwards into southern KZN in what has traditionally been known as the 'sardin run'. The shoals begin gathering in Algoa Bay as early as late February, moving northwards up the coast between March and May and reach the KZN coastline in June. The cool band of inshore water is critical to the 'run' as the sardines will either remain in the south or only move northwards further offshore if the inshore waters are above 20 °C. The shoals can attain lengths of 20-30 km and are typically pursued by Great White Sharks, Copper Sharks, Common Dolphins, Cape Gannets and various other large pelagic predators (www.sardinerun.co.za).

Figure 25: Cape fur seal preying on a shoal of pilchards (left). School of horse mackerel (right) (photos: www.underwatervideo.co.za; www.delivery.superstock.com).

Recent studies have indicated that the annual 'sardine run' constitutes a migration to localised upwelling centres inshore of the Agulhas Current (East London and Cape St Lucia) that provide a favourable temperate spawning environment for these small pelagic fish species during and subsequent to their annual migration along the East Coast (Beckley & Hewitson 1994; Coetzee *et al*. 2010). The sardine run occurs along the continental shelf, to the northeast of the Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System.

The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of the project area are the large migratory pelagic species, including various tunas (Figure 26, left), billfish (Figure 26, right) and sharks (Figure 27) (Van der Elst 1988; Smale *et al*. 1994), many of which are considered threatened by the International Union for the Conservation of Nature (IUCN), primarily due to overfishing (

Figure 27: The great white shark *Carcharodon carcharias* (left) and the spotted ragged-tooth shark *Carcharias taurus* (right) (photos: www.flmnh.ufl.edu; Two Oceans Aquarium).

Two species likely to be encountered along portions of the cable branch are singled out for further discussion, namely the great white shark *Carcharodon carcharias* and the spotted ragged-tooth shark *Carcharias taurus*. Both species have a cosmopolitan distribution. Although not necessarily threatened with extinction, both species are described as 'vulnerable' in the IUCN Red listing, and are listed in Appendix II (species in which trade must be controlled in order to avoid utilization incompatible with their survival) of CITES (Convention on International Trade in Endangered Species) and Appendix I and/or II of the Bonn Convention for the Conservation of Migratory Species (CMS). The great white shark is also listed as 'vulnerable' in the List of Marine Threatened or Protected Species (TOPS) as part of the National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA). In response to global declines in abundance, white sharks were legislatively protected in South Africa in 1991. Long-term catch-per-unit-effort data from protective gillnets in KZN, however, suggest a 1.6% annual increase in capture rate of this species following protection, although high interannual variation in these data lessen the robustness of the trend (Dudley & Simpfendorfer 2006).

Table 3). Tuna and swordfish are targeted by high seas fishing fleets and illegal overfishing has severely damaged the stocks of many of these species. Similarly, pelagic sharks, are either caught as bycatch in the pelagic tuna longline fisheries, or are specifically targeted for their fins, where the fins are removed and the remainder of the body discarded.

Figure 26: Large migratory pelagic fish such as longfin tuna (left) and sailfish (right) occur in offshore waters (photos: www.arkive.org; www.osfimages.com).

Figure 27: The great white shark *Carcharodon carcharias* (left) and the spotted ragged-tooth shark *Carcharias taurus* (right) (photos: www.flmnh.ufl.edu; Two Oceans Aquarium).

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Table 3: Some of the more important large migratory pelagic fish likely to occur in the offshore regions of the South and East Coasts.

Common Name	Species	IUCN Conservation Status
Tunas		
Southern Bluefin Tuna	*Thunnus maccoyii*	Critically Endangered
Bigeye Tuna	*Thunnus obesus*	Vulnerable
Longfin Tuna/Albacore	*Thunnus alalunga*	Near Threatened
Yellowfin Tuna	*Thunnus albacares*	Near Threatened
Frigate Tuna	*Auxis thazard*	Least concern
Eastern Little Tuna/Kawakawa	*Euthynnus affinis*	Least concern
Skipjack Tuna	*Katsuwonus pelamis*	Least concern
Billfish		
Blue Marlin	*Makaira nigricans*	Vulnerable
Striped Marlin	*Kajikia audax*	Near Threatened
Sailfish	*Istiophorus platypterus*	Least concern
Swordfish	*Xiphias gladius*	Least concern
Black Marlin	*Istiompax indica*	Data deficient
Pelagic Sharks		
Great Hammerhead Shark	*Sphyrna mokarran*	Endangered
Smooth Hammerhead shark	*Sphyrna zygaena*	Vulnerable
Pelagic Thresher Shark	*Alopias pelagicus*	Vulnerable
Bigeye Thresher Shark	*Alopias superciliosus*	Vulnerable
Common Thresher Shark	*Alopias vulpinus*	Vulnerable
Dusky Shark	*Carcharhinus obscurus*	Vulnerable
Great White Shark	*Carcharodon carcharias*	Vulnerable
Shortfin Mako	*Isurus oxyrinchus*	Vulnerable
Longfin Mako	*Isurus paucus*	Vulnerable
Whale Shark	*Rhincodon typus*	Vulnerable
Blue Shark	*Prionace glauca*	Near Threatened

The great white shark *Carcharodon carcharias* (Figure 27, left) is a significant apex predator in the Algoa Bay area, particularly in the vicinity of the seal colony at Black Rocks. White sharks migrate along the entire South African coast, typically being present at seal colonies during the winter months, but moving nearshore during summer (Johnson *et al*. 2009). The species is known to seasonally aggregate at specific localities along the South African coast, including False Bay, Gans Bay, Mossel Bay (Kock & Johnson 2006; Kock *et al*. 2013; Towner *et al*. 2013) and Algoa Bay (Dicken *et al*. 2013). The presence of the seal breeding colony on Black Rock is thought to act as an important factor for the aggregation of great white sharks in the bay (Kock *et al*. 2013; Hewitt *et al*. 2018). While a range of sizes of white sharks can be found around Seal Island, the inshore areas of Algoa Bay are home to the greatest proportion of young-of-year sharks (Dicken & Booth 2013). Recent research at Mossel Bay into the residency patterns of white sharks revealed that male sharks display low site fidelity, often rapidly moving in an out of the area. Females in contrast, display high site fidelity and may remain resident in the area for up to two months (Koch & Johnson 2006; see also Jewell *et al*. 2013, 2014; Ryklief *et al*. 2014). Great white sharks are, however, capable of transoceanic migrations (Pardini *et al*. 2001; Bonfil *et al*. 2005; Koch & Johnson 2006), with recent electronic tag data suggesting links between widely separated populations in South Africa and Australia and possible natal homing behaviour in the species. Although during transoceanic migrations they appear to spend most of the time just below the sea surface, frequent deep dives to a much as 980 m are made whilst *en route*. Long-distance return migrations along the South African coast are also frequently undertaken (Figure 28), particularly by immature individuals (Bonfil *et al*. 2005). These coastal migrations, which are thought to represent feeding-related events, traverse the project area.

Figure 28: The proposed Port Elizabeth branch (red line) of the main trunk (dashed white line) of the 2AFRICA/GERA (East) Cable System in relation to the long-distance return migrations of two tracked great white sharks along the South African coast. The black trace shows a migration from 24 May – 2 November 2003; the white trace shows a migration from 31 May – 1 October 2004 (adapted from Bonfil *et al*. 2005).

The ragged-tooth shark (*Carcharias taurus*) (Figure 27, right) is a wide-ranging coastal species found primarily in warm temperate and tropical waters. In South Africa, the shark is most commonly found at depths between 10 and 40 m close to inshore reefs and islands from Cape Town to KZN (Dicken 2006; Dicken *et al*. 2008). Mating occurs off the KZN coast after which near-term pregnant females move towards the cooler waters of the Eastern Cape, where they give birth around September (Dicken 2006). Algoa Bay provides shelter for juveniles of the species in the form of nursery areas. The 2017 National Assessment considers the ragged-tooth shark as 'data deficient', and it is rated as 'vulnerable' in TOPS.

Turtles

Five species of sea turtles occur along the Southeast Coast; the green turtle (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*) (Figure 29, left), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*)(Figure 29, right). Green turtles are non-breeding residents often found feeding on inshore reefs. They nest mainly along the coast of Mozambique and on both Europa and Tromelin Islands (Lauret-Stepler *et al*. 2007).

Figure 29: Leatherback (left) and loggerhead turtles (right) occur along the Southeast Coast of South Africa (Photos: Ketos Ecology 2009; www.aquaworld-crete.com).

Hawksbills also occur on inshore reefs but nest along the coastlines of Madagascar and the Seychelles (Mortimer 1984). Olive ridleys are infrequent visitors to South African waters and nest throughout the central and northern regions of Mozambique (Pereira *et al*. 2008). Leatherback turtles inhabit the deeper waters of the Atlantic Ocean and are considered a pelagic species. They travel the ocean currents in search of their prey (primarily jellyfish) and may dive to over 600 m and remain submerged for up to 54 minutes (Eckert *et al*. 1989; Hays *et al*. 2004; Lambardi *et al*. 2008). They come into coastal bays and estuaries to mate, and lay their eggs on the adjacent beaches. Loggerheads tend to keep more inshore, hunting around reefs, bays and rocky estuaries along the African East Coast, where they feed on a variety of benthic fauna including crabs, shrimp, sponges, and fish. In the open sea their diet includes jellyfish, flying fish, and squid (www.oceansafrica.com/turtles.htm).

Loggerheads and leatherbacks nest along the sandy beaches of the northeast coast of KZN (and thus over 300 km to the north of Algoa Bay), as well as southern Mozambique during summer months. These loggerhead and leatherback nesting populations are the southern-most in the world (Nel *et al*. 2013). Even though these populations are smaller (in nesting numbers) than most other populations, they are genetically unique (Dutton *et al*. 1999; Shamblin *et al*. 2014) and thus globally important populations in terms of conservation of these species.

Female loggerhead and leatherback turtles, however, do not nest every year due to the high energetic costs of reproduction (Wallace & Jones 2008). During this remigration interval they travel thousands of kilometres (particularly leatherbacks) with ocean currents in search of foraging grounds (Luschi *et al*. 2003a; Luschi *et al*. 2003b). Turtles marked with titanium flipper tags have revealed that South African loggerheads and leatherbacks have a remigration interval of 2 – 3 years, migrating to foraging grounds throughout the South Western Indian Ocean (SWIO) as well as in the eastern Atlantic Ocean (Lambardi *et al*. 2008; Robinson *et al*. 2016; Robinson *et al*. 2018). They follow different post-nesting migration routes (Hughes *et al*. 1998; Luschi *et al*. 2006; Harris *et al*. 2018), with loggerheads preferring to stay inshore whilst travelling northwards to foraging grounds along the southern Mozambican coastline or crossing the Mozambique Channel to forage in the waters off Madagascar (Figure 30).

In the IUCN Red listing, the leatherback is described as 'Critically Endangered', and the loggerhead and green turtles are 'Endangered' on a global scale. Leatherback Turtles are thus in the highest categories in terms of need for conservation in CITES and CMS. As a signatory of CMS, South Africa has endorsed and signed two sister agreements specific to the conservation and management of sea turtles (these are the Africa-Atlantic and Indian Ocean South East Asia Memoranda of Understanding). South Africa, as a nation, is therefore committed to the protection of all species of sea turtles occupying its national waters, whether they are non-resident nesters (loggerhead and leatherback turtles) or resident foragers (hawksbill and green turtles; Oceans and Coast, unpublished data). In addition to sea turtle habitat and physical protection in the St. Lucia and Maputaland Marine Reserves, turtles in South Africa are protected under the Marine Living Resources Act (1998). The most recent conservation status, which assessed the species on a sub-regional scale, is provided in Table 4.

Table 4: Global and Regional Conservation Status of the turtles occurring off the South Coast showing variation depending on the listing used.

Listing	Leatherback	Loggerhead	Green	Hawksbill	Olive Ridley
IUCN Red List:					
Species (date)	V (2013)	V (2017)	E (2004)	CR (2008)	V (2008)
Population (RMU)	CR (2013)	NT (2017)	*		*
Sub-Regional/National					
NEMBA (2007)	CR	E	E	CR	E
Sink & Lawrence (2008)	CR	E	E	CR	E
Hughes & Nel (2014)	E	V	NT	NT	DD

NT – Near Threatened V – Vulnerable E – Endangered CR – Critically Endangered
DD – Data Deficient UR – Under Review * - not yet assessed

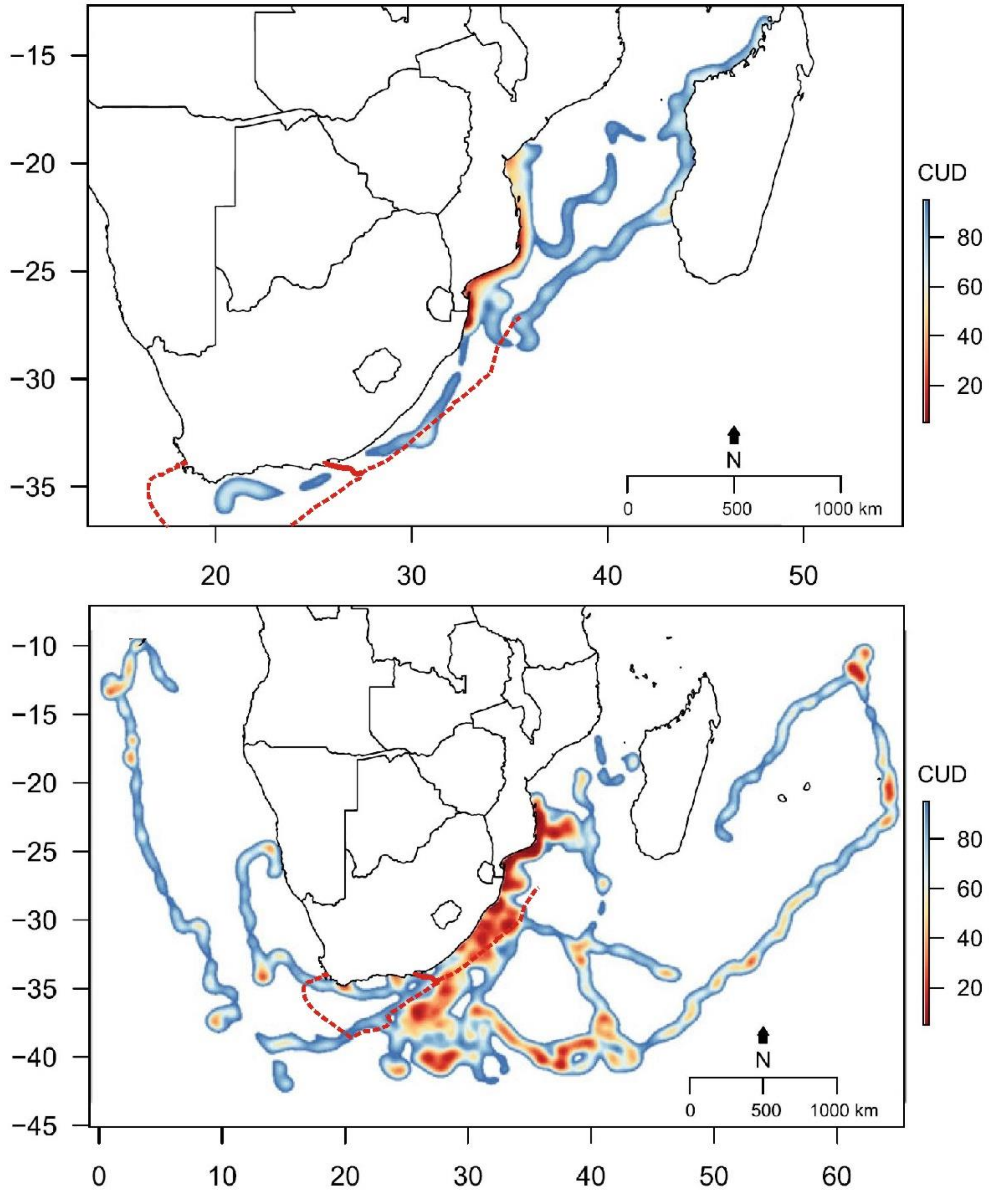

Figure 30: The proposed Port Elizabeth branch (red line) of the main trunk (dashed red line) of the 2AFRICA/GERA (East) Cable System in relation to the migration corridors of loggerhead (top) and leatherback (bottom) turtles in the south-western Indian Ocean. Intensity of shading for Cumulative Utilization Distribution (CUD): light, low use; dark, high use (adapted from Harris *et al*. 2018).

Seabirds

Along the Southeast Coast, 60 species of seabirds are known or thought likely to occur. South Coast seabirds can be categorised into three categories: 'breeding resident species', 'non-breeding migrant species' and 'rare vagrants' (Shaughnessy 1977; Harrison 1978; Liversidge & Le Gras 1981; Ryan & Rose 1989). Fifteen species breed within the South Coast region (**Error! Not a valid bookmark self-reference.**), including Cape Gannets (Algoa Bay islands) (Figure 31, left), African Penguins (Algoa Bay islands) (Figure 31, right), Cape Cormorants (a small population at Algoa Bay islands and mainland sites), White-breasted Cormorant, Roseate Tern (Bird and St Croix Islands), Swift Term (Stag Island) and Kelp Gulls. Furthermore, a number of species breed along the adjacent mainland coast; a breeding colony of Cape Cormorant has recently established on Robberg Peninsula (Marnewick *et al*. 2015), kelp gulls breed in high numbers on the Keurbooms River estuary spit (Witteveen 2015, but see also Whittington *et al*. 2006) and African Black Oystercatcher, Caspian Tern and White-fronted Plover breed on many of the beaches between Plettenberg Bay and the eastern boundary of the Tsitsikamma Section of the Garden Route National Park (http://www.birdlife.org.za/component/ k2/item/240-sa098-tsitsikamma-plettenberg-bay). African Black Oystercatchers breed as far east as East London while breeding of Whitefronted Plovers extends into KZN (Hockey *et al*. 2005). Damara Terns breed inshore between Cape Agulhas and Cape Infanta on the South Coast,, with the bulk of the South African population breeding in Algoa Bay (Taylor *et al*. 2015; Whittington *et al*. 2015).

Table 5: Breeding resident seabirds present along the South Coast (adapted from CCA & CMS 2001) and their Regional and Global IUCN status.

Species Name	Common Name	Regional IUCN Status	Global IUCN Status
Haematopus moquini	African black oystercatcher	Least Concern	Near Threatened
Spheniscus demersus	African Penguin	Endangered	Endangered
Phalacrocorax capensis	Cape Cormorant	Endangered	Endangered
Phalacrocorax neglectus	Bank Cormorant	Endangered	Endangered
Phalacrocorax coronatus	Crowned Cormorant	Near Threatened	Near Threatened
Phalacrocorax lucidus	White-breasted Cormorant	Least Concern	Least Concern
Morus capensis	Cape Gannet	Vulnerable	Endangered
Larus dominicanus	Kelp Gull	Least Concern	Least Concern
Larus cirrocephalus	Greyheaded Gull	Least Concern	Least Concern
Chroicocephalus hartlaubii	Hartlaub's Gull	Least Concern	Least Concern
Hydroprogne caspia	Caspian Tern	Vulnerable	Least Concern
Sterna bergii	Swift Tern	Least Concern	Least Concern
Sterna dougallii	Roseate Tern	Endangered	Least Concern
Sterna balaenarum	Damara Tern	Critically Endangered	Vulnerable


Figure 31: Typical diving seabirds on the South Coast are the Cape Gannets (left) (Photo: NACOMA) and the flightless African Penguin (right) (Photo: Klaus Jost).

Recent changes in bird populations along the South Coast include eastward extensions of the breeding range of Hartlaub's gull (*Larus hartlaubii*) and crowned cormorant (*Phalacrocorax coronatus*) (Whittington 2004; van der Lingen *et al*. 2006; Crawford *et al*. 2012), White-breasted Cormorants (Crawford *et al*. 2013), and Cape Gannet (Crawford *et al*. 2015). Plettenberg Bay has also recently been identified as a suitable area in which to establish a new African Penguin colony, in attempts to conserve this species.

Most of the breeding resident seabird species feed on fish (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans), at times intensively target shoals of pelagic fish, particularly during the 'sardine run'. Small pelagic species such as anchovy and pilchard form important prey items for Agulhas Bank seabirds, particularly the Cape Gannet and the various cormorant species. Feeding strategies include surface plunging (gannets and terns), pursuit diving (cormorants and penguins), and scavenging and surface seizing (gulls). All these species feed relatively close inshore, although gannets and kelp gulls may feed further offshore. Increases in numbers of breeding pairs at eastern colonies of kelp gull (*L. dominicanus*), crowned cormorant, swift terns (*Sterna bergii*), and Cape gannet (*Morus capensis*) but not African penguins, in response to the eastward shift of sardines have been reported (van der Lingen *et al*. 2006).

African Penguin colonies occur at Cape Recife, and on the Algoa Bay islands (St Croix Island, Jaheel Island, Bird Island, Seal Island, Stag Island and Brenton Rocks). This species forages at sea with most birds being found within 20 km of the coast (Figure 32). The majority of Algoa Bay penguins from St Croix Island forage to the south of Cape Recife and thus along a portion of the cable route. A recent tracking study (BirdLife South Africa unpublished data) has shown that during their pre- and post-moult periods (October to March) penguins forage in inshore areas between Cape Recife and the Robberg Peninsula. African Penguins mainly consume pelagic shoaling fish species such as anchovy, round herring, horse mackerel and pilchard and their distribution is consistent with that of the pelagic shoaling fish, which occur within the 200 m isobath.

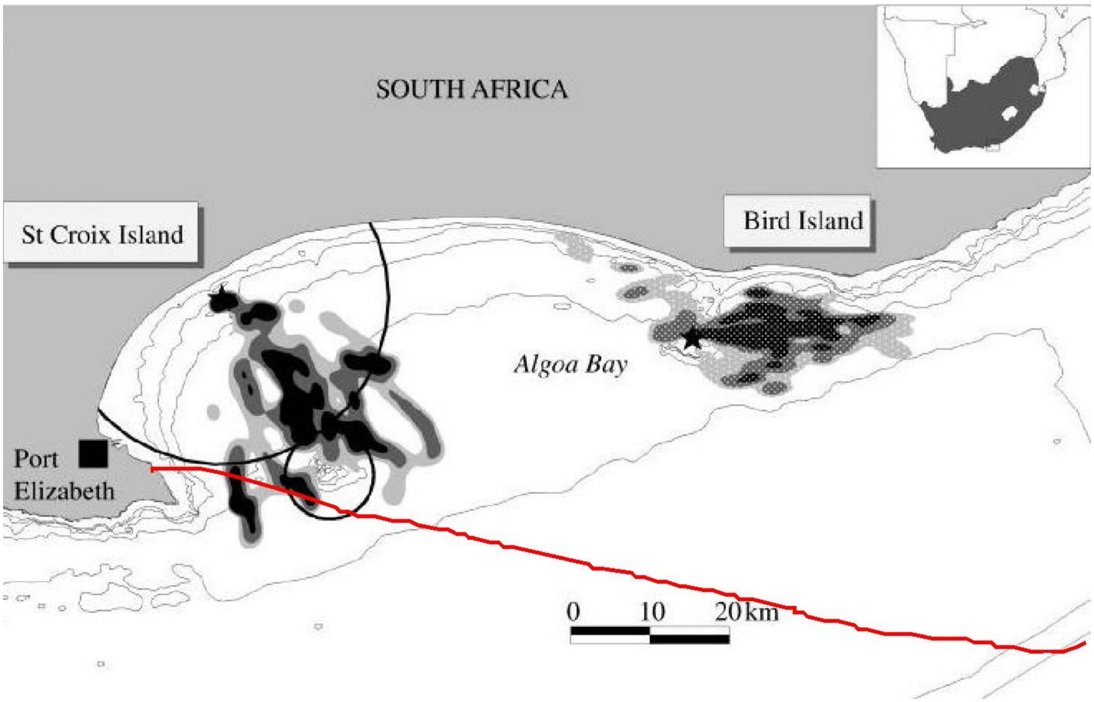

Figure 32: The proposed Port Elizabeth branch (red line) of the main trunk (dashed white line) of the 2AFRICA/GERA (East) Cable System in relation to the foraging areas (density of feeding dives) of African penguins breeding on St Croix Island and Bird Island (stars) in 2009, after closure to the purse-seine fishery within 20 km of St Croix Island (circled). Foraging range (feeding dives): black, 50%; dark grey, 50-75%; and light grey, 75-90% (Source: Pichegru *et al*. 2010).

Marine Mammals

The marine mammal fauna of the eastern coast of southern Africa comprises between 28 and 38 species of cetaceans (whales and dolphins) known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur here (Table 6) and one seal species, the Cape fur seal (*Arctocephalus pusillus*) (Best 2007). The offshore areas have been particularly poorly studied with almost all available information from deeper waters (>200 m) arising from historic whaling records, although in the past ten years, passive acoustic monitoring and satellite telemetry have begun to shed light on current patterns of seasonality and movement for some large whale species (Mate *et al*. 2011; DEFF 2015; Trudelle *et al*. 2017) but information on smaller cetaceans in deeper waters remains poor outside of reports from seismic surveys themselves. Of the migratory cetaceans listed in Table 6, the blue, sei and humpback whales are listed as 'Endangered' and the Southern Right, South African inshore Bryde's and fin whale as 'Vulnerable' in the IUCN Red Data book. Knowledge of cetacean distribution patterns in the project area is poor as it falls between the main east and west coast whaling grounds while most recent research in the area has been very coastal in nature (e.g. Caputo *et al*. 2020).

The distribution of whales and dolphins on the Southeast coast can largely be split into species associated with the continental shelf and species which occur in deep, oceanic waters. Species from both environments may, however, be found associated with the shelf break (200 – 1,000 m), so the shelf area is typically the most species-rich area for cetaceans. Cetacean density on the continental shelf is usually higher than in pelagic waters, as species associated with the pelagic environment tend to be wide-ranging across 1,000s of km.

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

Mysticetes (baleen whales)

The majority of baleen whales fall into the family Balaenopteridae (rorqual whales). Those potentially occurring in the offshore portions of the project area include the blue, fin, sei, minke, and dwarf minke, although the most likely to be seen are the humpback whale, southern right whale and inshore Bryde's, which are more strongly associated with the continental shelf Most of the 'offshore' species occur in pelagic waters, with only occasional visits onto the shelf. These species show some degree of migration either to, or through, the proposed exploration area when *en route* between higher-latitude feeding grounds (Antarctic or Subantarctic) and lower-latitude breeding grounds. Depending on the ultimate location of these feeding and breeding grounds, seasonality off South Africa can be either unimodal (usually in June-August, e.g. minke and blue whales) or bimodal (usually May-July and October-November, e.g. fin whales), reflecting a northward and southward migration through the South Coast area. As whales follow geographic or oceanographic features, the northward and southward migrations may take place at different distances from the coast, thereby influencing the seasonality of occurrence at different locations. Due to the complexities of the migration patterns, each species is discussed in further detail below.

Due to their presence in the project area only the humpback whale, sosuthern right whale and inshore Bryde's whale will be discussed in more detail below.

Bryde's whales (*Balaenoptera brydei* spp.)

Two types of Bryde's whales are recorded from South African waters - a smaller neritic 'inshore' form which recent research indicates is a subspecies of the larger pelagic form described as *Balaenoptera brydei* which occurs off the west coast and outside of the survey area (Olsen 1913; Penry 2010). The inshore population is unique in that it is resident year-round on the Agulhas Bank, only undertaking occasional small seasonal excursions up the east coast in winter during the annual sardine migration. Sightings over the last two decades suggest that the distribution of this population has shifted eastwards, most likely in response to a shift in their prey distribution (Best 2001, 2007; Penry *et al*. 2011). Peak encounter rates in Plettenberg Bay are during late summer and Autumn (March – May) (Penry *et al*. 2011), while in Algoa Bay sightings are lowest August-October but roughly similar in other months of the year suggesting an effective year-round residence. Its current distribution thus implies that this species likely to be encountered during cable installation. This is a small population (~600 individuals), which is possibly decreasing in size; an abundance estimate of 150 – 250 individuals was made for Bryde's whales using the Plettenberg Bay/Knysna area in 2005-2008 (Best *et al*. 1984; Penry 2010). As a small, genetically isolated population with a small distributional range largely concentrated on the Agulhas Banks – it is the most vulnerable of the baleen whales to anthropogenic threats. The recent South African National Red Data list assessment has also reclassified this population as 'Vulnerable' (Penry *et al*. 2016).

Table 6: Cetaceans occurrence off the Southeast Coast of South Africa, their seasonality (adapted from S. Elwen, Mammal Research Institute, pers. comm., Best 2007). IUCN Conservation Status is based on the SA Red List Assessment (2014) (Child *et al*. 2016).

Common Name	Species	Shelf (<200 m)	Offshore (>200 m)	Seasonality	IUCN Conservation Status
Delphinids					
Common bottlenose dolphin	*Tursiops truncatus*	Yes	Yes	Year round	Least Concern
Indo-Pacific bottlenose dolphin	*Tursiops aduncus* -Ifafa-Kosi Bay subpopulation	Yes		Year round	Vulnerable
	T. aduncus -Ifafa-False Bay subpopulation	Yes		Year round	Near threatened
	T. aduncus -Seasonal subpopulation	Yes		Year round	Data Deficient
Common (short beaked) dolphin	*Delphinus delphis*	Yes	Yes	Year round	Least Concern
Common (long beaked) dolphin	*Delphinus capensis*	Yes		Year round	Least Concern
Fraser's dolphin	*Lagenodelphis hosei*		Yes	Year round	Least Concern
Spotted dolphin	*Stenella attenuata*	Yes	Yes	Year round	Least Concern
Striped dolphin	*Stenella coeruleoalba*		Yes	Year round	Least Concern
Spinner dolphin	*Stenella longirostris*	Yes		Year round	Least Concern
Indo-Pacific humpback dolphin	*Sousa plumbea*	Yes		Year round	Endangered
Long-finned pilot whale	*Globicephala melas*		Yes	Year round	Least Concern
Short-finned pilot whale	*Globicephala macrorhynchus*		Yes	Year round	Least Concern
Killer whale	*Orcinus orca*	Occasional	Yes	Year round	Least Concern
False killer whale	*Pseudorca crassidens*	Occasional	Yes	Year round	Least Concern
Risso's dolphin	*Grampus griseus*	Yes (edge)	Yes	Year round	Least Concern
Pygmy killer whale	*Feresa attenuata*		Yes	Year round	Least Concern

Common Name	Species	Shelf (<200 m)	Offshore (>200 m)	Seasonality	IUCN Conservation Status
Sperm whales					
Pygmy sperm whale	*Kogia breviceps*		Yes	Year round	Data Deficient
Dwarf sperm whale	*Kogia sima*		Yes	Year round	Data Deficient
Sperm whale	*Physeter macrocephalus*		Yes	Year round	Vulnerable
Beaked whales					
Cuvier's	*Ziphius cavirostris*		Yes	Year round	Least Concern
Arnoux's	*Beradius arnouxii*		Yes	Year round	Data Deficient
Southern bottlenose	*Hyperoodon planifrons*		Yes	Year round	Least Concern
Strap-toothed whale	*Mesoplodon layardii*		Yes	Year round	Data Deficient
Longman's	*Mesoplodon pacificus*		Yes	Year round	Data Deficient
True's	*Mesoplodon mirus*		Yes	Year round	Data Deficient
Gray's	*Mesoplodon grayi*		Yes	Year round	Data Deficient
Blainville's	*Mesoplodon densirostris*		Yes	Year round	Data Deficient
Strap-toothed whale	*Mesoplodon layardii*		Yes	Year round	Data Deficient

Common Name	Species	Shelf (<200 m)	Offshore (>200 m)	Seasonality	IUCN Conservation Status
Baleen whales					
Antarctic Minke	*Balaenoptera bonaerensis*	Yes	Yes	>Winter	Least Concern
Dwarf minke	*B. acutorostrata*	Yes		Year round	Least Concern
Southern Hemisphere Fin whale	*B. physalus*		Yes	MJJ & ON, rarely in summer	Endangered
Pygmy Blue whale	*B. musculus brevicauda*		Yes	MJJ	Data Deficient
Blue whale	*B. musculus intermedia*		Yes	Winter	Critically Endangered
Sei whale	*B. borealis*		Yes	MJ & ASO	Endangered
Bryde's (inshore)	*B. edeni (inshore form)*		Yes	Year round	Vulnerable
Pygmy right	*Caperea marginata*	Yes		Year round	Least Concern
Humpback	*Megaptera novaeangliae*	Yes	Yes	AMJJASOND	Least Concern
Southern right	*Eubalaena australis*	Yes		JJASON	Least Concern
Delphinids					

Southern right whales (*Eubalaena australis*)

Southern right whales migrate to the southern African subregion to breed and calve, inhabiting shallow coastal waters in sheltered bays (90% were found <2 km from shore; Best 1990; Elwen & Best 2004). The southern African population of southern right whales (Figure 33,, right) historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baie dos Tigres) and is considered a single population within this range (Roux *et al*. 2015). The main winter breeding concentration is in the bays off the Cape South Coast between Cape Town and Port Elizabeth, with the highest density between Walker Bay and St Sebastian Bay. Southern right whale sightings east and offshore of Algoa Bay are thus likely to be very rare. They typically occur in coastal waters off the south coast between June and November, although animals may be sighted as early as April and as late as January.

The most recent abundance estimate for this population (2017), estimated the population at ~6,116 individuals including all age and sex classes (Brandão *et al*. 2018). This is thought to be at least 30 % of the original population size and with the population growing at ~6.5% per year since monitoring began (Brandão *et al*. 2018). Although the population is likely to have continued growing indications are that food shortages have resulted in changes in breeding cycles and feeding areas (Van Den Berg *et al*. 2020) with concomitant changes in the numbers of different classes of right whales seen along the South African coast (Roux *et al*. 2015; Vermeulen *et al*. 2020). These changes in behaviour and distribution patterns are indications of a population undergoing nutritional stress and disturbance during these times should be avoided.

Figure 33: The humpback whale (left) and the southern right whale (right) migrate along the South and East Coasts during winter (Photos: www.divephotoguide.com; www.aad.gov.au).

Humpback whales (*Megaptera novaeangliae*)

Humpback whales (Figure 33, left) are known to migrate between their Antarctic feeding grounds and their winter breeding grounds in tropical waters e.g. Angola, Mozambique and Madagascar. During this migration they use subtropical coastal areas as important migratory corridors (Best 2007). Although they have a cosmopolitan distribution (Best 2007) they exhibit a distinct seasonality in occurrence along the South African East Coast. This species can be observed between May and February, with peak sightings in June and November/December (Banks 2013). These peaks correspond to the northward migration, as animals pass through the exploration area *en-route* to their breeding grounds off Mozambique and Madagascar, and the southward migration when they migrate back to their Southern Ocean feeding grounds. Cow-calf pairs can be seen closer to the coast during the southward migration than non-calf groups, and they appear to use the relatively protected bays along the South Coast to rest during their migration, while Banks (2013) showed the migration stream to extend to at least 16 km offshore with opportunistic sightings suggesting animals are spread across the entire shelf. Recent satellite tagging of animals during the northward migration on the Transkei coast (well into what is historically through of as the 'east coast population area', showed them to turn around and end up feeding in the Southern Benguela (DEFF 2015) and the population origin of these animals remains unknown. Unexpected results such as this highlight the complexities of understanding whale movements and distribution patterns and the fact that descriptions of broad season peaks in no way captures the wide array of behaviours exhibited by these animals.

Other baleen whales that may be encountered in the area include the Sei and dwarf Minke whales. A recent sighting (January 2020) of a sei whale by a tour operator in Algoa Bay, confirms their current presence along the coast in low numbers. Dwarf minke whales occur close to shore and have been seen <2 km from shore on several occasions during the 'sardine run' (O'Donoghue *et al*. 2010a, 2010b, 2010c).

<u>Odontocetes (toothed whales)</u>

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader project area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site-specific to oceanic and wide ranging. Those in the region can range in size from 1.9 m long (Spinner dolphin) to 17 m (bull sperm whale).

Sperm whales (*Physeter macrocephalus*)

Sperm whales (Figure 34, left) are the largest of the toothed whales and have a complex, well-structured social system with adult males behaving differently to younger males and female groups. Sperm whales live in deep ocean waters over 1,000 m deep; however, males occasionally move into depths of 500-200 m on the shelf (Best 2007). They may therefore be encountered in the section of the cable route closest to the shelf edge. Seasonality of catches off the East Coast suggest that medium- and large-sized males are more abundant during winter (June to August), while female groups are more abundant in summer (December - February), although animals occur year-round (Best 2007).

There are almost no data available on the abundance, distribution or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters off the shelf of eastern South Africa. Beaked whales are all considered to be true deep water species usually being seen in waters in excess of 1,000 - 2,000 m depth (see various species accounts in Best 2007). Their presence in the area may fluctuate seasonally, but insufficient data exist to define this clearly. Of the smaller odontocetes, the long-beaked common dolphin, Indo-Pacific bottlenose dolphin and Indian Ocean humpback dolphin regularly occur along the southeast coast of South Africa and are frequently encountered in Mossel Bay, Knysna, Plettenberg Bay and Tsitsikamma area (Phillips 2006; Best 2007; Greenwood 2013; James *et al*. 2015).

Figure 34: Sperm whales *Physeter macrocephalus* (left) and killer whales *Orcinus orca* (right) are toothed whales likely to be encountered in offshore waters (Photos: www.onpoint.wbur.org; www.wikipedia.org).

Humpback dolphins (*Sousa plumbea*)

Humpback dolphins (Figure 35, right) occur along the South African South and East coasts in two apparently separate populations. These populations range from False Bay to approximately East London and from Durban to Richards Bay. Humpback dolphins in the western Indian Ocean were only recognised as a separate species in 2014 (Jefferson & Rosenbaum 2014). Globally they are listed as 'vulnerable' and within South Africa as 'endangered' on the IUCN Red List (Plön *et al*. 2015), and are considered to be South Africa's most endangered marine mammal.

Recent studies in Plettenberg Bay and Algoa Bay indicated a decrease in sightings and group sizes in both locations by approximately 50% in the last decade and a reduction in mean group sizes from 7 to 4 individuals (Greenwood 2013; Koper *et al*. 2015, 2016). Several hypotheses have been put forward as likely reasons for the decline; a decrease in prey availability, prolonged disturbance from whale and dolphin watching tourism and other marine recreation, coastal development and sustained pollution that contaminates the prey on which this species depends.

Figure 35: Toothed whales that occur on the South Coast include the Indo-Pacific bottlenose dolphin (left) and the Indian Ocean humpback dolphin (right) (Photos: www.fish-wallpapers.com; www.shutterstock.com).

Humpback dolphins inhabit the extreme inshore coastal environment, particularly the shallow water (< 15 m depth) reef areas within Algoa Bay and are rarely encountered much beyond 20 m water depth and a few hundred meters of land. The proposed cable landing site at Pollok Beach falls within an area frequented by this species. But given their highly endangered nature a precautionary approach during cable installation is therefore advised.

Indo-Pacific Bottlenose dolphins (*Tursiops aduncus*)

The Indo-Pacific bottlenose dolphin (Figure 35, left) occurs throughout coastal and shallow offshore waters of the temperate and tropical regions of the Indian Ocean and south-west Pacific to as far west as the Cape Peninsula. Off South Africa, they inhabit waters less than 50 m deep between the Mozambique border in the east and False Bay in west (Ross 1984; Ross *et al.* 1987). They occur year-round in coastal inshore habitats and are often seen in large groups of 10s to 100s of animals (Saayman *et al.* 1972; Ross 1984; Melly 2011) with calves seen year-round along the southeast coast (Cockcroft *et al.* 1990; Best 2007). In Algoa Bay peak sightings were recorded in April/May (autumn) and October/November (spring) (Melly *et al.* 2017).

A mark-recapture study conducted in Knysna-Tsitsikamma area estimated a population of approximately 1,873 – 2,479 individuals (Vargas-Fonseca *et al.* 2020), which is a substantial reduction from the ~7,000 bottlenose dolphins in only the Plettenberg Bay area estimated by Phillips (2006). They are thought to be part of a larger population of between 16,000 and 41,000 that ranges along a broader southeast coast area (Reisinger & Karczmarski 2010; Caputo *et al.* 2021). The large decline in the Plettenberg Bay area is not currently understood and it is not know if it represents a total decline of the population or a more regional shift in habitat use associated with a shift in food resources or increase in human pressures in Plettenberg Bay area (e.g. marine tourism). Regardless, such a large decrease in a population of a significant section of its range (145 km) suggests the population is likely to be stressed at some level making it more vulnerable to external impacts.

Within its range, the Indo-Pacific bottlenose dolphin seems to have 'preferred areas' (Ross *et al.* 1987; Ross *et al.* 1989; Cockcroft *et al.* 1990, 1991) in which it is more frequently encountered. These are about 30 km apart, and are thought to correspond to discrete home ranges. Genetic assessments have identified a resident population North of Ifafa (KZN coast, listed as 'vulnerable'), a resident population south of Ifafa (listed as 'near threatened'), as well as a migratory population South of Ifafa ('data deficient'), which appears to undertake seasonal migrations into KZN waters in association with the 'sardine run' (Natoli *et al.* 2008; Cockcroft *et al.* 2016).

Common dolphins (*Delphinus spp.*)

Two species of common dolphin are currently recognised, the short-beaked common dolphin (*Delphinus delphis*) and the long-beaked common dolphin (*Delphinus capensis*). The long-beaked common dolphin (*D. capensis*) is resident to the temperate Agulhas Bank (cf. Agulhas Eco-region) with sightings extending as far up the West Coast as St Helena Bay and up the East coast to Richards Bay, in waters less than 500 m deep. Individuals of this species are wide ranging within this area and may move hundreds of kilometers in short periods of time. They are not known to show any degree of residency to coastal areas. Group sizes in this species tend to be large: 100s to even 1000s of animals. No population estimate is available for the two species, but they are thought to be large (15,000 – 20,000; Cockcroft & Peddemors 1990; Peddemors 1999). The short-beaked common dolphin prefers offshore habitats and is likely to be encountered only in the offshore portions of the project area. Estimates of the population size and seasonality for the subregion are lacking.

A few studies have suggested that common dolphins inhabit the Eastern Cape coastline during summer, with movements towards the southern KwaZulu-Natal coastline during winter (Ross 1984; Cockcroft & Peddemors 1990; O'Donoghue *et al*. 2010a, 2010b, 2010c), associated with the annual sardine migration up the east coast in winter (Best 2007). Aerial surveys carried out between Port Elizabeth and East London in the late 1980s detected common dolphins in low densities throughout the year (Cockcroft & Peddemors 1990) and surveys along the Eastern Cape (East London to Port Edward) by the KZN Sharks Board from 1996-2014 (May to August only) showed common dolphins to be the most populous cetacean along this coast with 10s of sightings of large groups per month. Long-beaked common dolphins can thus be assumed to be present in high numbers year round.

<u>Other species</u>

Killer whales (Figure 34, right), false killer whales and common bottlenose dolphins are regularly reported by fishermen operating in deeper waters off the Southeast Coast of South Africa. These species are therefore likely to occur in the project area. Rarely encountered dwarf and pygmy sperm whales, pygmy killer whales, Risso's and Frazer's dolphins, striped, spinner and Pan-tropical spotted dolphins, and several beaked whale species have distributions that overlap with the project area (Findlay *et al*. 1992; Best 2007); their occurrence is thought to be rare, but insufficient data is available on the abundance and spatio-temporal distribution of these species to make an accurate assessment of their susceptibility.

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

The Cape fur seal (*Arctocephalus pusillus pusillus*) (Figure 36) is the only seal species that has breeding colonies along the Southeast Coast, namely on the northern shore of the Robberg Peninsula in Plettenberg Bay and at Black Rocks (Bird Island group) in Algoa Bay (Figure 37). The timing of the annual breeding cycle is very regular occurring between November and January, after which the breeding colonies break up and disperse. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991).

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. The movement of seals from the three South Coast colonies are poorly known, however, limited tracking of the Algoa Bay colony has suggested these seals generally feed in the inshore region south of Cape Recife. The diet varies with season and availability and includes pelagic species such as horse mackerel, pilchard, and hake, as well as squid and cuttlefish.

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

Figure 36: Colony of Cape fur seals (Photo: Dirk Heinrich).

3.3. Marine Protected Areas and Conservation Areas

3.3.1 Coastal and Offshore MPAs

'No-take' Marine Protected Areas (MPAs) offering protection of the offshore biozones (sub-photic, deep-photic and shallow-photic) were until recently absent around the South African coast. This resulted in substantial portions of the shelf-edge marine biodiversity in the area being assigned a threat status of 'Critically endangered', 'Endangered' or 'Vulnerable' (Lombard *et al.* 2004; Sink *et al.* 2012). Using biodiversity data mapped for the 2004 and 2011 National Biodiversity Assessments a systematic biodiversity plan was developed for the Southwest Coast (Majiedt *et al.* 2013) with the objective of identifying both coastal and offshore priority areas for MPA expansion. Potential VMEs that were explicitly considered during the planning included the shelf break, seamounts, submarine canyons, hard grounds, submarine banks, deep reefs and cold water coral reefs. The biodiversity data were used to identify numerous focus areas for protection on the South Coast. These focus areas were carried forward during Operation Phakisa, which identified potential offshore MPAs. A network of 20 MPAs was gazetted on 23 May 2019, thereby increasing the ocean protection within the South African EEZ to 5%. The approved coastal and offshore MPAs within the broad project area are shown in Figure 37 and described briefly below.

Eastern Cape MPAs include the Sardinia Bay MPA at Cape Recife, the Addo Elephant MPA in Algoa Bay (which includes the former Bird Island MPA), the Amathole MPA in the vicinity of East London, and the Dwesa-Cwebe, Hluleka and Pondoland MPAs located on the Wild Coast.

The **Sardinia Bay MPA** has a shoreline 7 km in length and extends one nautical mile seawards of the high-water mark, between Schoenmakerskop and Bushy Park. It contains representative habitat including rocky platforms, sandy beaches, subtidal rocky reefs, and subtidal sandy benthos.

The **Port Elizabeth Corals MPA,** which was proclaimed in 2019, lies offshore between Port Elizabeth and Cape St. Francis and falls within the proposed Algoa 3D survey area. This 270 km^2 MPA features a long narrow rocky ridge and series of underwater hills creating a unique seascape on the continental slope ranging from 200 m to 5,000 m. The area is recognized as an 'Ecologically and Biologically Significant Area' because of its importance in the life history of a wide variety of marine species, including Kingklip. A seasonal fisheries management area that borders on the MPA was established to protect kingklip during their spawning season, when they aggregate in large numbers. To gather in the same place, the fish use specialised drumming muscles to communicate across the ocean. The MPA protects important seabed features that provide important habitat for corals. The three-dimensional structure of these deep coral reefs are important nursery areas for kingklip, as they provide protection to young fish.

The **Addo Elephant MPA**, which incorporates the Algoa Bay Islands was gazetted in May 2019. This 1,200 km^2 MPA expands on the original Bird Island MPA (comprising Bird, Seal, Stag and Black Rock Islands) to protect sandy beaches, rocky shores, reefs, an estuary and islands and aid recovery of valuable fisheries resources such as abalone and kob, as well as great white sharks and whales (brydes, minke, humpback and right). The MPA protects important feeding areas for the 9,000 pairs of Endangered African penguins breeding at St Croix Island and the 60 000 pairs of Endangered Cape gannets breeding at Bird Island. These islands are the only important seabird islands along a 1,800 km stretch of coastline between Dyer Island near Hermanus in the Western Cape and Inhaca Island in Mozambique. Together with St Croix, Jahleel and Brenton Islands (also in Algoa Bay) they are classed as Important Bird Areas (IBAs) because they regularly support significant numbers of globally threatened bird species and hold large concentrations of seabirds. Six of the 14 South African resident seabird species breed either on the islands or at the adjacent coast. The islands play an important national and international role in the conservation of Cape Gannet, African Penguin and Roseate Tern. The islands form ecological distinct subtidal habitats, containing many endemic invertebrates, algae and linefish (e.g. santer and red roman). Black Rocks is an important seal breeding colony and serves as a great white shark feeding area. The MPA is also of particular importance to the threatened abalone as abalone poaching activities are strictly controlled.

The 400 km^2 **Amathole MPA** was proclaimed in 2019 and extends two of three existing coastal areas protected by the Amathole MPA either side of East London, namely from Christmas Rock to the Gxulu River mouth, from Nahoon Point to Gonubie Point, and from the Nyara River mouth to the Kei River mouth. The offshore portions of the MPA protects the Gxulu canyon, deep reefs and some of the fragile cold-water lace corals, which offer refuge to the South Coast rock lobster. The northern part of the MPA protects the sediment fan of the Kei River mouth that is home to sponge and soft coral gardens. The MPA also protects overexploited and sensitive fish species such as seventy four, dageraad, red steenbras, white steenbras, dusky kob and wreckfish, as well as the spawning, nursery, foraging, aggregation and refuge areas for many of these overexploited species. Because the continental shelf is narrow in this region, the MPA covers a wide variety of shelf and slope ecosytems extending to a depth of 2,200 m thereby protecting an area of life history importance for migratory species including seabirds, turtles, sharks, seabreams, and wreckfish. The proposed Great Kei 3D survey area overlaps with this MPA.

The proposed Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System does not pass through any of these MPAs.

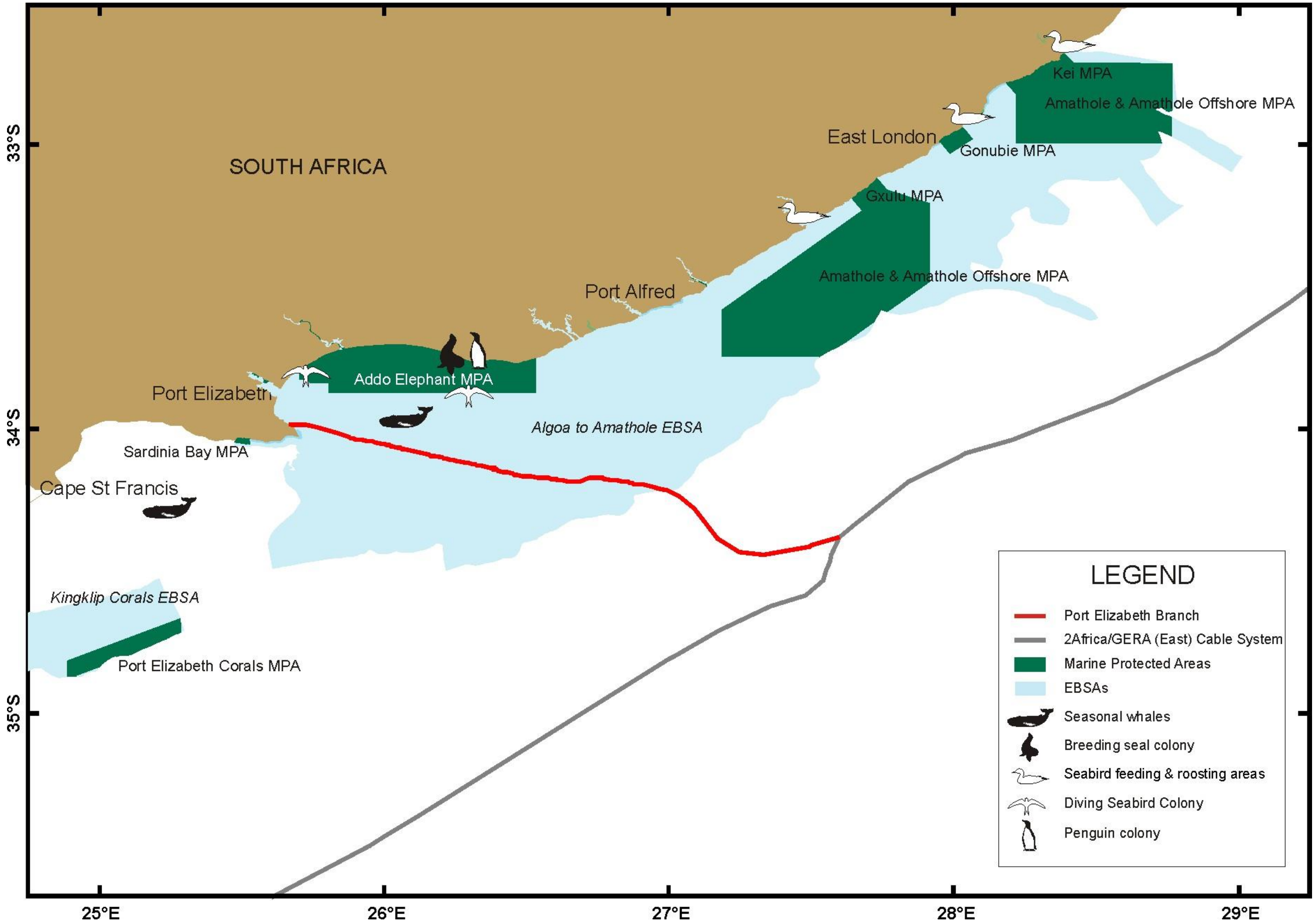

Figure 37: The proposed Port Elizabeth branch (red line) of the main trunk (grey line) of the 2AFRICA/GERA (East) Cable System in relation to Marine Protected Areas (MPAs) and Ecologically and Biologically Significant Areas (EBSAs) on the South and East Coasts, illustrating the location of seabird and seal colonies, and seasonal whale populations.

Sensitive Areas

Despite the development of the offshore MPA network a number of 'Vulnerable' ecosystem types (i.e. Agulhas Coarse Sediment Shelf Edge, Southwest Indian Mid Slope, Southwest Indian Lower Slope and Southwest Indian unclassified Abyss) are currently 'poorly protected' or 'not protected' and further effort is needed to improve protection of these threatened ecosystem types (Sink *et al.* 2019) (Figure 38). Ideally, all highly threatened ('Critically Endangered' and 'Endangered') ecosystem types should be well protected. Currently, however, most of the Agulhas Coarse Sediment Shelf Edge and Southwest Indian Mid Slope are poorly protected receiving only 0.2-10% protection, whereas the Southwest Indian Lower Slope and Southwest Indian unclassified Abyss receive no protection at all (Sink *et al.* 2019). Although most of the ecosystem types in the inshore portions of the project area are either moderately protected, most of the offshore areas of the proposed Port Elizabeth branch route are poorly protected or not protected.

Ecologically or Biologically Significant Areas

As part of a regional Marine Spatial Management and Governance Programme (MARISMA) the Benguela Current Commission (BCC) and its member states have identified a number of Ecologically or Biologically Significant Areas (EBSAs) both spanning the border between Namibia and South Africa (see Figure 37) and along the South African West, South and East Coasts, with the intention of implementing improved conservation and protection measures within these sites. South Africa currently has 11 EBSAs solely within its national jurisdiction with a further four having recently been proposed. It also shares five trans-boundary EBSAs with Namibia (3) and Mozambique (2). The principal objective of these EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. They currently carry no legal status. Although no specific management actions have as yet been formulated for the EBSAs, they have been considered as part of the National Coastal and Marine Spatial Biodiversity Plan and the development of the Critical Biodiversity Map (CBA), which is addressed in the next section.

The proposed Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System passes through the Algoa to Amathole EBSAs. The description below of the EBSAs in the broader project area is taken largely from the EBSA portal (https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa).

The **Kingklip Corals EBSA** was established to offer protection to Secret Reef, Kingklip Koppies and Kingklip Ridge, which lie on and extend east of Grue Bank, on the shelf edge and upper bathyal area, about 100 km offshore of Knysna (Sink 2016). The feature spans a broad depth range of -150 to -800 m. This newly discovered biogenic coral reef structure is most important for its benthic features as it includes threatened benthic habitats, particularly fragile and sensitive corals (scleractinian corals, stylasterine corals) and byrozoans, as well as vulnerable mollusc and crab species (Sink 2016). Reef-forming scleratinean corals characterise the crest and edges of the northern end of the ridge, and dense clouds of plankton and hake occur above the ridge. The Kingklip koppies, west of the ridge, are rocky hills that also support fragile benthic species. Secret Reef further west, is a newly discovered biogenic coral reef structure on the shelf edge and upper bathyal area, which includes threatened benthic habitats and fragile, sensitive, vulnerable species, such as scleractinian corals, stylasterine corals, bryozoans, molluscs, and crabs (Sink 2016). The EBSA is thus most important for benthic features, although the overlying water column is also relevant.

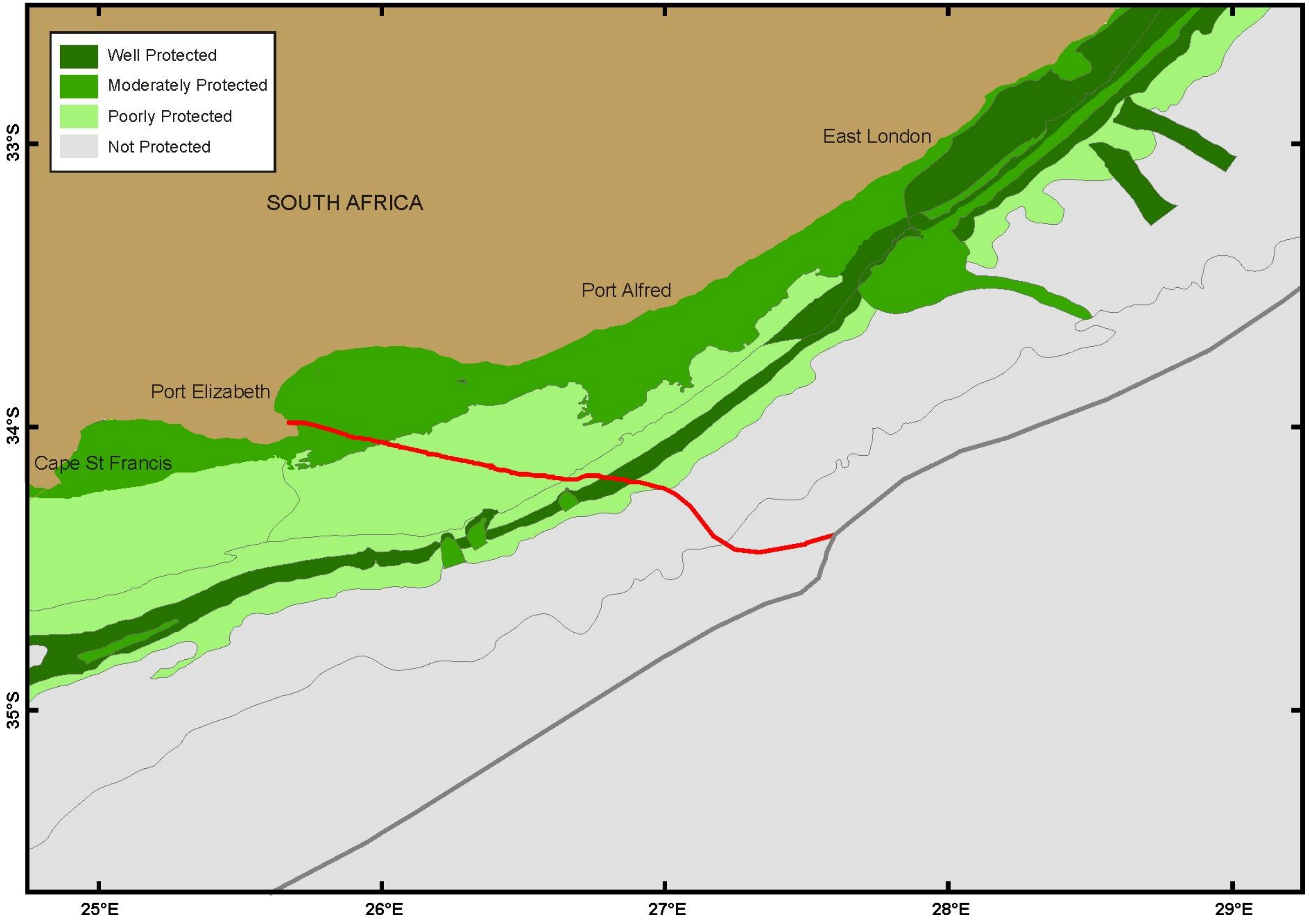

Figure 38: Protection levels of 150 marine ecosystem types as assessed by Sink *et al.* (2019) in relation to the proposed Port Elizabeth branch (red line) of the main trunk (grey line) of the 2AFRICA/GERA (East) Cable System.

The **Algoa to Amathole EBSA** encompasses the likely largest single collection of significant and special marine features in the country that also jointly support key ecological processes, including important land-sea connections. It spans the Eastern Cape shoreline between Sardinia Bay MPA and Amathole MPA/Kei River mouth, extending from the dune base to approximately the continental shelf break/slope at -2000 m. Complex ocean circulation occurs where the Agulhas Current leaves the coast, following the shelf break resulting in the formation of cold-water eddies, intrusions of Agulhas water onto the shelf and large offshore meanders of the Agulhas Current. Consequently, this EBSA includes spawning areas, nursery areas and key transport pathways for demersal and pelagic fish, which in turn support a myriad of top predators, including shark and seabird breeding and foraging areas. The Algoa Bay islands support the easternmost colony of Endangered African penguins and the largest colony of Cape Gannets in southern Africa. Regionally 'Critically Endangered' leatherback and regionally 'Near Threatened' loggerhead turtles migrate through the EBSA between their nesting and foraging grounds, with hatchlings of both species also passing through during their dispersal from the nesting beaches. Green turtles have also been sighted in the area. The EBSA includes 36 ecosystem types, 18 of which are threatened and a further seven that are Near Threatened. Sensitive features and species include submarine canyons, steep shelf edge, deep reefs, outer shelf and shelf edge gravels, and reef-building cold-water corals ranging in depth between 100 and 1,000 m. It also contains several key biodiversity features, including: stromatolites; sites where coelocanths are present; a 'Critically Endangered' localised endemic estuarine pipefish, several priority estuaries, rare ecosystem types of limited spatial extent and a few existing coastal marine protected areas.

Biodiversity Priority Areas

The latest version of National Coastal and Marine Spatial Biodiversity Plan (v1.0 (Beta 2) was released on 26th February 2021) (Harris *et al*. 2020). This National Coastal and Marine Spatial Biodiversity Plan is intended to be used by managers and decision-makers in those national government departments whose activities occur in the coastal and marine space, e.g., environment, fishing, transport (shipping), petroleum, mining, and others. It is relevant for the Marine Spatial Planning Working Group where many of these departments are participating in developing South Africa's emerging marine spatial plans. It is also intended for use by relevant managers and decision-makers in the coastal provinces and coastal municipalities, EIA practitioners, organisations working in the coast and ocean, civil society, and the private sector.

The biodiversity priority areas and management objectives of each category have been defined and mapped as part of the marine spatial planning process. CBA Map categories are as follows: Protected Area, Critical Biodiversity Area 1 (CBA 1), Critical Biodiversity Area 2 (CBA 2), and Ecological Support Area (ESA). Sea-use guidelines are then proposed, with the Conservation Zones likely to comprise a Strict Biodiversity Conservation Zone (including Marine Protected Areas, and Other Effective Area-Based Conservation Measures (OECMs) as two separate types), and an Environmental Impact Management Zone. Protected areas will be managed according to their gazetted regulations. The intention is that the CBA Map (CBAs and ESAs) and sea-use guidelines inform the MSP Conservation Zones and management regulations, respectively.

Activities within these management zones are classified into those that are compatible, those that are incompatible, and those that may be compatible subject to certain conditions. Undersea cables will be permitted in ESAs and may be compatible, subject to certain conditions, in CBAs (Harris *et al*. 2020).

These zones have been incorporated into the most recent iteration of the national Coastal and Marine Critical Biodiverity Area (CBA) Map (v1.0 (Beta 2) released 26th February 2021) (Harris *et al*. 2020) (Figure 39). This indicates that the cable route of the Port Elizabeth branch crosses numerous CBA1 areas, particularly around Cape Recife and on the sandy shelf edge. CBA 1 indicates irreplaceable or near-irreplaceable sites that are required to meet biodiversity targets with limited, if any, option to meet targets elsewhere, whereas CBA 2 indicates optimal sites that generally can be adjusted to meet targets in other areas. Ecological Support Areas (ESAs) represent EBSAs outside of MPAs and not already selected as CBAs. Sea-use within the CBAs and ESAs reflect those specified by the EBSA biodiversity conservation and management zones described above.

Hope Spots

Hope Spots are defined by Mission Blue of the Sylvia Earle Alliance as special conservation areas that are critical to the health of the ocean. The first six Hope Spots were launched in South Africa in 2014 and include Aliwal Shoal in KZN, Algoa Bay in the Eastern Cape, and Plettenberg Bay, Knysna, the Cape Whale Coast (Hermanus area) and False Bay in the Western Cape. Of these, the Algoa Bay Hope Spot overlaps with the proposed Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System.

Important Bird Areas(IBAs)

Of the Important Bird Areas (IBAs) designated by BirdLife International in the Southern Cape, those located along the coastline of the broader project area are listed in Table 7.

The Algoa Bay Islands Nature Reserve IBA comprise the only islands between Cape Agulhas and Inhaca in Mozambique and are therefore ecologically extremely important. Fourteen seabird species, as well as several shorebird and 33 terrestrial bird species have been recorded on the Algoa Bay Islands. Eight seabird species currently breed there namely Roseate Tern, Arctic Tern, Common Tern, Swift Tern, African Penguins, Cape Gannet, Cape Cormorant and White-breated Cormorant. The Algoa Bay Islands support almost 50% of the global population of African Penguins, mostly on St Croix Island. St Croix is also one of the few breeding locations for Cape Cormorants. Bird Island supports over 65,000 breeding pairs of Cape Gannets and is one of only six such sites in the world. The islands were also known to hold large numbers of Antarctic Tern, which roosted there in winter.

Various marine IBAs have also been proposed in South African territorial waters, with those in the broader project area shown in (Figure 40). Marine IBAs are primarily defined for the regular presence of globally threatened species, and congregations of >1% of biogeographic or global populations. ‘Confirmed’ IBAs are those that have had a full assessment made of qualifying species and populations, as well as a site description and associated boundary, which have been reviewed and approved by both BirdLife Partners and the BirdLife Secretariat. In contrast, ‘Proposed’ sites are those that have not yet gone through this cycle but are mapped to indicate they are in the process of being identified and reviewed. Although IBA designation does not bring any legal obligation, IBAs may be used to inform the designation of MPAs under national legislation or international agreements. IBA data is submitted to the Convention on Biological Diversity (CBD) workshops to assist in describing EBSAs. The proposed Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System crosses through the proposed Alexandria coastal belt/Algoa Bay Islands Nature Reserve Marine IBA, specifically aimed at protecting the African Penguin, Cape Gannet, Kelp Gull, Damara Tern and Roseate Tern (BirdLife International 2020).

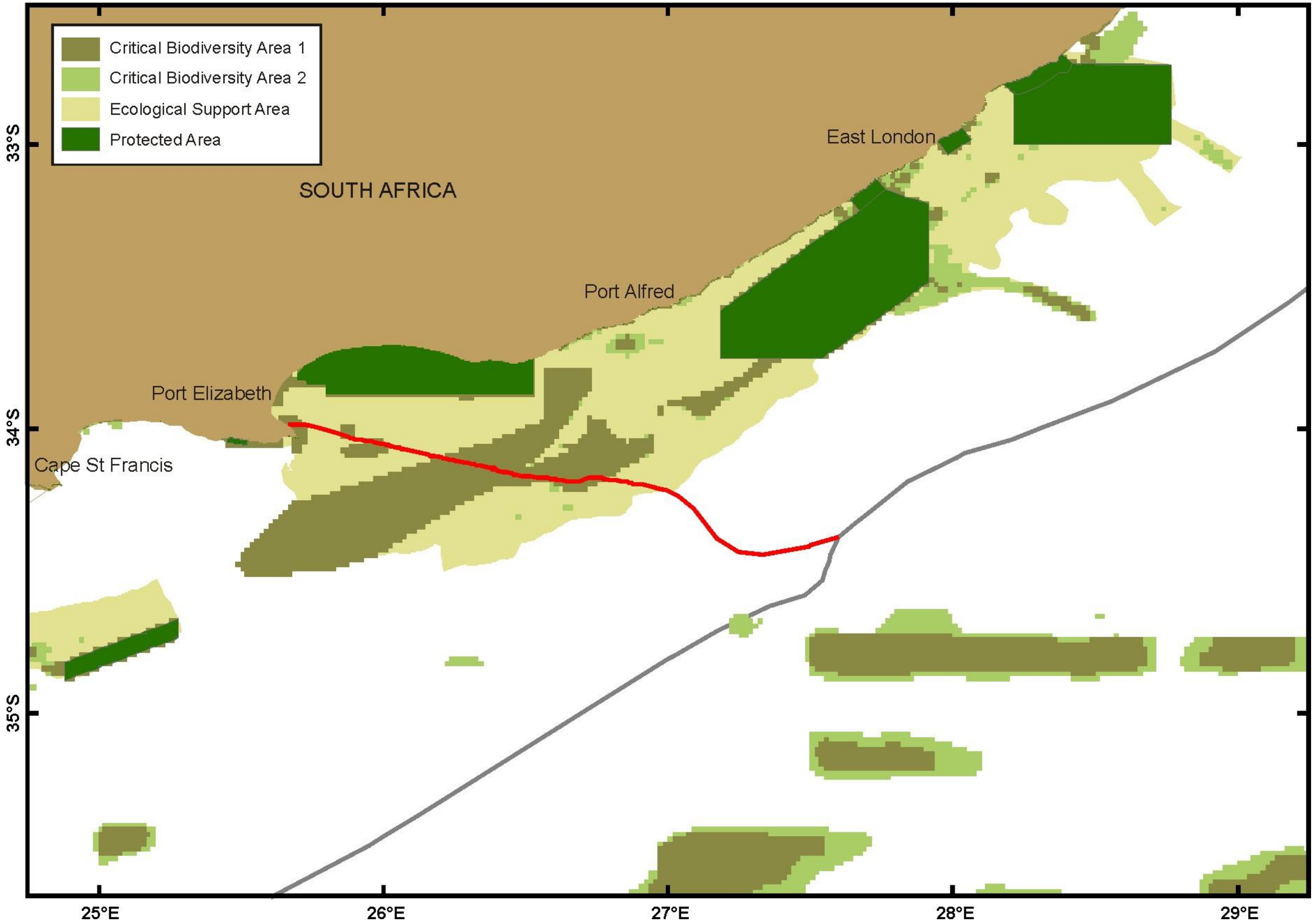

Figure 39: The proposed Port Elizabeth branch (red line) of the main trunk (grey line) of the 2AFRICA/GERA (East) Cable System in relation to Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) (version 1.0 (Beta 2)) (adapted from Harris *et al*. 2020).

Table 7: List of coastal Important Bird Areas (IBAs) and their criteria listings.

Site Name	IBA Criteria
Swartkops Estuary – Redhouse and Chatty Saltpans	A1, A4i, A4iii
Algoa Bay Islands: Addo Elephant National Park	A1, A4i, A4ii, A4iii
Woody Cape Section: Addo Elephant National Park	A1, A2, A3

A1. Globally threatened species
A2. Restricted-range species
A3. Biome-restricted species
A4. Congregations
i. applies to 'waterbird' species
ii. This includes those seabird species not covered under i.
iii. modeled on criterion 5 of the Ramsar Convention for identifying wetlands of international importance. The use of this criterion is discouraged where quantitative data are good enough to permit the application of A4i and A4ii.

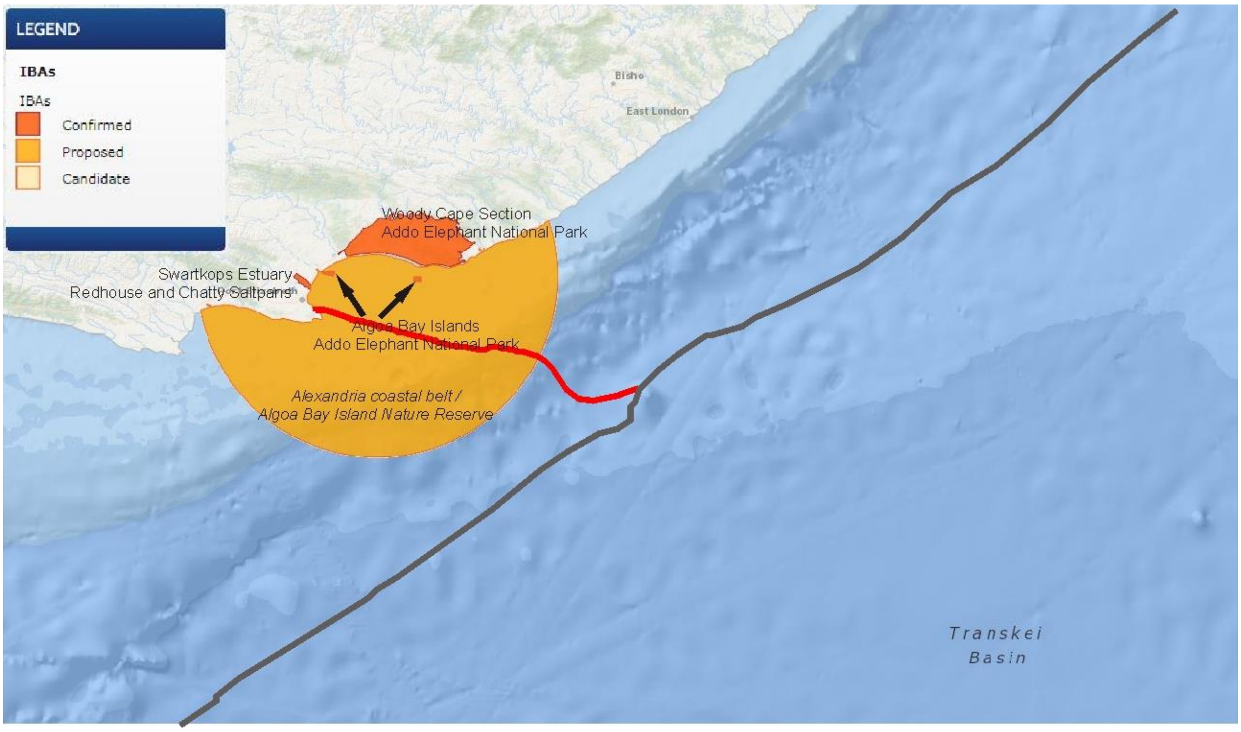

Figure 40: The proposed Port Elizabeth branch (red line) of the main trunk (grey line) of the 2AFRICA/GERA (East) Cable System in relation to confirmed and proposed coastal and marine IBAs in the Eastern Cape (Source: https://maps.birdlife.org/marineIBAs).

Proposed Marine Protection Zone

The formation of a Humpback Dolphin Marine Sanctuary extending 800 m offshore from Bird Rock to Cape Recife has been proposed to protect the rare and endangered Indo-Pacific Humpback Dolphin. Degradation of their shallow inshore habitat and an increase in boating activity has been identified as the primary causes of their unfavourable conservation status. The high frequency noise emitted by speeding Inflatable Boats or Personal Water Craft (PWC), as well as these craft travelling at high speeds could result in behavioural disturbance and physical injury to these animals. It is proposed that motorised craft will be required to travel slower than planing speed within the Sanctuary, and that inflatable Boat & PWC riding will not be permitted. The landing site for the proposed Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System crosses through the northwestern corner of the proposed Sanctuary.

4. ASSESSMENT OF IMPACTS ON MARINE FAUNA

4.1. Impact Assessment Methodology

An EIA methodology should minimise subjectivity as far as possible and accurately assess the project impacts. In order to achieve this ACER has followed the methodology defined below.

4.1.1 Impact Identification and Characterisation

An 'impact' is any change to a resource or receptor caused by the presence of a project component or by a project-related activity. Impacts can be negative, positive or neutral.

Nature of the Impact *– describes whether the impact would have a negative, positive or zero effect on the affected environment*	
Positive	The impact benefits the environment
Negative	The impact results in a cost to the environment
Neutral	The impact has no effect

Type of impacts assessed:

Type of impacts assessed	
Direct (Primary)	Impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
Indirect	Indirect or induced changes that may occur because of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place because of the activity.
Cumulative	Impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over time and can include both direct and indirect impacts.

Impacts are described in terms of their characteristics, including the impact type and the impact spatial and temporal features (namely extent, duration, scale and frequency). The following convention was used to determine significance ratings in the assessment:

Rating	Definition of Rating
Intensity *– establishes whether the magnitude of the impact is destructive or benign in relation to the sensitivity of the receiving environment*	
Negligible	Inconsequential change, disturbance or nuisance. The impact affects the environment in such a way that natural functions and processes are not affected.
Low	Minor (Slight) change, disturbance or nuisance. The impact on the environment is not detectable.
Medium	Moderate change, disturbance or discomfort. Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way.
High	Prominent change, disturbance or degradation. Where natural functions or processes are altered to the extent that they will temporarily or permanently cease.
Duration *– the time frame over which the impact will be experienced*	
Short-term	<3 years.
Medium-term	3 – 10 years.
Long-term	>10 years, but where the impact will eventually cease either because of natural processes or by human intervention.
Permanent	Where mitigation either by natural processes or by human intervention would not occur in such a way or in such time span that the impact can be considered transient.
Extent *- defines the physical extent or spatial scale of the impact*	
Site specific	Impacts are limited to the site area only.
Local	Impacts extend only as far as the activity; limited to the site and its immediate surroundings; <2 km.
Regional	Impacts are confined to the region or are experienced within 30 km of the site.
National	Impacts are limited to the coastline of South Africa.
International	Impacts extend beyond the borders of South Africa.
Loss of resources *- the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable*	
Low	Where the activity results in a loss of a particular resource which is easily replaceable.
Medium	Where the loss of a resource occurs, but it can be replaced with effort.
High	Where the activity results in an irreplaceable loss of a resource.
Reversibility *- defines the potential for recovery to pre-impact conditions*	
Irreversible	Impacts are permanent.
Low	Where the impact can be reversed to only a limited degree.
Medium	Where the impact can be partially reversed.
High	Where the impact can be completely reversed.

Probability *– the likelihood of the impact occurring*	
Improbable	Where the possibility of the impact to materialise is very low either because of design or historic experience, i.e. ≤ 30% chance of occurring.
Probable	Where there is a distinct possibility that the impact would occur, i.e. > 30 to ≤ 60% chance of occurring.
Highly Probable	Where it is most likely that the impact would occur, i.e. > 60 to ≤ 80% chance of occurring.
Definite	Where the impact would occur regardless of any prevention measures, i.e. > 80% chance of occurring.

Using the core criteria above (namely extent, duration, intensity and loss of resources), the consequence of the impact is determined:

Consequence *– attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity*	
Low	Impacts could be EITHER: of low intensity, duration, extent and impact on irreplaceable resources; OR of low intensity with up to two of the other criteria rated as medium; OR of medium intensity with all three other criteria rated as low.
Medium	Impacts are of medium intensity with at least two of the other criteria rated as medium.
High	Impacts could be EITHER: of high Intensity and impact on irreplaceable resources, with any combination of extent and duration; OR of high intensity, with all of the other criteria rated medium or high.

The consequence rating is considered together with the probability of occurrence in order to determine the overall significance using the table below.

		PROBABILITY			
		IMPROBABLE	**POSSIBLE**	**PROBABLE**	**DEFINITE**
CONSEQUENCE	**LOW**	VERY LOW	VERY LOW	LOW	LOW
	MEDIUM	LOW	LOW	MEDIUM	MEDIUM
	HIGH	MEDIUM	MEDIUM	HIGH	HIGH

Further criteria assessed are:

Frequency - Description of any repetitive, continuous or time-linked characteristics of the impact	
Once-off	occuring any time during construction.
Intermittent	occuring from time to time, without specific periodicity.
Periodic	occuring at more or less regular intervals.
Continuous	occuring without interruption.
Degree of confidence in predictions *– in terms of basing the assessment on available information and specialist knowledge*	
Low	Less than 35 % sure of impact prediction.
Medium	Between 35 % and 70 % sure of impact prediction.
High	Greater than 70 % sure of impact prediction.

A key objective of an EIA is to identify and define environmentally and technically acceptable and cost effective measures to manage and mitigate potential impacts. Mitigation measures are developed to avoid, reduce, remedy or compensate for potential negative impacts, and to enhance potential environmental benefits.

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

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

Degree to which impact can be mitigated *- the degree to which an impact can be reduced / enhanced*	
None	No change in impact after mitigation.
Very Low	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
Low	Where the significance rating drops by one level, after mitigation.
Medium	Where the significance rating drops by two to three levels, after mitigation.
High	Where the significance rating drops by more than three levels, after mitigation.

4.2. Identification of Impacts

Potential impacts to the marine environment as a result of the installation and operation of the subsea cable are briefly summarised below, and discussed in more detail in Sections 4.3 and 4.4.

4.2.1 Cable Route Survey

The cable route survey could result in:

- Physiological injury or behavioural disturbance of marine fauna by the sounds emitted by the geophysical survey equipment; and
- Potential injury to marine mammals and turtles through vessel strikes.

4.2.2 Subsea Cable Installation

The installation of the subsea cable would result in:

- Disturbance of sediments and associated fauna during the pre-lay grapnel run;
- Disturbance of sediments and associate fauna during cable installation;
- Elimination of biota in the cable's structural footprint;
- Reduced area of unconsolidated seabed available for colonisation by infaunal communities; and
- Physical presence of the cable providing an alternative substratum for colonising benthic communities, or resulting in faunal attraction to fish and mobile invertebrates.

4.2.3 Shore crossing of the Subsea Cable

Infrastructure crossing the shore will impact on intertidal and shallow subtidal biota during the construction phase in the following ways:

- Temporary loss of benthic habitat and associated sessile communities due to preparation of seabed for buried cable laying and associated activities;
- Possible temporary impacts on adjacent habitat health due to turbidity generated during trenching and installation;
- Temporary disturbance of marine biota, particularly marine mammals and coastal birds, due to construction activities;
- Possible impacts to marine water quality and sediments through hydrocarbon pollution by marine construction infrastructure and machinery, and inappropriate disposal of used lubricating oils from marine machinery maintenance; and
- Potential contamination of marine waters and sediments by inappropriate disposal of spoil from trenching activities or backfilling, and human wastes, which could in turn lead to impacts upon marine flora, fauna and habitat.

4.2.4 Operation of the Subsea Cable System

As no routine maintenance of the subsea cable system is required, impacts associated with the operational phase would consitute temporary disturbance of the seabed if subsea cable sections require replacing. Impacts would be highly localised and sporadic.

4.2.5 Decommissioning

As the subsea cable will most likely be left in place at decommissioning, the potential impacts during the decommissioning phase are expected to be minimal and no key issues related to the marine environment are identified at this stage. As full decommissioning will require a separate EIA process, potential issues related to this phase will not be dealt with further in this report.

4.3. Geophysical Surveying of the Cable Route

Although the geophysical surveying of the cable route has already been undertaken, it is discussed and assessed briefly below for the sake of completeness and in the event that portions of the proposed cable route may need to be re-surveyed for some reason.

Noise propagation represents energy travelling either as a wave or a pressure pulse through a gas or a liquid. Due to the physical differences between air and water (density and the speed at which sound travels), the decibel units used to describe noise underwater are different from those describing noise in air. Furthermore, hearing sensitivities vary between species and taxonomic groups. Underwater noise generated by drilling activities is therefore treated separately from noise generated in the air.

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation (see references in McCauley 1994). Such acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean can thus be expected to interfere directly or indirectly with such activities thereby affecting the physiology and behaviour of marine organisms (NRC 2003). Natural ambient noise will vary considerably with weather and sea state, ranging from about 80 to 120 dB re 1 µPa (Croft & Li 2017). Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 dB re 1 µPa at 1 m (NRC 2003). Especially at low frequencies between 5 to 100 Hz, vessel traffic is a major contributor to noise in the world's oceans, and under the right conditions, these sounds can propagate 100s of kilometres thereby affecting very large geographic areas (Coley 1994, 1995; NRC 2003; Pidcock *et al.* 2003). Other forms of anthropogenic noise include 1) multi-beam sonar systems, 2) seismic acquisition, 3) hydrocarbon and mineral exploration and recovery, and 4) noise associated with underwater blasting, pile driving, and construction (Figure 41).

The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern (Koper & Plön 2012), as such sound sources interfere directly or indirectly with the animals' biological activities. Reactions of marine mammals to anthropogenic sounds have been reviewed by McCauley (1994), Richardson *et al.* (1995), Gordon & Moscrop (1996) and Perry (1998) (amongst others), who concluded that anthropogenic sounds could affect marine animals in the surrounding area in the following ways:

- Physiological injury and/or disorientation;
- Behavioural disturbance and subsequent displacement from key habitats;
- Masking of important environmental sounds and communication;

- Indirect effects due to effects on prey.

It is the received level of the sound, however, that has the potential to traumatise or cause physiological injury to marine animals. As sound attenuates with distance, the received level depends on the animal's proximity to the sound source and the attenuation characteristics of the sound.

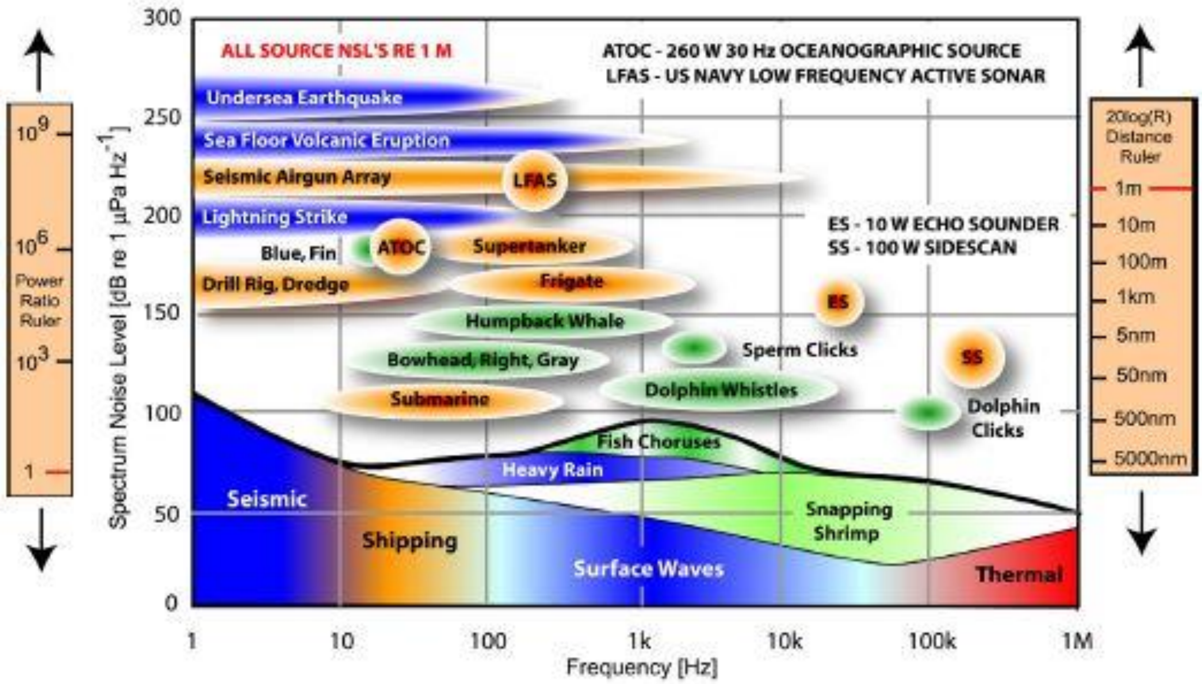

Figure 41: Comparison of noise sources in the ocean (Goold & Coates 2001).

The survey vessel would be equipped with a high to very high resolution multi-beam echo sounder (MBES), sub-bottom profiler and side scan sonar. This equipment emits a fan of acoustic beams from a transducer at frequencies ranging from 12 – 850 kHz[1] and typically produce maximum sound levels in the order of 190 to 240 dB re 1 µPa at 1 m. The operating frequencies falls into the high frequency kHz range, and are thus beyond the low frequency hearing ranges of fish species and sea turtles (from below 100 Hz to up to a few kHz) (Table 8). The high frequency active sonar sources, however, have energy profiles that clearly overlap with cetaceans' hearing sensitivity frequency range, particularly for cetaceans of High Frequency and Very High Frequency hearing groups, and would be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels. The noise emissions from the geophysical sources are highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction. The noise impact would therefore be highly localised for the majority of marine mammal species. As surveys using the

1 Low frequency MBES (12-50 kHz) are designed for deep water (4,000 – 6,000 m) and intermediate depths and continental slopes. Medium- (70-150 kHz) and high-frequency (>200 kHz) MBES are designed for shallow to intermediate depths and ultrashallow depths (few metres to tens of metres), respectively (Lurton 2015).

Table 8: Known hearing frequency ranges of various marine taxa (adapted from Koper & Plön 2012; Southall *et al*. 2019).

Taxa	Order	Hearing frequency (kHz)
Shellfish	Crustaceans	0.1 – 3
Fish	Teleosts	
Hearing specialists		0.03 - >3
Hearing generalists		0.03 – 1
Sharks and skates	Elasmobranchs	0.1 – 1.5
African penguins	Sphenisciformes	0.6 - 15
Sea turtles	Chelonia	0.1 – 1
Seals and sea lions	Pinnipeds	0.75 – 75
Low Frequency Cetaceans	Mysticetes	0.007 – 22
High-frequency Cetaceans	Odontocetes	0.15 – 160
Very High-Frequency Cetaceans	Odontocetes	0.2 - 180

MBES, sub-bottom profiling and side sacan sonar sources have much lower noise emissions compared with seismic airgun sources, no specific considerations have been put in place in developing assessment criteria for these. Despite being audible by most marine mammals, the emission of underwater noise from geophysical surveying is not considered to be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals (Burkhardt *et al*. 2008; Lurton 2010; Lurton 2015). Whereas behavioural effects (e.g. avoidance of the source) have been reported, there has been no evidence of physical damage (i.e. Permanent Threshold Shifts (PTS) and Temportary Threshold Shifts (TTS)) (Childerhouse *et al*. 2016). Recent sound transmission loss modelling studies undertaken for MBES surveys to depths of 3,600 m off the edge of the Agulhas Bank (Li & Lewis 2020) have predicted that marine mammals of all hearing groups except very-high-frequency cetaceans would experience PTS effect within 10 m from the MBES source, whereas for very-high-frequency cetaceans the maximum zones of PTS effect occurs within ~70 m from the MBES source along the cross-track direction. The zones of TTS due to a single pulse exposure for marine mammals of all hearing groups except very-high-frequency cetaceans are predicted to be within approximately 25 m from the MBES source, extending to within 140 m from the MBES source along the cross-track direction for very-high frequency cetaceans. Therefore, only directly below or within the sonar beam would received sound levels be in the 240 dB range where exposure would result in trauma or physiological injury. Furthermore, as the anticipated radius of influence of a multi-beam sonar is significantly less than that for a seismic airgun array, the statistical probability of crossing a cetacean or pinniped with the narrow multi-beam fan several times, or even once, is very small. As most pelagic species likely to be encountered along the cable route are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur.

Due to the extremely strong source directivity characteristics, the sound energy emissions from individual MBES pulses at cross-track directions are expected to dominate cumulative sound energy exposure at receiving locations. Very high-frequency cetaceans (e.g. Heaviside's dolphins, pygmy sperm whale, dwarf sperm whale) were predicted to have the highest zones of impact for cumulative PTS and TTS, being in the order of 400 m and 1,200 m, respectively. However, as these are limited to cross-track directions, the actual impact footprints are significantly smaller than with omnidirectional noise emissions. For cetaceans of other hearing groups and for seals, no PTS impact was predicted. For Low Frequency and High Frequency cetaceans (baleen whales and most delphinids and beaked whales, respectively), the cumulative sound exposure impact was predicted to be highly localised around the MBES source location, with the highest impact zone being <100 m from the source.

The underwater noise from the survey systems may, however, induce localised behavioural changes in some marine mammal. The maximum impact distance for behavioural disturbance caused by the immediate exposure to individual sonar MBES pulses was predicted to be within ~2 km from the MBES source for marine mammals of all hearing groups, at cross-track directions. Evidence of significant behavioural changes that may impact on the wider ecosystem is lacking (Perry 2005).

Given the evidence available from the scientific literature and the results of sound transmission loss modelling, the effects of high frequency sonars on marine fauna is considered to be of low intensity, localised along the cable route and short-term (for duration of survey i.e. weeks). Any behavioural or physiological impacts on marine fauna would be fully reversible and consequently the impact is considered of **VERY LOW** significance both without and with mitigation.

Mitigation Measures

Despite the low significance of impacts for geophysical surveys, the Joint Nature Conservation Committee (JNCC) provides a list of guidelines to be followed by anyone planning marine sonar operations that could cause acoustic or physical disturbance to marine mammals (JNCC 2017). These have been revised to be more applicable to the southern African situation.

- Onboard Marine Mammal Observers (MMOs) should conduct visual scans for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses.
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
- “Soft starts” should be carried out for any equipment of source levels greater than 210 dB re 1 μPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the area.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- Avoid planning geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of June to end of November), and ensure that migration paths are not blocked by sonar operations. As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended.
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place at night or between June and November.
- A dedicated MMO and PAM operator should be appointed to ensure compliance with mitigation measures during seismic geophysical surveying. The MMO can be either an independent MMO or a suitably trained crew member.

The mitigation measures recommended above are considered industry best-practice and have become accepted by the authorities as the norm.

Impacts of multi-beam and sub-bottom profiling sonar on marine fauna		
Characteristic	Impact	Residual Impact
Intensity	Low	Low
Duration	Short-term; for duration of survey	Short-term
Extent	Local: limited to within the path of the subsea cable route, but with indirect effects on adjacent areas	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Improbable	Improbable
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4. Installation of the Subsea Cable

Construction phase impacts associated with the installation of the subsea cable are discussed below.

4.4.1 Disturbance of the Coastal Zone[2]

Installation of the subsea cable through the surf-zone and across the beach would require the subsea cable to be buried to sufficient depth to ensure it is not exposed during seasonal variation of the beach levels. If rock substrate is encountered at sediment depths shallower than the target 2 m burial depth, rock trenching will be undertaken to a water depth of approximately 0.5 – 1 m to bury the cable. This would involve using a cutter-head and/or jack hammers to excavate a 30-cm wide trench in the rock to a depth of ~30 cm thereby allowing the cable to be installed below the natural rock profile. Once the cable has been installed, the excavated channel would be backfilled with the rock cuttings and mixed with a cement suitable for the marine environment.

Likewise, installation and burial of the sea earth plate and earth cable would require excavation of beach sediments. Excavated sandy material would be disposed of onto the beach and into the surf-zone down-current of the construction site. Subtidal trenching would result in the mobilisation and redistribution of sediments in tidal currents and the littoral drift. This would result in localised increased suspended sediment concentrations in the water column. Where burial cannot be achieved and additional cable protection is required, an articulated split-pipe may be used to maximise cable security. The trenching and cable burial process would result in disturbance of high shore, intertidal and shallow subtidal sandy beach habitats and their associated macrobenthic communities through displacement, injury or crushing.

2 The coastal zone is defined as the coastal strip from 500 m inland of the high water mark to the 30 m depth contour (Sink *et al*. 2012).

Although the activities on the shore and in the shallow subtidal regions would be localised and confined to within a few 10s of metres of the construction site and cable shore-crossing route, the benthic biota would be damaged or destroyed through moving of equipment and machinery and the general activities of contractors around the construction site. Mobile organisms such as fish and marine mammals, on the other hand, would be capable of avoiding the construction area. Any shorebirds feeding and/or roosting in the area would also be disturbed and displaced for the duration of construction activities (see assessment by Smallie 2021).

The invertebrate macrofauna inhabiting these beaches are all important components of the detritus / beach-cast seaweed-based food chains, being mostly scavengers, particulate organic matter and filter-feeders (Brown & McLachlan 1994). As such, they assimilate food sources available from the detritus accumulations typical of this coast and, in turn, become prey for surf-zone fishes and migratory shorebirds that feed on the beach slope and in the swash zone. By providing energy input to higher trophic levels, they are all important in nearshore nutrient cycling, and significant reduction or loss of these macrofaunal assemblages may therefore have cascade effects through the coastal ecosystem (Dugan *et al*. 2003).

On a high-energy coastline the recovery of the physical characteristics of intertidal and shallow subtidal unconsolidated sediments to their pre-disturbance state following trenching and cable burial will occur within a few tidal cycles under heavy swell conditions, and will typically result in subsequent rapid recovery of the invertebrate epifaunal and infaunal communities to their previous state. Previous studies on the impact of cofferdam and larger-scale seawall mining on macrofaunal beach communities identified that the physical state of beaches on the South Coast is entirely driven by natural conditions, and is not affected (except during the actual disturbance) in the medium- to long-term (Pulfrich *et al*. 2004; Pulfrich *et al*. 2015). Removal of beach sands results in a significant, yet localised and short-term decrease in macrofaunal abundance and biomass. Intertidal beach macrofauna appear to be relatively tolerant to disturbance, and re-colonization of disturbed areas is rapid (van der Merwe & van der Merwe 1991; Brown & Odendaal 1994; Newell *et al*. 1998; Peterson *et al*. 2000; Schoeman *et al*. 2000; Seiderer & Newell 2000; Nel *et al*. 2003). Impacted areas are initially colonized by small, abundant and opportunistic pioneer species with fast breeding responses to tolerable conditions (e.g. crustaceans and polychaetes). If, following the disturbance, the surface sediment is similar to the original surface material, and if the final long-term beach profile has similar contours to the original profile, the addition or removal of layers of sand does not have enduring adverse effects on the sandy beach benthos (Hurme & Pullen 1988; Nel & Pulfrich 2002; Nel *et al*. 2003).

Provided the construction activities are all conducted concurrently, the duration of the construction disturbance should be limited to a few weeks. Disturbed subtidal communities within the wave base (<40 m water depth) might recover even faster (Newell *et al*. 1998). However, while recovery of the intertidal and subtidal communities is rapid, physical alteration of the shoreline in ways that cannot be remediated by swell action, such as deposition of large piles of pebbles and boulders, can be more or less permanent. Whilst the construction activities associated specifically with the cable installation are unlikely to have a significant effect at the ecosystem level, the cumulative effects of increasing development along this stretch of coast must be kept in mind.

The impacts on benthic communities as a result of cable installation through the littoral zone would be of medium intensity. Impacts would, however, be once-off and highly localised, being restricted to an ~10 m wide strip through the intertidal and surf-zone. Impacts would be expected to endure over the short-term only as communities within the wave-influenced zone are adapted to frequent natural disturbances and recover relatively rapidly. Although the subsea cable routing passes through inshore benthic habitats identified as 'vulnerable' (Eastern Agulhas Bay, Agulhas Inner Shelf Mosaic, Agulhas Sandy Outer Shelf and Agulhas Coarse Sediment Shelf Edge) and 'near threatened (Agulhas Sandy Mid Shelf) the loss of resources would be low and impacts would be fully reversible. The shore crossing itself passes through Agulhas Dissipative-Intermediate Sandy Shore, which is identified as of 'least concern'. Disturbance of intertidal and shallow subtidal benthic organisms will definitely occur, but the potential impacts of the cable's shoreline crossing on benthic organisms is deemed to be of **LOW** significance without mitigation.

If boulders are encountered on the beach, Horizontal Directional Drilling (HDD) is being considered as an alternative method to install the cable through the shallow water environment. The undersea tunnel would be bored from the land to the sea and all material would be removed on the landward side for disposal. Following drilling of the pilot borehole to a predetermined offshore location, the borehole would be enlarged with a reamer and the cable would be pulled back through the borehole (i.e. from the offshore location onto land). Intertidal and shallow subtidal habitats would thus not be affected at all as the borehole would pass well below the seabed before surfacing out of the seabed at an offshore location. At the seaward end of the borehole, emergence of the drill bit and reamer would result in localised increased suspended sediment concentrations in the water column, and potential highly localised smothering of seabed communities by re-depositing sediments. A rock berm or concrete collar would be constructed where the cable enters the seabed to aid in stabilisation. This would crush any biota in the highly localised footprint of the berm/collar, but the berm/collar itself would provide an alternative substrate for colonisation by benthic organisms. The potential impacts of the HDD exit hole on benthic organisms is deemed to be INSIGNIFICANT.

Mitigation Measures

As standard industry practice, the routing of the proposed subsea cable should be planned to as far as practicably possible avoid sensitive benthic habitats in the coastal and nearshore zone.

The following essential mitigation measures should be implemented:

- Obtain a vehicle access permit from DEA (Branch Oceans and Coasts) prior driving in the coastal zone.
- Restrict disturbance of the intertidal and subtidal areas to the smallest area possible. Once the shore crossing is finalised and the associated construction site is determined, the area located outside of the site should be clearly demarcated and regarded as a 'no-go' area.

The following best-practice mitigation measures are recommended:

- As far as practicably possible, and subject to feasibility, make HDD the preferred option for the cable shore crossing, thereby avoiding damage to intertidal and shallow subtidal habitats by trenching or anchoring of the cable on the seabed.
- Restrict rock trenching to the minimum required to ensure the cable is suitably protected should storm-induced sand deflation result in the exposure of the underlying rock shelves.
- As far as practicable, ensure that construction activities required for subsea cable installation occur concurrently thereby minimizing the disturbance duration in the coastal and nearshore zone;

- Restrict traffic in the intertidal area to the minimum required;
- Restrict traffic to clearly demarcated access routes and construction areas only. These areas should be defined in consultation with the Environmental Control Officer (ECO);
- Have good house-keeping practices in place during construction, specifically waste management; and
- No accumulations of excavated sediments or rock stockpiles should be left above the high water mark. Any substantial sediment accumulations below the high water mark should be levelled to follow the natural profile.

Disturbance and destruction of sandy beach biota during trench excavation and subsea cable installation		
Characteristic	Impact	Residual Impact
Intensity	Medium	Medium
Duration	Short-term; recovery is expected within 2-5 years	Short-term
Extent	Local: limited to within a few metres of the subsea cable route, but with indirect effects on adjacent areas	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Definite	Definite
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.2 Disturbance of nearshore Benthic Habitats

Trenching of the subsea cable in the littoral zone beyond 10-15 m depth would result in the mobilisation and redistribution of sediments in tidal currents and the littoral drift. This would result in localised increased suspended sediment concentrations in the water column. Where burial cannot be achieved and additional cable protection is required, an articulated split-pipe may be used to maximise cable security. Within the wave-base (0 – 50 m), the subsea cable and/or articulated split-pipes may be held in place with saddle clamps at specific locations. This would require drilling into the bedrock to secure the clamps. The subsea cable burial and/or securing process would result in disturbance of subtidal unconsolidated sediments and their associated macrobenthic communities through displacement, injury or crushing.

Although the activities in the subtidal regions would be localised and confined to within a few metres of the subsea cable route, the benthic biota would be disturbed, damaged or destroyed through displacement of sediments during trenching and subsea cable burial. Mobile organisms such as fish and marine mammals, on the other hand, would be capable of avoiding the construction area. Any seabirds feeding in the area may also be disturbed and displaced for the duration of construction activities (see assessment by Smallie 2021).

Once the subsea cable has been buried, the affected seabed areas would, with time, be recolonised by benthic macrofauna. The ecological recovery of the disturbed sea floor is generally defined as the establishment of a successional community of species, which progresses towards a community that is similar in species composition, population density and biomass to that previously present (Ellis 1996; Ellis & Garnett 1996; Ellis 2000). In general, communities of short-lived species and/or species with a high reproduction rate (opportunists) may recover more rapidly than communities of slow growing, long-lived species. Opportunists are usually small, mobile, highly reproductive and fast growing species and are the early colonisers. Sediments in the nearshore wave-base regime, which are subjected to frequent disturbances, are typically inhabited by these opportunistic species (Newell *et al*. 1998). Recolonisation will start rapidly after cessation of trenching, and species diversity and abundance may recover within short periods (weeks) whereas biomass often remains reduced for several years (Kenny & Rees 1994, 1996). Disturbed subtidal communities within the wave base (<40 m water depth) and in areas of substantial longshore sediment drift might recover even faster (Newell *et al*. 1998; Porter-Smith *et al*. 2004; Sherwood *et al*. 2016). Although recovery is site specific and dependent on different modes of cable burial and varied sediment environments, Kraus and Carter (2018) reported that on the inner and middle shelf, recovery of benthic communities following cable burial by plough typically occurs within 1-2 years (see also Grannis 2005; Sherwood *et al*. 2016). From their study they concluded that the physical presence of the cable and the disturbance caused by its burial had little effect on the benthic communities along the cable route.

The impacts of trenching and increased suspended sediments on benthic communities within and beyond the surf-zone as a result of the subsea cable installation would be of medium intensity. Impacts would be once-off and highly localised, being restricted to within a few metres of the cable trench and subsea cable route, possibly extending to immediately adjacent areas. Impacts would be expected to endure over the short-term only as communities within the wave-influenced zone are adapted to frequent natural disturbances and recover relatively rapidly. Although the subsea cable route passes through nearshore benthic habitats identified as 'vulnerable' (Eastern Agulhas Bay, Agulhas Inner Shelf Mosaic), the loss of resources would be low and impacts would be fully reversible. Using the total available areas provided for the various marine ecosystem types (Sink *et al*. 2019), and assuming a worst-case disturbance footprint of 5 m wide, the proportion of vulnerable Agulhas Inner-Shelf Mosaic habitat affected by the subsea cable installation was calculated at 0.0007% and that for Eastern Agulhas Bay habitat at 0.002% of the total 1,854 km^2 and 1,631 km^2 available for these 'vulnerable' nearshore habitats, respectively. This disturbance of benthic habitats can be considered negligible in relation to the available habitat areas. The potential impacts of cable installation on benthic organisms in the nearshore environments is consequently deemed to be of **LOW** significance without mitigation.

Mitigation Measures

As standard industry practice, the routing of the proposed subsea cable should be planned to as far as practicably possible avoid sensitive benthic habitats in the nearshore zone.

Disturbance and destruction of nearshore biota during trench excavation and cable installation		
Characteristic	**Impact**	**Residual Impact**
Intensity	Medium	Medium
Duration	Short-term; recovery is expected within 2-5 years	Short-term
Extent	Local: limited to within a few metres of the subsea cable route, but with indirect effects on adjacent areas	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Probable	Probable
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.3 Disturbance of Offshore Habitats

The grapnel used during the pre-lay grapnel run, and the subsea cable plough and/or tracked jet-trenching/burial ROV implemented during subsea cable laying would result in the disturbance and turnover of unconsolidated sediments along a swath of seabed. The extent of disturbed seabed depends on the cable laying method used (i.e. ploughing or jetting), which in turn depends on the nature of the sea-floor. Each method results in different spatial and temporal scales of damage (Kraus & Carter 2018; Taormina *et al*. 2018). Ploughs are usually 2–8 m wide, mounted on skids, wheels or caterpillar tracks, and are towed by a cable laying ship. The plough blade disturbs a swath of seabed ≤1 m wide but potentially extending to a depth of 3 m. The excavated sediment is allowed to fall back into the furrow once the cable has been laid (Kraus & Carter 2018; Taormina *et al*. 2018). Any epifauna or infauna associated with the disturbed sediments are likely to be displaced, damaged or destroyed. Similarly, the plough skids would injure or crush benthic invertebrates in their path. Mobilisation and redistribution of sediments in near-bottom currents during cable burial would result in localised increased suspended sediment concentrations near the seabed and in the water column (see Section 4.4.5).

In contrast, during jetting the seabed is liquified to allow the cable to settle in the trench, with burial occuring through the redeposition of sediments out of the slurry. Although the jetted trench is also typically ≤1 m wide, sediment disturbance is extensive and redeposition can spread to 100s of metres from the trench, with plumes of the suspended mud fractions potentially extending to 2 km from the cable route, thereby creating a larger impact footprint (Kraus & Carter 2018).

As the cable is typically only 25 mm[3] – 200 mm[4] in diameter the disturbance associated with laying it

[3] un-armoured cable at depths >900 m.

[4] armoured cable in the littoral zone, including articulated split-pipes.

on top of the sediment or consolidated substrate is limited to the footprint of the cable itself and any protective encasing material. Impacts associated with placing the cable directly onto the seabed include crushing, damaging or displacement of oarganisms (Dunham *et al.* 2015; Taormina *et al.* 2018). Unless cables traverse habitats supporting vulnerable slow-growing species (e.g. glass sponges, deep-water corals) (see for example Dunham *et al.* 2015), the loss of substratum would, however, be temporary the cable itself would provide an alternative substratum for colonising benthic communities or provide shelter for mobile invertebrates (see Section 4.4.6). Where the subsea cable is exposed, colonisation of the cable would commence within a few weeks. Studies from elsewhere have determined that benthic macro- and mega-fauna within 0–100 m of trenched and surface-laid cables showed negligible changes in abundance and distribution following cable installation (Kogan *et al.* 2006; Kuhnz *et al.* 2015).

Once the cable has been laid, the affected seabed areas around the cable would with time be recolonised by benthic macrofauna, with the encrusting epifauna resembling that inabiting natural reefs in the area. The rate of recovery/re-colonisation depends largely on the type of community that inhabits the affected benthic habitats, the extent to which the community is naturally adapted to high levels of disturbances, the sediment character (grain size) and physical factors such as depth and exposure (waves, currents) (Newell *et al.* 1998; Herrmann *et al.* 1999).

Communities of short-lived species with a high reproduction rate tend to recover more rapidly than communities of slow growing, long-lived species. Recolonisation takes place by passive translocation of animals during storms or sediment influx from nearby unaffected areas, active immigration of mobile species, and immigration and settlement of pelagic larvae and juveniles (Hall 1994; Kenny & Rees 1994, 1996; Herrmann *et al.* 1999; Ellis 2000). More stable deep-water habitats are typified by large, often burrowing, slow growing and long-lived species (Newell *et al.* 1998). As long-lived species need longer to re-establish the normal age and size structure of the population, biomass often remains reduced for several years (Kenny & Rees 1994, 1996; see also Duna *et al.* 2016; Biccard *et al.* 2016, 2017, 2018, 2019).

It must be kept in mind, however, that re-colonisation is a site specific process, with the recovery time and resulting community structure being dependent not only upon sediment characteristics, but also local hydrodynamic conditions (Morton 1977; van der Veer *et al.* 1985) and depth. In deep water benthic community recovery rates are appreciably slower than in shallower areas subject tostrong swell or current effects. Recovery of benthic macrofaunal communities following diamond mining in 80-150 m depth off the southern African West Coast has been demonstrated to occur within eight years (Duna *et al.* 2016), but at depths excess of 1,000 m, re-colonization of disturbed seabeds to conditions similar to undisturbed areas is thought to take decades (Foell *et al.* 1990, 1992a, 1992b, Thiel & Schriever 1994; Schriever *et al.* 1997; Schratzberger & Warwick 1999). In contrast, recovery of shallow water (<30 m depth) sandy seabed communities can occur within 1 year following disturbance (Saloman *et al.* 1982; Hall & Harding 1997). Provided the sediment characteristics of the areas disturbed along the cable route are not dramatically altered, full recovery of such communities on the continental shelf following disturbance by the grapnel and cable plough would be expected within 5-10 years (Lopez-Jamar *et al.* 1995; Ellis & Garnett 1996; Kaiser *et al.* 1996). Studies on recovery of the seabed and associated benthic communities in deeper water also reported impacts persisting for as long as 15 years (Grannis 2005; Kuhnz *et al.* 2015), with recovery depending upon depositional rates of suspended load and bed load. The impacts assocated with cable burial are, however, a once-off disturbance, with affected communities able to recover naturally following the cable installation. NOAA (2005) noted that a single impact such as a cable burial, is preferred to continuous, multiple or recurring impacts such as those associated with, for example, a demersal trawl.

The potential direct impacts on benthic organisms of crushing and sediment disturbance would be of medium intensity and once off (unless cable repair is necessary). Although the cable will extend along some 11,500 km of seabed, benthic impacts will be highly localised along the length of the subsea cable route. Impacts would be limited to the medium-term only as recolonisation of disturbed sediments from adjacent areas would occur within a year, but full recovery to functional similarlity can take longer (medium- to long-term). The change in habitat from unconsolidated sediments to the hard sustratum of the cable itself would, however, be permenent. Although the subsea cable route passes through offshore benthic habitats identified as 'vulnerable' (Agulhas Sandy Outer Shelf and Agulhas Coarse Sediment Shelf Edge) and 'near threatened' (Agulhas Sandy Mid Shelf) the loss of resources would be low and impacts would be partially reversible as unconsolidated habitat will be replaced by hard substratum in areas where the cable is not buried. Furthermore, the proportion of vulnerable habitat affected by the subsea cable installation can be considered negligible in relation to the available habitat area. Using the total available areas provided for the various marine ecosystem types (Sink *et al*. 2019), and assuming a worst-case disturbance footprint of 5 m wide, the cable would disturb 0.004% and 0.002% of the 'vulnerable' Agulhas Sandy Outer Shelf and Agulhas Coarse Sediment Shelf Edge habitats. For the Agulhas Sandy Mid Shelf, which is considered 'near threatened', the disturbance footprint of the cable installation would amount to 0.006% of the available habitat.

Consequently, the potential impacts on benthic organisms of cable installation across the continental shelf and abyss is deemed to be of **LOW** significance without mitigation. The elimination of marine benthic communities in the structural footprint of the cable is an unavoidable consequence of the installation of subsea cables, and no direct mitigation measures, other than the no-project option, are possible. Impacts will, however, be temporary as recolonisation of disturbed sediments from adjacent areas will occur within a few weeks.

Mitigation Measures

As standard industry practice, the routing of the proposed subsea cable should be planned to as far as practicably possible avoid sensitive deepwater benthic habitats.

Disturbance and destruction of offshore benthic biota during cable laying		
Characteristic	**Impact**	**Residual Impact**
Intensity	Medium	Medium
Duration	Medium- to Long-term: recovery of deep-water benthos can be expected within 10 years	Medium-term
Extent	Site specific: limited to the subsea cable route	Site specific
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Definite	Possible
Reversibility	Partially reversible	Fully reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.4 Increase in Noise

During installation of the subsea cable shore-crossing, noise and vibrations from excavation machinery and rock trenching operations may have an impact on surf-zone biota, marine mammals and shore birds in the area. Noise levels during construction are generally at a frequency much lower than that used by marine mammals for communication (Findlay 1996), and these are therefore unlikely to be significantly affected. Additionally, the maximum radius over which the noise may influence is very small compared to the population distribution ranges of surf-zone fish species, resident cetacean species and shore birds. Both fish and marine mammals are highly mobile and should move out of the noise-affected area (Findlay 1996). Similarly, shorebirds and terrestrial biota are typically highly mobile and would be able to move out of the noise-affected area. However, birds that nest and breed on beaches (e.g. African Black Oystercatcher) would be particularly susceptible to disturbance and noise from pedestrian traffic and construction activities on the beach.

Further offshore, underwater noise generated during subsea cable installation could affect a wide range of fauna; from benthic invertebrates and demersal species residing on the seabed along the subsea cable route, to those invertebrates and vertebrates occurring throughout the water column and in the pelagic habitat near the surface. Due to their hearing frequency ranges, the taxa most vulnerable to noise disturbance are turtles, pelagic seabirds, large migratory pelagic fish, and both migratory and resident cetaceans.

The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern (Koper & Plön 2012). The sound level generated by the subsea cable laying vessel and subsea apparatus would fall within the hearing range of most fish and marine mammals, and would be audible for considerable ranges (in the order of tens of kms) before attenuating to below threshold levels. However, the noise is not considered to be of sufficient amplitude to cause direct physical injury or mortality to marine life, even at close range. The underwater noise may, however, induce localised behavioural changes or masking of biologically relevant sounds in some marine fauna (see also Elwen 2021). As much of the cable route is aligned with the main offshore shipping lanes that pass around southern Africa, the vessel noise component of the ambient noise environment is expected to be significant along the cable route. Given the significant local shipping traffic and relatively strong metocean conditions specific to the area, ambient noise levels are expected to be 90 - 130 dB re 1 μPa for the frequency range 10 Hz – 10 kHz (SLR Consulting Australia 2019). The noise generated by the cable laying vessel would be no different from that of other vessel traffic throughout the oceans, and from the point of vessel operations no specific mitigation (e.g. avoidance of marine mammal migration periods) is therefore deemed necessary when the vessel is in high seas waters.

Disturbance and injury to marine biota due to construction noise or noise generated by the vessel and cable plough is thus deemed of low magnitude within the immediate vicinity of the construction site/subsea cable route, with impacts persisting over the short-term only. In both cases impacts are fully reversible once construction and subsea cable installation operations are complete. Without mitigation, the direct impacts of construction and vessel noise are therefore assessed to be of **VERY LOW** significance, respectively. As the noise associated with construction and subsea cable installation is unavoidable, no direct mitigation measures, other than the no-project alternative, are possible. Impacts of construction noise can, however, be kept to a minimum through responsible construction practices.

Mitigation Measures

The following best-practice mitigation measures are recommended:

- If cable installation across the continental shelf is scheduled during the whale migration period (beginning of June to end of November), consideration will be required from the cable-laying vessel to appoint a suitably trained crew member as a dedicated Marine Mammal Observer (MMO) with experience in seabird, turtle and marine mammal identification and observation techniques, to carry out daylight observations of the subsea cable route and record incidence of marine mammals, and their responses to vessel activities. Data collected should include position, distance from the vessel, swimming speed and direction, and obvious changes in behaviour (eg, startle responses or changes in surfacing/diving frequencies, breathing patterns). Both the identification and the behaviour of the animals must be recorded accurately.

Disturbance and avoidance behaviour of surf-zone fish communities, shore birds and marine mammals through coastal construction noise and offshore cable installation noise		
Characteristic	Impact	Residual Impact
Intensity	Low	Low
Duration	Temorary (Short): for duration of shore-crossing installation and construction	Temporary
Extent	Local: limited to the construction site and around the cable vessel	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Possible	Possible
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	Very Low	

Behavioural changes and masking of biologically significant sounds in Marine Fauna due to noise from cable installation operations		
Characteristic	Impact	Residual Impact
Intensity	Low	Low
Duration	Temorary (Short): for duration of shore-crossing installation and construction	Short-term
Extent	Local: limited to the construction site and around the cable vessel	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Possible	Possible
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.5 Increased Turbidity

The disturbance and turnover of sediments during the pre-lay grapnel run and during trenching will result in increased suspended sediments in the water column and physical smothering of biota by the re-depositing sediments. The effect of sediment plumes generated by cable burial on the resident biota depends upon several variables including (i) the mode of burial (jetting will produce more suspended sediment than ploughing), (ii) sediment type (mud produces longer-lived plumes compared to sand and gravel), (iii) rate of plume dispersal by waves and currents and (iv) the response of the biota to increased turbidity (e.g. Gooding *et al.* 2012; Meißner *et al.* 2006). Generally, plumes tend to be short-lived when mainly sandy deposits of the inner shelf are ploughed as the coarse sediment grain-size will encourage rapid deposition close to the trench (Swanson *et al*. 2006; Gooding *et al*. 2012; Taormina *et al*. 2018). In contrast, cable burial in mid-to outer shelf and upper slope mud deposits will generate sediment plumes that have the potential to last for days due to the fine grain-size, with active shelf currents, especially along the shelf edge, affecting plume stability and dilution and potentially distributing suspended sediments up to 2 km from the trench (Gooding *et al*. 2012).

The effects of elevated levels of particulate inorganic matter and depositions of sediment have been well studied, and are known to have marked, but relatively predictable effects in determining the composition and ecology of intertidal and subtidal benthic communities (e.g. Zoutendyk & Duvenage 1989, Engledow & Bolton 1994, Iglesias *et al*. 1996, Slattery & Bockus 1997). Increased suspended sediments in the surf-zone and nearshore can potentially affect light penetration and thus phytoplankton productivity and algal growth, whereas further offshore it can load the water with inorganic suspended particles, which may affect the feeding and absorption efficiency of filter-feeders. The increase accurrence of turbidity plumes near the surface can also affect the feeding success of visual predators (Simmons 2005; Braby 2009; Peterson *et al*. 2001). For example, the foraging areas of African Penguins and Cape Gannets overlaps with the section of the cable crossing south of St Croix Island (Pichegru *et al*. 2010) and suspended sediment plumes generated during cable installation could affect foraging success. However, due to the rapid dilution and widespread dispersion of settling particles, any adverse effects in the water column would be ephemeral and highly localised. Any biological effects on nectonic and planktonic communities would be negligible (Aldredge *et al*. 1986). Turbid water is a natural occurrence along the Southern African coast, resulting from aeolian and riverine inputs, resuspension of seabed sediments in the wave-influenced nearshore areas and seasonal phytoplankton production in the upwelling zones.

The impact of the sediment plume is thus expected to be relatively localised and temporary (only for the duration of pre-lay, construction and trenching activities below the low water mark). As the biota of sandy and rocky intertidal and subtidal habitats in the wave-dominated nearshore areas of southern Africa are well adapted to high suspended sediment concentrations, periodic sand deposition and resuspension, impacts are expected to occur at a sublethal level only. Considering the extended ranges over which visual predators such as seabirds feed, localised suspended sediment plumes are not expected to effect their feeding efficiency in any way.

Rapid deposition of material from the water column and direct deposition of excavated sands on adjacent areas of seabed may result in the physical smothering of resident biota by the depositing sediments. Some mobile benthic animals inhabiting soft-sediments are capable of migrating vertically through more than 30 cm of deposited sediment (Maurer *et al*. 1979; Newell *et al*. 1998; Ellis 2000; Schratzberger *et al*. 2000a, 2000b). Sand inundation of shallow-water reef habitats was found to directly affect species diversity, whereby community structure and species richness appears to be controlled by the frequency, nature and scale of disturbance of the system by sedimentation (Seapy & Littler 1982; Littler *et al*. 1983; Schiel & Foster 1986, McQuaid & Dower 1990, Santos 1993, Airoldi & Cinelli 1997 amongst others). For example, frequent sand inundation may lead to the removal of grazers, thereby resulting in the proliferation of algae (Hawkins & Hartnoll 1983; Littler *et al*. 1983; Marshall & McQuaid 1989; Pulfrich *et al*. 2003a, 2003b; Pulfrich & Branch 2014).

Elevated turbidity is thought to negatively affect squid spawning and the survival of paralarvae, as visual cues are important in the formation of spawning aggregations; and paralarvae movement, respiration and feeding are constrained by high turbidity with mortality expected at above 20 mg/l (Roberts & Sauer 1994). During natural high turbidity events squid move to offshore spawning grounds (Roberts & Sauer 1994). As the cable routing passes within ~400 m of a known spawning area at Cape Recife, and the prevailing nearshore currents tend to flow in a southerly direction (Dawson *et al*. 2019) there is a risk that sediments suspended during the cable installation process may result in adverse effects on this spawning area.

Elevated suspended sediment concentrations due to trenching and burial activities associated with the subsea cable installation is, however, deemed of low intensity and would extend locally around the subsea cable route and down-current of the shore-crossing, with impacts persisting only temporarily. Within the wave-base at least, marine biota are typically adapted to periods of elevated turbidity and as suspended sediment concentrations would remain at sub-lethal levels, the loss of resources would be low and impacts would be fully reversible. The impact is therefore assessed to be of **VERY LOW** significance without mitigation. As elevated suspended sediment concentrations are an unavoidable consequence of trenching activities, no direct mitigation measures, other than the no-project alternative, are possible. In the intertidal and shallow subtidal zone, impacts can however be kept to a minimum through responsible construction practices.

Mitigation Measures

No mitigation other than the no-go option is deemed feasible or necessary.

The following best-practice mitigation measures is recommended:

- As far as practicably possible, avoid cable installation at the shore crossing during the peak squid spawning period between September and December.

Reduced physiological functioning of marine organisms due to increased turbidity in surf-zone as a result of excavations and mobilising of sediments

Characteristic	Impact	Residual Impact
Intensity	Low	Low
Duration	Temporary; suspended sediment plumes will rapidly dissipate	Temporary
Extent	Local: limited to within a few metres of the subsea cable route, but with indirect effects on adjacent areas	Local
Frequency	Intermittent during trenching	Intermittent
Loss of resource	Low	Low
Probability	Possible	Possible
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.6 Physical Presence of Subsea Cable

Although the cable is typically only 25 mm – 200 mm in diameter, its presence and that of any protective steel sleeves or concrete mattresseseffectively reduces the area of seabed available for colonisation by macrobenthic infauna in seabed sediments. The subsea cable itself and any protective covering, however, would serve as an alternative substratum for colonising benthic communities or provide shelter for mobile invertebrates and demersal fish (

Figure 42). Assuming that the hydrographical conditions around the subsea cable and repeaters would not be significantly different to those on the seabed, a similar community to that typically found on hard substrata in the area can be expected to develop over time. As offshore portions of the subsea cable will be located on unconsolidated sediments, biota developing on the structures would be different from the original soft sediment macrobenthic communities, and the artificial reef' effect is expected to be stronger than where cables are laid on top of or among natural rocky reefs (Taormina *et al*. 2018). The presence of subsea infrastructure (namely cable and repeaters) can therefore alter the community structure in an area, and effectively increase the availability of hard substrate for colonisation by sessile benthic organisms, thereby locally altering and increasing biodiversity and biomass (Grannis 2005; Kogan *et al*. 2006; Bicknell *et al*. 2019), potentially also attracting mobile macro- and megafauna who utilize the biofouling community as a food source. Where cable protections are of a different structure than the surrounding natural reef (e.g. concrete mattresses vs. boulders), different species assemblages and reef effects may result (Sheehan *et al*. 2018).

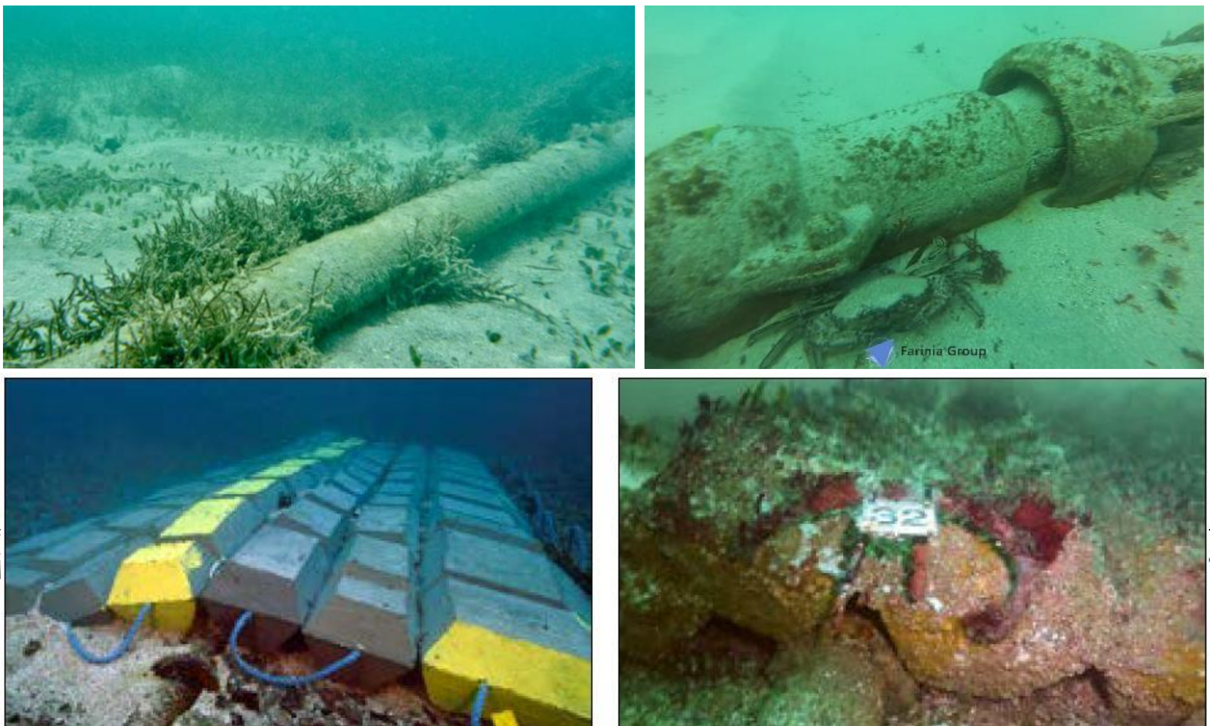

Figure 42: Subsea cables and their protective armouring can provide alternative substratum for colonising benthic biota and shelter for mobile invertebrates (Source: www.digit.in/telecom/reliance-jio-launches-longest-100gbps-subsea-cable-system-aae-1-35827; www.farinia.com; Copping & Hemery 2020).

The composition of the fouling community on artificial structures depends on the age (length of time immersed in water) and the composition of the substratum, and usually differs somewhat from the communities of nearby natural rocky reefs (Connell & Glasby 1999; Connell 2001). In the intertidal and shallow subtidal habitats, colonisation of hard substratum goes through successional stages (Connell & Slayter 1977). Early successional communities are characterized by opportunistic algae (eg, *Ulva* sp., *Enteromorpha* sp.). These are eventually displaced by slower growing, long-lived species such as mussels, sponges and/or coralline algae, and mobile organisms, such as urchins and lobsters, which feed on the fouling community. With time, a consistent increase in biomass, cover and number of species can usually be observed (Bombace *et al.* 1994; Relini *et al.* 1994; Connell & Glasby 1999). Depending on the supply of larvae and the success of recruitment, the colonization process can take up to several years. For example, a community colonising concrete blocks in the Mediterranean was found to still be changing after five years with large algae and sponges in particular increasing in abundance (Relini *et al.* 1994). Other artificial reef communities, on the other hand, were reported to reach similar numbers of species (but not densities and biomass) to those at nearby natural reefs within eight months (Hueckel *et al.* 1989).

Studies investigating the abundance, diversity and size class structure of macrobenthos associated with oil platforms (Ellis *et al.* 1996) and marine renewable energy devices (Macleod *et al.* 2016; Want *et al.* 2017; Dannheim *et al.* 2019) concluded that differences in community structure of associated fauna were attributable to the physical presence of the subsea infrastructure, and the unique physical environment around each piece of infrastructure. Differences in epifaunal communities near the structures compared to far away were attributed to differences in food availability and predation. Mobile fish and invertebrates would be attracted by the shelter and food (biofouling organisms) provided by the underwater structures (Bull & Kendall 1994; Fechhelm *et al.* 2001; Copping & Hemery 2020 and references therein). Designated cable protection zones with suitable habitats may in fact help to maintain and improve biodiversity and species abundance, and therefore act as *de facto* marine reserves or sanctuaries (Shears & Usmar 2006), although this concept has yet to be proven.

The impacts on marine biodiversity through the physical presence of the subsea cable would be of medium intensity and highly localised along the cable itself. As the subsea cable would likely be left in place on the seabed beyond decommissioning of the project, its impacts would thus be permanent. No direct mitigation measures, other than the no-project alternative, are possible.

The potential impacts on marine biota is consequently deemed to be of **LOW** significance without mitigation.

Mitigation Measures

No mitigation other than the no-go option is deemed feasible or necessary.

Physical presence of the subsea cable		
Characteristic	**Impact**	**Residual Impact**
Intensity	Medium	Medium
Duration	Permanent: cable will be left in place	Permanent
Extent	Site-specific: limited to the cable and repeaters	Site-specific
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Definite	Definite
Reversibility	Partially reversible	Partially reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.7 Other potential Impacts of Subsea Cable

Heat Dissipation

A subsequent effect of burying subsea cables in the sediment is the localized increase in temperature at the cable-sediment interface. While high and medium voltage seabed power transmission cables can emit heat, the voltage associated with telecommunication cables (for powering the repeaters) is very low, and any associated heat emissions are understood to be negligible. Although the potential consequences of this thermal radiation on benthic organisms has not yet been investigated *in situ*, the narrow footprint of the cables and the expected low temperature differences suggest that impacts are likely to be negligible (Heath 2001; Taormina *et al*. 2018 and references therein).

Sound Emmissions

Under normal operations, fibre optics cables do not emit any audible sound. During the laying of the cable it does vibrate as a result of regular vortex shedding as its descends through the water column. At ~10 Hz, this is a low frequency phenomenon and well below the hearing frequencies of marine fauna (see Table 8). Once the cable comes to rest on the seabed the sound ceases (Heath 2001).

In areas of high wave or current action on the continental shelf, cables can be exposed and undermined. Where undermining is significant, the suspended cable can vibrate or strum under the water motions (Carter *et al*. 2009). This sound would likewise be of low frequency and would not be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals. The sound is expected to attenuate rapidly to below ambient levels.

Electric and Electromagnetic fields

Fibreoptics cables carry a constant direct current of 1 - 1.6 Amps to power the underwater repeaters. This current is fed along the inner conductor and depending on the length of the cable span it may require several thousands of volts to maintain it. Typically half of the required voltage is applied at positive polarity to one end of the system and half the voltage at negative polarity to the other end, thereby establishing a zero voltage point midway along the cable span and reducing the level of voltage stress on the cable and repeaters. There is no external electric field associated with the power on the inner conductor as the polyethylene insulation ensures that the electric field remains only within the cable insulation (Heath 2001).

The direct current in the inner conductor does, however, set up a stationary magnetic field in the form of concentric rings emanating from the cable. The magnetizing force produced by this field diminishes with increasing radius from the cable such that at a distance of 1 m from the cable, the electromagnetic field (EMF) would be in the order of 0.32 micro Tesla. This is two orders of magnitude lower than the typical magnetic flux densities of the earth, which range from 30 microTesla at the equator to 60 microTesla at the magnetic poles. Animals with the capacity to detect and use constant geomagnetic fields are thus likely to only detect the signal within close proximity to the source (within centimetres) (Heath 2001; but see also Kraus & Carter 2015).

The marine environment is by no means devoid of electric and magnetic fields. An electrical current is generated (induced) in any conductor moving through a magnetic field (as per Faraday's Law). The geomagnetic field may thus also produce weak electric fields when, for example, an ocean current moves at right angles to it. Furthermore, all marine animals are electrical conductors as they continually generate internal voltage gradients and electrical currents as part of normal functions, sensory and motor mechanisms, reproductive processes, and membrane integrity. Organisms use internal electric potentials and signals for a wide variety of biological functions (e.g orientation or prey detection), and in some cases can perceive very small electric and magnetic fields. Perturbations from external electric and magnetic fields on such physiological systems need not necessarily have detrimental biological effects, as the magnitude of the effect will depend on the field intensities and exposure times to them, their frequency content, modulation, etc. Comprehensive descriptions on electromagnetism and its potential effects on marine organisms are provided in the reviews by Johnsson & Ramstad (2004) and Buchanan *et al.* (2006).

A wide variety of taxa are sensitive to electromagnetic fields and some examples are provided summarised from Johnsson & Ramstad (2004) and Buchanan *et al.* (2006) . Western Atlantic spiny lobsters (*Panulirus argus*), which undertake mass migrations, were found to orientate to the polarity of the Earth's field or to an induced magnetic field. Most species of salmon travel great distances from their natal streams to oceanic feeding grounds, and some (Pacific, Atlantic, Chinook, Sockeye) have been reported to orientate magnetically. While the electroreceptive sensitivity of sharks, skates, and rays is well established, and some studies have shown that these fishes can detect the Earth's geomagnetic field, empirical evidence that elasmobranchs use geotaxis to navigate is still lacking. There is strong evidence that turtle hatchings (at least loggerhead and leatherback sea turtles) and loggerhead juveniles use geomagnetic orientation to navigate long distances although there is little evidence that adults do the same. It has been theorized that cetaceans use geomagnetic information for orientation, with live strandings being attributed to areas where geomagnetic contour lines run perpendicular to shore, generally occurring 1-2 days after major geomagnetic storms.

Elasmobranchs and chimaerids are the taxa most likely to detect the electrical fields produced by fibre-optics cables because their electroreceptive organs are sensitive to stimuli in the very low frequency range from 0.125 Hz to 8.0 Hz. This may explain fibre-optic cable failures as a result of shark attacks in water depths of 1,060 – 1,900 m. Although the reasons for the attacks are uncertain, sharks may be encouraged by the electromagnetic fields, particularly from suspended cables that strum in the currents (Carter *et al*. 2009).

The injection of a low frequency electrical signal from the land station is known as 'toning' and is undertaken to aid in cable location in the event of a fault or when a safe distance needs to be kept from a cable during other marine work. The resultant proportion of current in the seawater, enables electrodes trailed from a ship to detect the cable by locating the maximum level of the tone. The level of the signal injected is usually 160 mA at 25 Hz. The attenuation of the cables at low frequency is such that a tone injected at the terminal should be detectable across most of the continental shelf by the electrodes whose threshold level of detection on electrodes is normally around 20mA. Toning has been used for many years on submarine cables throughout the world, and no adverse affects on marine life has been reported.

Leaching of Contaminants

Modern deep-water fibre-optic cables are composed of hair-like glass fibres, a copper power conductor and steel wire strength member, all of which are sheathed in high-density polyethylene. Where extra protection is required, as for areas of rocky seabed or strong wave and current action, additional steel wire armour is added. No anti-fouling agents are used. The cable-grade polyethylene used for the sheath is essentially inert in seawater. Oxidation, hydrolysis and mineralization processes for polyethylene are extremely slow, with the total conversion to carbon dioxide and water estimated to take centuries. The effects of ultraviolet light, the main cause of degradation in most plastics, are minimized through the use of light-stabilized materials, burial of the cable into the seabed and the natural reduction in light penetration through the photic zone. Where the cable is located on the energetic continental shelf and mechanical abbrasion of the cable's plastic sheathing by fine-grained particles is possible, the cable is either armoured or buried (Carter *et al*. 2009).

A study investigating potential leachates of copper, iron and zinc from the conductors and galvanized steel armour, identified that only zinc passed into the seawater, yielding concentrations of less than 6 mg/l for intact cables and less than 11 mg/l for cut cables with exposed wire armour ends[6]. The amount of leaching declined after ~10 days. Although this is above the recommended BCLME water quality guideline value of 5 µg/l (CSIR 2006), dilution of leachates by the surrounding water would be rapid and any negative effects on marine organisms are likely to be highly localised. Although zinc is an essential food element and occurs as Zn^{II} in dissolved form, it is listed amongst the 129 priority pollutants by the US Environmnetal Protection Agency as it can have lethal and sub-lethal effects at concentrations as low as 170 µg/l, particularly on the egg and larval stages of marine invertebrates.

Based on available information in the literature, the impacts on marine fauna through the generation of heat, sound, EMFs and leachates by the submarine cable would be of negligible intensity and highly localised along the cable itself. As the subsea cable would be in operation for up to 25 years, the impacts would persist over the long-term. No direct mitigation measures, other than the no-project alternative, are possible. The potential impacts on marine biota is consequently deemed to be of **VERY LOW** significance without mitigation.

6 Tests were carried out in a small, finite volume of seawater (Collins 2007)

Mitigation Measures

No mitigation other than the no-go option is deemed feasible or necessary.

Heat, Sound, Electromagnetic fields and leaching of contaminats from thesubsea cable		
Characteristic	Impact	Residual Impact
Intensity	Negligible	Negligible
Duration	Long-term: for the life time of the cable	Long-term
Extent	Site-specific: limited to the cable and repeaters	Site-specific
Frequency	Intermittent (Leaching) to Continuous (heat, EMF)	Intermittent to Continuous
Loss of resource	Low	Low
Probability	Improbable	Improbable
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	None	

4.5. Decommissioning Phase

No decommissioning procedures have been developed at this stage. In the case of decommissioning the cable will most likely be left in place. The potential impacts during the decommissioning phase are thus expected to be minimal in comparison to those occurring during the installation phase.

4.6. Unplanned Events

4.6.1 Pollution and Accidental Spills

Trenching during installation of the shore-crossing of the subsea cable will involve excavation and construction activities. There would thus be potential for or accidental spillage or leakage of fuel, chemicals or lubricants, litter, inappropriate disposal of human wastes and general degradation of ecosystem health on the shoreline. Any release of liquid hydrocarbons has the potential for direct, indirect and cumulative effects on the marine environment through contamination of the water and/or sediments. These effects include physical oiling and toxicity impacts to marine fauna and flora, localised mortality of plankton, pelagic eggs and fish larvae, and habitat loss or contamination (CSIR 1998; Perry 2005). Many of the compounds in petroleum products have been known to smother organisms, lower fertility and cause disease in aquatic organisms. Hydrocarbons are incorporated into sediments through attachment to fine-grained particles, sinking and deposition in low turbulence areas. Due to differential uptake and elimination rates, filter-feeders, particularly mussels, can bioaccumulate organic (hydrocarbons) contaminants (Birkeland *et al.* 1976).

During construction, litter can enter the marine environment. Inputs can be either direct by discarding garbage into the sea, or indirectly from the land when litter is blown into the water by wind. Marine litter is a cosmopolitan problem, with significant implications for the environment and human activity all over the world. Marine litter travels over long distances with ocean currents and winds. It originates from many sources and has a wide spectrum of environmental, economic, safety, health and cultural impacts. It is not only unsightly, but can cause serious harm to marine organisms, such as turtles, birds, fish and marine mammals. Considering the very slow rate of decomposition of most marine litter, a continuous input of large quantities will result in a gradual increase in litter in coastal and marine environment. Suitable waste management practices should thus be in place to ensure that littering is avoided.

Potential hydrocarbon spills and pollution in the intertidal and shallow subtidal zone during installation of the subsea cable are deemed of medium intensity within the immediate vicinity of the construction site, with impacts persisting over the short- to medium-term. Impacts of pollution and accidental spills would be direct, indirect and cumulative. As the coastal habitats at the shore-crossing have been identified as 'least concern' (Southern Benguela Dissipative Sandy Shore) the loss of resources could potentially be medium, with impacts being only partially reversible in the worst-case scenario. Pollution and accidental spills on the shoreline during the construction phase is probable and the impact is therefore assessed to be of **MEDIUM** significance.

Mitigation Measures

The recommended best-practice mitigation measures for the construction phase of the proposed ASN 2AFRICA/GERA (East) cable installation are:

- All construction activities in the coastal zone must be managed according to a strictly enforced EMPr.
- Ensure that contracted construction personnel are aware of, and adhere to, the requirements of the EMP.
- Keep heavy vehicle traffic associated with construction in the coastal zone to a minimum.
- Restrict vehicles to clearly demarcated access routes and construction areas only. These should be selected under guidance of the local municipality.
- Maintain vehicles and equipment to ensure that no oils, diesel, fuel or hydraulic fluids are spilled.
- For equipment maintained in the field, oils and lubricants must be contained and correctly disposed of off-site.
- Good housekeeping must form an integral part of any construction operations on the beach from start-up.
- Ensure regular collection and removal of refuse and litter from intertidal areas.

The following essential mitigation measures should be implemented during construction:

- There is to be no vehicle maintenance or refuelling on beach.
- Ensure that all accidental diesel and hydrocarbon spills are cleaned up accordingly.
- No mixing of concrete in the intertidal zone.

- Regularly clean up concrete spilled during construction.
- No dumping of construction materials, excess concrete or mortar in the intertidal and subtidal zones or on the sea bed.
- After completion of construction activities remove all artificial constructions or created shore modifications from above and within the intertidal zone. No accumulations of excavated intertidal sediments should be left above the high water mark, and any substantial sediment accumulations below the high water mark should be levelled.

If these mitigation measures are implemented, all residual impacts are expected to be of low significance.

Accidental spillage or leakage of fuel, chemicals or lubricants, cement and disposal of litter may cause water or sediment contamination and/or disturbance to intertidal and subtidal biota		
Characteristic	Impact	Residual Impact
Intensity	Medium	Low
Duration	Short- to Medium-term	Short-term
Extent	Site-specific: limited to the cable and repeaters	Site-specific
Frequency	Intermittent	Once-off
Loss of resource	Medium	Low
Probability	Probable	Possible
Reversibility	Partially reversible	Fully reversible
Significance of Impact	**MEDIUM**	**LOW**
Confidence	High	
Mitigation Potential	High	

4.6.2 Collisions with and entanglement by Marine Fauna

Vessel traffic can affect large cartilaginous fish species, turtles and marine mammals by direct collisions or propeller injuries. The potential effects of vessel presence on turtles and cetaceans include behavioural disturbance, physiological injury or mortality.

Collisions between cetaceans and vessels are not limited to survey or cable laying vessels. In areas of heavy ship traffic, whales and dolphins can experience propeller or collision injuries, with most of these injuries caused by fast moving vessels. Injuries and deaths resulting from direct ship collisions represent a significant threat to several whale populations (Laist *et al*. 2001; Jensen & Silber 2003). All types and sizes of vessels hit whales, but most lethal and serious injuries are caused by larger vessels and most vessel strikes occur on the continental shelf and when vessels were doing in excess of 10 knots (Laist *et al*. 2001).

During acquisition of swath bathymetry, the survey vessel typically travels at a speed of around 6 knots. Depending on the onboard equipment and types of ploughs used, prevailing sea conditions as well as the nature of the seabed, subsea cable vessels can lay 100-150 km of cable per day, with modern ships and ploughs achieving up to 200 km of cable laying per day (www.independent.co.uk>science). This equates to a vessel speed of between 2.3 – 4.5 knots. Once the cable has reached the seabed, the ship can increase its speed to 6-8 knots, slowing only to pass repeaters and amplifiers through the machinery that controls cable tension and pay-out speed (Carter *et al*. 2009). The pre-laying grapnel run is typically conducted at 0.5 knots; and vessels will maintain the same speed when plough-burying cable. Given the slow speed of the vessels during surveying, the pre-lay grapnel run and the cable installation, ship strikes with marine mammals and turtles are unlikely, and should the impact occur it would be very infrequent.

Ship strikes have been reported to result in medium-term effects such as evasive behaviour by animals experiencing stress, or longer-term effects such as decreased fitness or habitual avoidance of areas where disturbance is common and in the worst case death (see for example Constantine 2001; Hastie *et al*. 2003; Lusseau 2004, 2005; Bejder *et al*. 2006; Lusseau *et al*. 2009). Ship strikes have been documented from many regions and for numerous species of whales (Panigada *et al*. 2006; Douglas *et al*. 2008; Elvin & Taggart 2008) and dolphins (Bloom & Jager 1994; Elwen & Leeney 2010), with large baleen whales being particularly susceptible to collision.

Entanglement of whales with old telegraph cables occurred during the telegraph era (1850s to 1950s) at sites where cables had been repaired on the edge of the continental shelf or on the adjacent continental slope in water depths down to 1,135 m. With improved design, laying and maintenance techniques,sincedevelopment of the coaxial submarine cables in the 1950s and into the fibre-optic era in the early 1980s, no further entanglements with marine mammals have been recorded (Wood & Carter 2008). As the cable would be under constant tension during installation, entanglements are highly unlikely and once on the seabed, the weight of the cable and torsional balance will prevent coils and loops (Carter *et al*. 2009). Furthermore, as the cable would be buried along much of its length on the continental shelf, entanglements are highly unlikely.

As much of the cable would be installed in the offshore marine environment, the strong operational lighting used to illuminate the survey and cable vessels may disturb and disorientate pelagic seabirds feeding in the area. Operational lights may also result in physiological and behavioural effects of fish and cephalopods as these may be drawn to the lights at night where they may be more easily preyed upon by other fish and seabirds. The response of marine organisms to artificial lights can vary depending on a number of factors such as the species, life stage and the intensity of the light. Considering the extensive distributions and low numbers of pelagic seabirds likely to be encountered in the offshore environment, the olikelihood of collisions would be low.

In the event of a collision or entaglement, the impact is deemed of low intensity and would be site specific to the vessel/cable location. Injury through collision and/or entanglement would persist over the short term and considering the slow vessel speed would likely remain at sub-lethal levels. Although this direct impact could result in a medium loss of resources, the impact is assessed to be of **LOW** significance without mitigation.

Mitigation Measures

The recommended best-practice mitigation measures for the installation phase of the proposed 2AFRICA/GERA (East) subsea cable are:

- The lighting on the survey and cable laying vessels should be reduced to a minimum compatible with safe operations whenever and wherever possible. Light sources should, if possible and consistent with safe working practices, be positioned in places where emissions to the surrounding environment can be minimised.

- If cable installation across the continental shelf is scheduled during the whale migration period (beginning of June to end of November), consideration will be required from the cable-laying vessel to appoint a suitably trained crew member as a dedicated Marine Mammal Observer (MMO) with experience in seabird, turtle and marine mammal identification and observation techniques, to carry out daylight observations of the subsea cable route and record incidence of marine mammals, and their responses to vessel activities. Data collected should include position, distance from the vessel, swimming speed and direction, and obvious changes in behaviour (eg, startle responses or changes in surfacing/diving frequencies, breathing patterns). Both the identification and the behaviour of the animals must be recorded accurately.
- Should a cetacean become entangled in towed gear, contact the South African Whale Disentanglement Network (SAWDN) formed under the auspices of DEA to provide specialist assistance in releasing entangled animals.

Collisions with and Entanglement by Marine Fauna		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Site-specific: limited to around the vessel	Site-specific
Frequency	Once-off	Once-off
Loss of resource	Medium	Low
Probability	Improbable	Improbable
Reversibility	Partially reversible	Fully reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Medium	

4.7. Cumulative Impacts

The primary impacts associated with the installation of subsea cables in the Agulhas and Southwest Indian Deep Ocean Ecoregions, relate to physical disturbance of the seabed, either through placing the cable on the seabed (>1,500 m depth) or by burying the cable in a trench excavated by a fit-for-purpose cable plough, diver-operated jet-pump or (where it crosses the beach) a tracked backhoe digger. As the 2AFRICA/GERA (East) cable routing will largely follow that of the existing SAFE cable, cumulative impacts need to be considered.

The proposed cable route, where possible, avoids sensitive reef areas and environments such as MPAs. Consequently impacts will mostly affect communities in unconsolidated habitats, which are less sensitive to disturbance and recover more quickly than those inhabiting hard grounds. The beach at the cable landing site (Pollok Beach) as well as those beaches to the south and north of it are by no means pristine and have been heavily impacted by numerous coastal developments (Figure 43). Cumulative impacts are therefore likely, particularly considering the regular use of the beach by the public. Further offshore on the shelf and beyond the shelf break, the greatest possibility of cumulative impacts is where the proposed ASN cable route meets those of other existing subsea cables (Figure 44). Available evidence suggests that there are no other cables landing in Algoa Bay, with the closest landing site being at East London, where the IOX cable comes ashore. The IOX cable crosses the main trunk of the proposed ASN cable route ~130 km offshore of Mazepa Bay on the Wild Coast and the SAFE cable about 160 km offshore of the Wild Coast. These cumulative impacts are, however, assessed to be of low to very low significance as in reality the total cumulative impacted area at any one time would be minimal, due to the natural recovery of benthic communities of unconsolidated habitats over the medium term.

Figure 43: King's Beach, the Shark Rock Pier, Humewood Pillars and tidal pool that lie ~1.5 km to the northwest of the proposed cable landing site at Pollok Beach (left) and the stormwater pipe that discharges into the surf zone at Pollok Beach ~70 m south of the proposed beach crossing of Port Elizabeth branch of the 2AFRICA/GERA (East) Cable System (Source: margateplace.co.za; wannasurf.com).

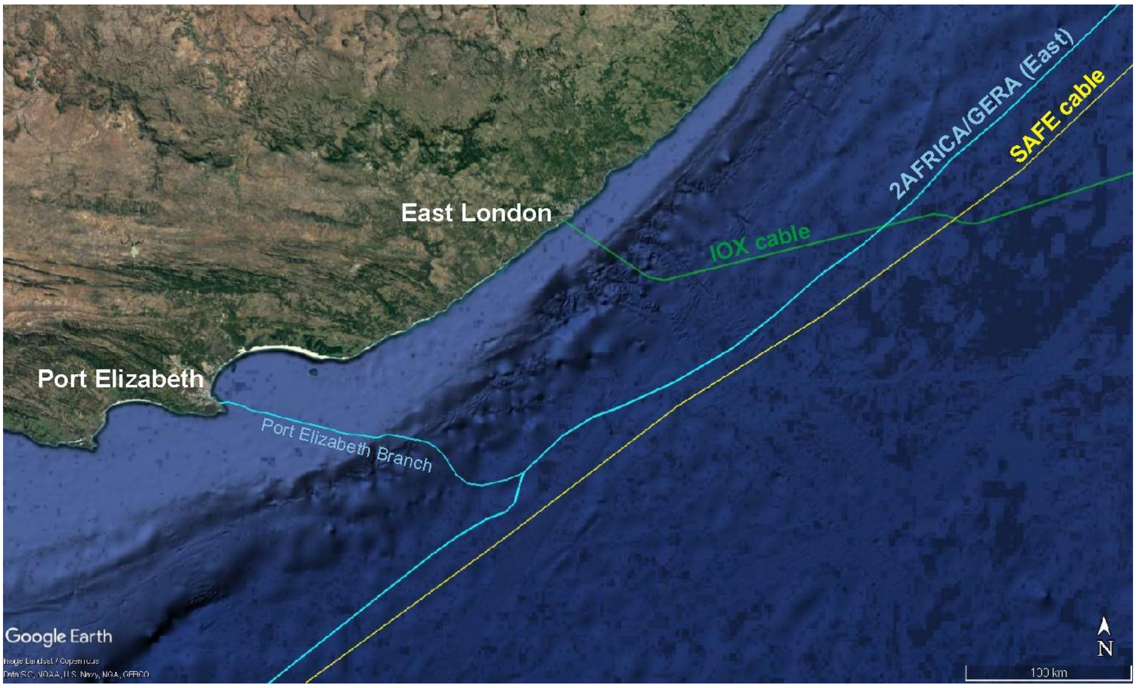

Figure 44: The Port Elizabeth Branch of the 2AFRICA/GERA (East) Cable System in relation to other submarine cables along the southeast coast of South Africa.

5. ENVIRONMENTAL STATEMENT AND CONCLUSIONS

5.1 Environmental Statement

Installation of the cable will potentially result in localised disturbance of the upper beach and intertidal and shallow subtidal sandy habitats, as well as unconsolidated seabed beyond the surf-zone and across the shelf. Most potentially negative impacts were rated as being of low significance, with only pollution and accidental spills during construction rated as medium significance. As recovery of marine communities over the short- to medium-term can be expected, residual impacts were all considered minor.

5.2 Management Recommendations

From the marine ecology assessment in Chapter 4, certain recommendations can be put forward as how best to manage potential impacts to the marine environment of the proposed installation of the subsea cable. Some of these are already part of standard industry practice, but they are documented here for the sake of completeness. These include:

- Plan routing of proposed cable to as far as practicably possible avoid sensitive benthic habitats in the coastal and nearshore zone. This is undertaken following analysis of the geophysical data collected during the cable route survey.
- Ensure that constant monitoring for the presence of marine mammals and turtles is maintained by a ship's staff member designated as a marine mammal observer. The observation post must keep a record of sightings, recording date, time, coordinates and approximate distance. This is particularly important should cable installation across the continental shelf be scheduled during the whale migration period (beginning of June to end of November).
- Should a cetacean become entangled in towed gear, contact the South African Whale Disentanglement Network (SAWDN) formed under the auspices of DEA to provide specialist assistance in releasing entangled animals.

For the construction phase of the proposed cable shore-crossing the recommended best-practice mitigation measures include:

- As far as practicably possible, and subject to feasibility, make HDD the preferred option for the cable shore crossing, thereby avoiding damage to intertidal and shallow subtidal habitats by trenching or anchoring of the cable on the seabed.
- Restrict rock trenching to the minimum required to ensure the cable is suitably protected should storm-induced sand deflation result in the exposure of the underlying rock shelves.
- As far as practicable, ensure that construction activities required for subsea cable installation occur concurrently thereby minimizing the disturbance duration in the coastal and nearshore zone.
- As far as practicable, avoid cable installation within Algoa Bay during the peak squid spawning period between September and December.

- All construction activities in the coastal zone must be managed according to a strictly enforced EMPr.
- Ensure that contracted construction personnel are aware of, and adhere to, the requirements of the EMP.
- Keep heavy vehicle traffic associated with construction in the coastal zone to a minimum.
- Restrict vehicles to clearly demarcated access routes and construction areas only. These should be selected under guidance of the local municipality.
- Maintain vehicles and equipment to ensure that no oils, diesel, fuel or hydraulic fluids are spilled.
- For equipment maintained in the field, oils and lubricants must be contained and correctly disposed of off-site.
- Good housekeeping must form an integral part of any construction operations on the beach from start-up.
- Ensure regular collection and removal of refuse and litter from intertidal areas.

The following essential mitigation measures should be implemented during construction of the shore crossing:

- Obtain a vehicle access permit from DEA (Branch Oceans and Coasts) prior driving in the coastal zone.
- Restrict disturbance of the intertidal and subtidal areas to the smallest area possible. Once the shore crossing is finalised and the associated construction site is determined, the area located outside of the site should be clearly demarcated and regarded as a ‘no-go’ area.
- There is to be no vehicle maintenance or refuelling on the beach.
- Ensure that all accidental diesel and hydrocarbon spills are cleaned up accordingly.
- No mixing of concrete in the intertidal zone.
- Regularly clean up concrete spilled during construction.
- No dumping of construction materials, excess concrete or mortar in the intertidal and subtidal zones or on the sea bed.
- After completion of construction activities remove all artificial constructions or created shore modifications from above and within the intertidal zone. No accumulations of excavated intertidal sediments should be left above the high water mark, and any substantial sediment accumulations below the high water mark should be levelled.

If these mitigation measures are implemented, all residual impacts are expected to be of low to very low significance. Potential cumulative impacts are likewise expected to be of low to very low significance.

5.3 Conclusions

If all environmental guidelines and appropriate management and monitoring recommendations advanced in this report are implemented, there is no reason why the proposed installation of the Port Elizabeth branch of the ASN 2AFRICA/GERA (East) fibre optics cable should not proceed.

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Curriculum Vitae

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1999: Senior researcher at the University of Cape Town on contract to Namdeb Diamond Corporation and De Beers Marine South Africa; investigating and monitoring the impact of diamond mining on the marine environment and fisheries resources; experimental design and implementation of dive surveys; collaboration with fishermen and diamond divers; deep water benthic sampling, sample analysis and macrobenthos identification.

1996-1999: Senior researcher at the University of Cape Town, on contract to the Chief Director: Marine and Coastal Management (South African Department of Environment Affairs and Tourism); investigating and monitoring the experimental fishery for periwinkles on the Cape south coast; experimental design and implementation of dive surveys for stock assessments; collaboration with fishermen; supervision of Honours and Masters students.

1989-1994: Institute for Marine Science at the Christian-Albrechts University of Kiel, Germany; research assistant in a 5 year project to investigate the population dynamics of mussels and cockles in the Schleswig-Holstein Wadden Sea National Park (employment for Doctoral degree); extensive and intensive dredge sampling for stock assessments, collaboration with and mediation between, commercial fishermen and National Park authorities, co-operative interaction with colleagues working in the Dutch and Danish Wadden Sea, supervision of Honours and Masters projects and student assistants, diving and underwater scientific photography. Scope of doctoral study: experimental design and implementation of a regular sampling program including: (i) plankton sampling and identification of lamellibranch larvae, (ii) reproductive biology and condition indices of mussel populations, (iii) collection of mussel spat on artificial collectors and natural substrates, (iv) sampling of recruits to the established populations, (v) determination of small-scale recruitment patterns, and (vi) data analysis and modelling. Courses and practicals attended as partial fulfilment of the degree: Aquaculture, Stock Assessment and Fisheries Biology, Marine Chemistry, and Physical and Regional Oceanography.

1988-1989: Australian Institute of Marine Science; volunteer research assistant and diver; implementation and maintenance of field experiments, underwater scientific photography, digitizing and analysis of stereo-photoquadrats, larval culture, analysis of gut contents of fishes and invertebrates, carbon analysis.

1985-1987: Sea Fisheries Research Institute of the South African Department of Environment Affairs and Tourism: scientific diver on deep diving surveys off Cape Agulhas; censusing fish populations, collection of benthic species for reef characterization.

South African National Research Institute of Oceanography and Port Elizabeth Museum: technical assistant and research diver; quantitative sampling of benthos in Mossel Bay, and census of fish populations in the Tsitsikamma National Park.

University of Cape Town, Department of Zoology and Percy Fitzpatrick Institute of African Ornithology; research assistant; supervisor of diving survey and collection of marine invertebrates, Prince Edward Islands.

1984-1986: University of Cape Town, Department of Zoology; research assistant (employment for MSc Degree) and demonstrator of first year Biological Science courses. Scope of MSc study: the biology, ecology and fishery of the western Cape linefish species *Pachymetopon blochii*, including (i) socio-economic survey of the fishery and relevant fishing communities, (ii) collection and analysis of data on stomach contents, reproductive biology, age and growth, (iii) analysis of size-frequency and catch statistics, (iv) underwater census, (v) determination of hook size selectivity, (vi) review of historical literature and (vii) recommendations to the Sea Fisheries Research Institute of the South African Department of Environment Affairs and Tourism for the modification of existing management policies for the hottentot fishery.

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

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

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

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

PROJECT TITLE

PROPOSED MARINE TELECOMMUNICATIONS SYSTEM (ASN 2AFRICA/GERA (East) CABLE SYSTEM) TO BE LANDED AT PORT ELIZABETH ON THE SOUTH COAST OF SOUTH AFRICA

Specialist:	Dr Andrea Pulfrich		
Contact person:	Dr Andrea Pulfrich		
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Project Consultant:	Giles Churchill			
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Telephone:	035 3402715	Cell:	082 9079738
E-mail:	Giles.churchill@acerafrica.co.za	Fax:	035 3402232

4.2 The specialist appointed in terms of the Regulations_

I, Andre~~a Pulfrich, declare that -- General declara~~tion:

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

Signature of the specialist:

Pisces Environmental Services (Pty) Ltd
Name of company (if applicable):

15 December 2020
Date: