7 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This chapter provides a description of the West Coast region and the physical, biological and socio-economic environment likely to be affected by the proposed exploration activities.

7.1 INTRODUCTION

The Reconnaissance Permit application area is situated along the entire West Coast of South Africa from the Namibian border in the north, around Cape Point to Cape Agulhas. The proposed 2D seismic survey area would stretch from the Namibian border along the West Coast up to a point approximately 200 km southwest of Cape Point and ranges between 40 and 440 km from the coast. Water depths in the proposed survey area range from 100 m to beyond 4 500 m (see Figure 1-1).

The West Coast is characterised by the cool Benguela upwelling system (Shannon 1985). In this chapter, descriptions of the physical and biological environments are summarised from information provided in the Generic EMPr for Oil and Gas Prospecting off the Coast of South Africa (CCA & CMS 2001) which has been updated for this EMP with information from more recent scientific studies undertaken in the general area. Information on the social environment has been summarised from internet resources and recent studies in the area.

7.2 AREAS OF INFLUENCE

The Area of Influence of the project is defined as a basis for defining the boundaries for baseline data gathering by taking into consideration the spatial extent of potential direct and indirect impacts of the project.

In terms of International Finance Corporation (IFC) Performance Standard (PS) 1, a "*Project's Area of Influence encompasses, as appropriate:*

- *The area likely to be affected by:*
  - *the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project;*
  - *impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or*
  - *indirect project impacts on biodiversity or on ecosystem services upon which affected communities' livelihoods are dependent.*
- *Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.*
- *Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted*".

For seismic operations, the direct areas of influence during normal operations are set out below:

- The proposed Orange Basin survey operational area (including turning circles). This includes all seismic data acquisition and maintenance of an operational safety zone around the survey vessel and gear;
- Port of Cape Town for provision of supplies, waste management services, refuelling and crew changes; and
- Marine traffic route between Cape Town and the proposed survey area.

Based on the above area of influence, Sections 7.3, 7.4 and 7.5 detail the physical and biological marine environment (including protected and other sensitive areas) within the Orange Basin off the West Coast of South Africa. Section 7.6 describes the regional and local social and human context; Section 7.7 details the marine-based fisheries; Section 7.8 provides a brief overview of other marine infrastructure and users and Section 7.9 briefly covers marine archaeology.

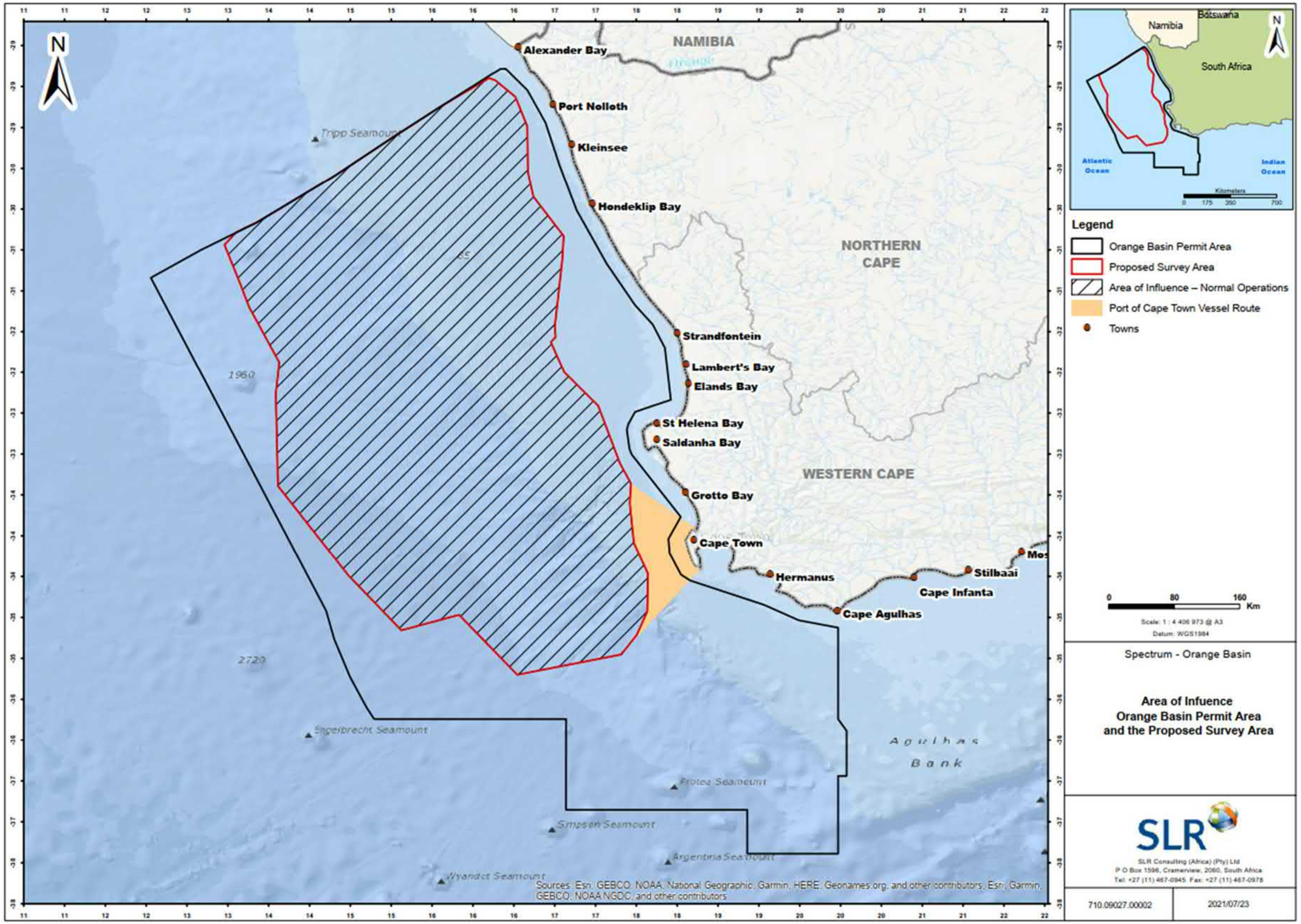

Figure 7-1: Areas of Influence during seismic operations

7.3 PHYSICAL ENVIRONMENT

This section describes the climate, bathymetry and seafloor sediment; ocean currents and thermal structure; winds and swells, turbidity and sedimentary phosphates.

7.3.1 Climate

The climate along the west coast of South Africa transitions from the Mediterranean winter (May to August) rainfall climate in the Western Cape which occurs between Cape Town and Saldanha Bay to arid conditions in Namaqualand to the north (refer to Figure 7-2**Error! Reference source not found.**).

Namaqualand also receives rainfall during the winter months (April to September). The Benguela current plays a very important role in Namaqualand's climate, with onshore winds blowing over the cold, up-welled waters of the Atlantic Ocean. Along the coastline, temperatures reach 25°C in summer. Winter temperatures range between 5°C and 15°C. Frost occurs in the high lying regions with snow occasionally falling in the uplands region. The fog that blankets much of Namaqualand is a phenomenon that occurs frequently during the autumn months when onshore wind speeds are not strong enough to produce the turbulence that breaks up the fog (Department of Co-operative Governance, Human Settlements and Traditional Affairs, 2012).

Average minimum and maximum temperatures at Cape Towns are 15 and 26°C, respectively, in summer and approximately 7 to 18°C in winter (see Figure 7-2). At Cape Columbine (located near to Saldanha Bay), average minimum and maximum temperatures are similar at approximately 13°C and 26.5°C in summer and approximately 7°C and 17.5°C in winter.

Climate change predictions along the West Coast coastline indicated a general reduction in precipitation (CSAG 2020).

7.3.2 Bathymetry and Sediments

The continental shelf along the West Coast is generally both wide and deep, although large variations in both depth and width occur (Figure 7-3). The shelf maintains a general NNW trend, widening north of Cape Columbine and reaching its widest off the Orange River (180 km). Between Cape Columbine and the Orange River, there is usually a double shelf break, with the distinct inner (closest to shore) and outer slopes separated by a gently sloping ledge.

The immediate nearshore area consists mainly of a narrow (to about 8 km wide) rugged rocky zone which initially slopes steeply seawards to a depth of about 30 m and then gradually to about 80 m. The middle and outer shelf normally lacks relief and slope gently seawards reaching the shelf break (where the slope becomes significantly steeper) at a depth of approximately 350 m to 500 m.

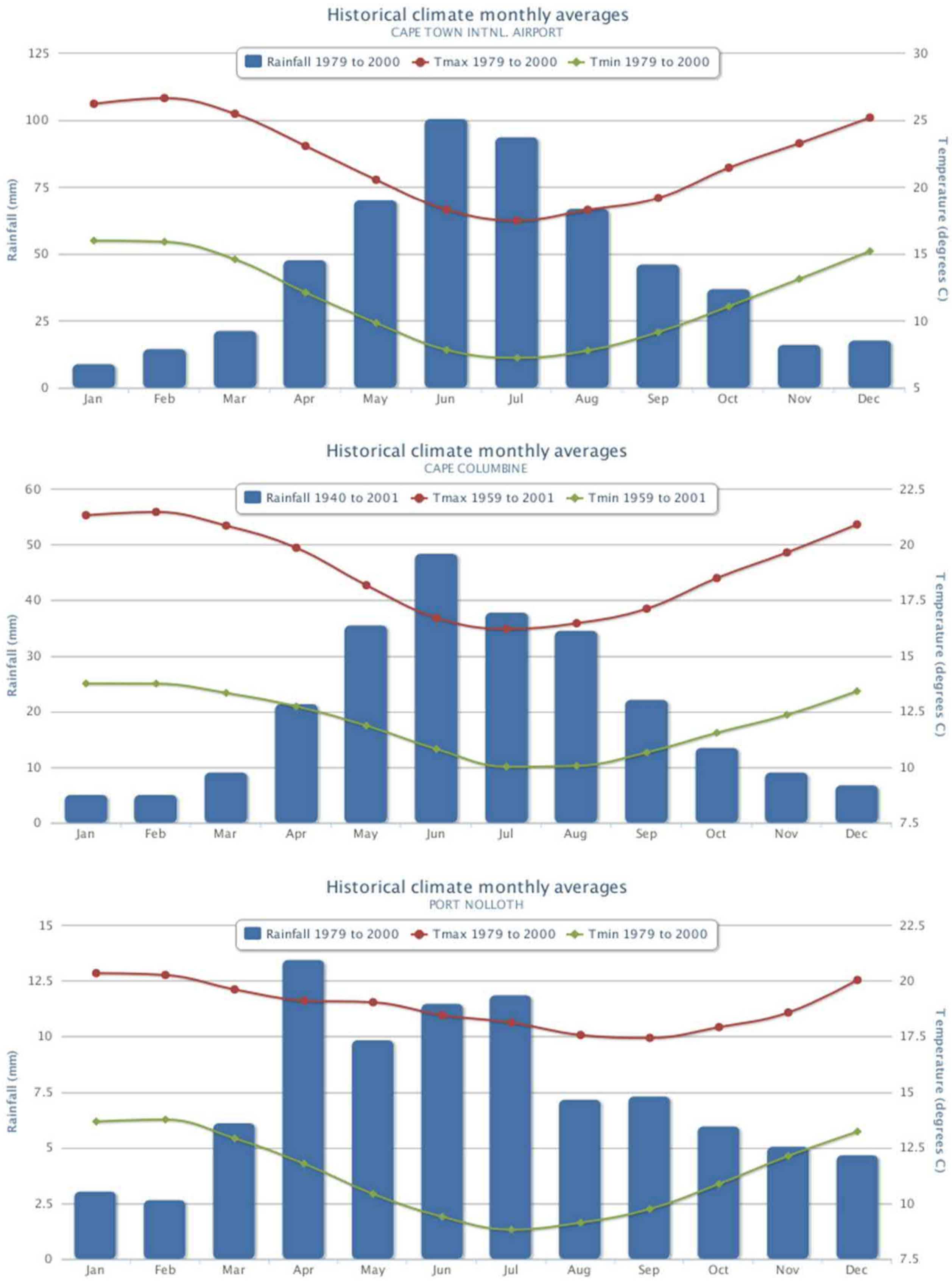

Figure 7-2: **Historic rainfall and temperature monthly averages for Cape Town (top), Cape Columbine (middle) and Port Nolloth (bottom)**

Source: CSAG 2020

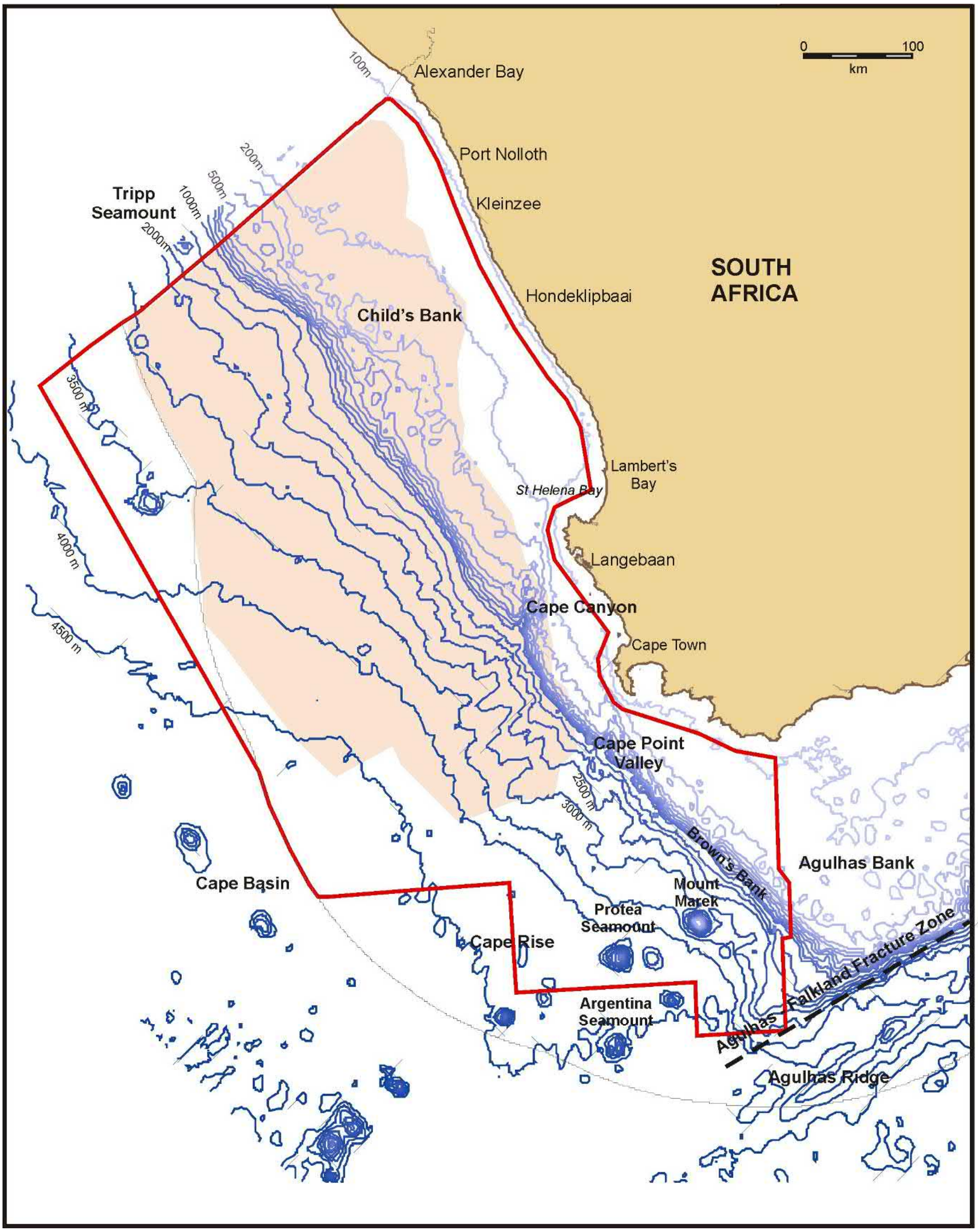

Figure 7-3: Location, bathymetry and seabed features of the West Coast in relation to the Reconnaissance Permit area and proposed survey area (shaded area)

Banks on the continental shelf include the Orange Bank (Shelf or Cone), a shallow (160 to 190 m) zone that reaches maximal widths (180 km) offshore of the Orange River, and Childs Bank, situated approximately 150 km offshore at about 31°S, and within the northern portion of the proposed survey area. Child's Bank is a major feature on the West Coast margin and is the only known submarine bank within the EEZ, rising from a depth of 350 to 400 m water to less than 200 m at its shallowest point. The bank area has been estimated to cover approximately 1 450 km^2 (Sink *et al*. 2012). Tripp Seamount is a geological feature approximately 30 km north of the proposed survey area, which rises from the seabed at approximately 1 000 m water depth to a depth of 150 m.

The Southeast Atlantic Seamounts, which include the Argentina and Protea Seamounts are located in the southern portion of the Reconnaissance Permit area. The recently discovered Mount Marek on the continental slope is considered a different ecosystem type, namely Southeast Atlantic Slope Seamount. It lies south of Brown's Bank on the western shelf edge of the Agulhas Bank. These seamounts, which were formed by volcanic activity, rise up from 2 500 m depth in the Cape Basin abyss to 700 m deep.

Further underwater features in the Reconnaissance Permit Area include the Cape Canyon and Cape Valley, which lie on the eastern boundary of the proposed 2D survey area (Simpson & Forder 1968; Dingle 1986; Wigley 2004; Wigley & Compton 2006). The canyon head forms a well-developed trench on the continental shelf, 100 m deep and 4 km wide (Wigley 2004; Wigley & Compton 2006). South of Cape Columbine the canyon becomes progressively narrower and deeper. Adjacent to Cape Town in a water depth of 1 500 m, the canyon has a local relief in the order of 500–800 m (Simpson & Forder 1968; Dingle *et al*. 1987). The Cape Canyon has a longitudinal extent of at least 200 km and can be traced to a water depth of at least 3 600 m (Dingle 1970). Sediments in the canyon are predominately unconsolidated sands and muds. The canyon serves as an upwelling feature funneling cold, nutrient-rich South Atlantic Central Water up the canyon slope providing highly productive surface waters which in turn power feeding grounds for cetaceans and seabirds (Filander *et al*. 2018; www.environment.gov.za/dearesearchteamreturnfromdeepseaexpedition).

The Cape Point Valley, which lies about 70 km south of the Cape Peninsula, is another large canyon breaching the shelf. This canyon has sustained the highest fishing effort and catches in the South African demersal trawl fishery for almost a century (www.marineprotectedareas.org.za/canyons).

Using high-resolution bathymetry collected between 315 – 3 125 m depth in the southern portion of the Reconnaissance Permit area, Palan (2017) identified numerous new and previously undocumented submarine canyon systems, most of which are less extensive than the Cape Canyon and Cape Point Valley and do not incise the shelf (see Figure 7-4). Canyon morphology was highly variable and included linear, sinuous, hooked and shelf-indenting types. Large fluid seep/pockmark fields of varying morphologies were similarly revealed situated in close proximity to the sinuous, hooked and shelf-indenting canyon types thereby providing the first evidence of seafloor fluid venting and escape features from the South African margin. These pockmarks represent the terminus of stratigraphic fluid migration from an Aptian gas reservoir, evidenced in the form of blowout pipes and brightened reflectors.

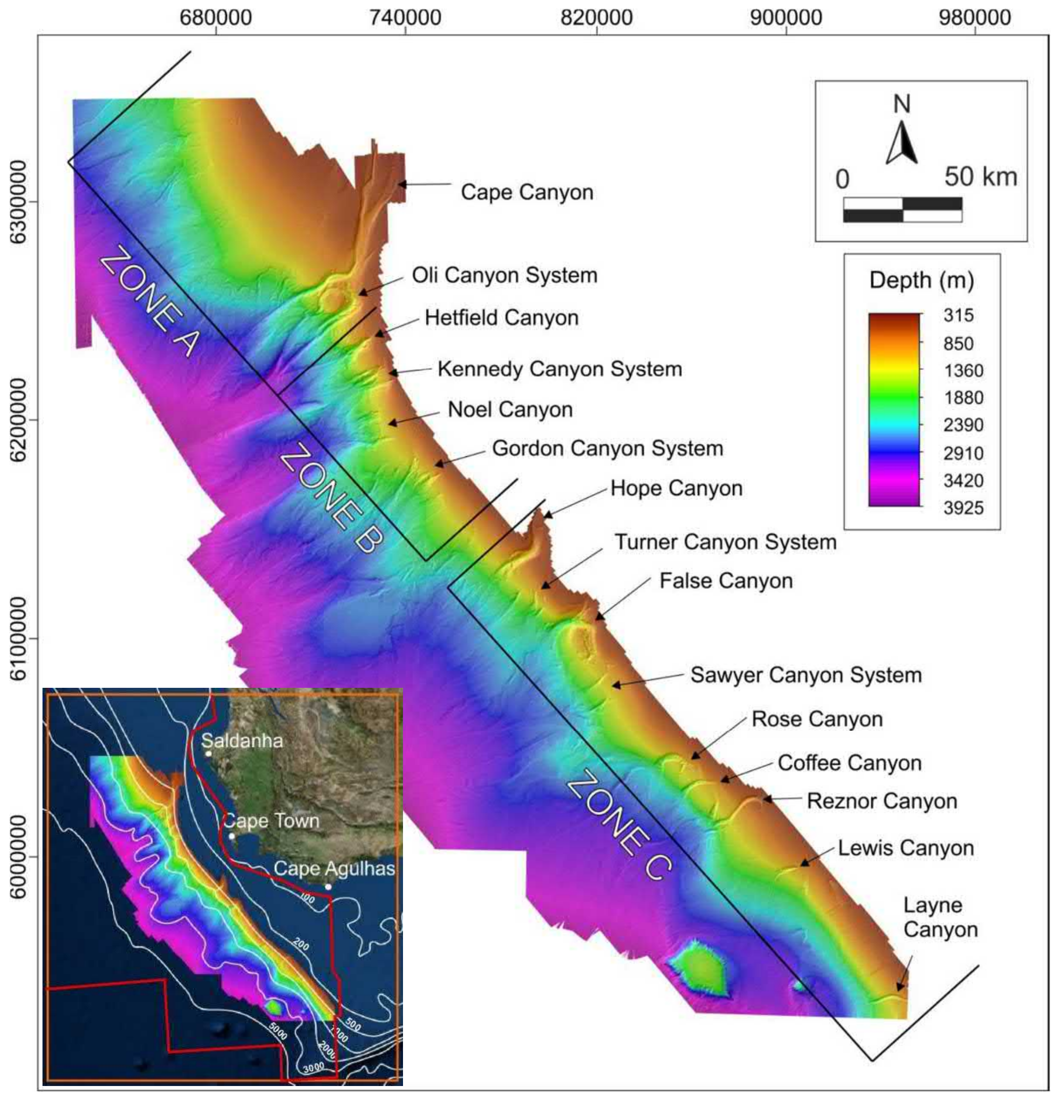

Figure 7-4: Submarine canyon domains of the southwestern Cape continental margin. Insert shows the locality of the study area within the southern portion of the Reconnaissance Permit area (red line).

Source: Palan 2017

7.3.1 Coastal and Inner-shelf Geology and Seabed Geomorphology

The inner shelf is underlain by Precambrian bedrock (also referred to as Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle 1973; Birch *et al*. 1976; Rogers 1977; Rogers & Bremner 1991).

As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. An almost 500 km long mud belt (of up to 40 km wide and of 15 m average thickness) is situated over the inner shelf between the Orange River and St Helena Bay (Birch *et al*. 1976). Further offshore and within the Reconnaissance

Permit area, sediment is dominated by muds and sandy muds (see Figure 7-5). The continental slope, seaward of the shelf break, has a smooth seafloor, underlain by calcareous ooze.

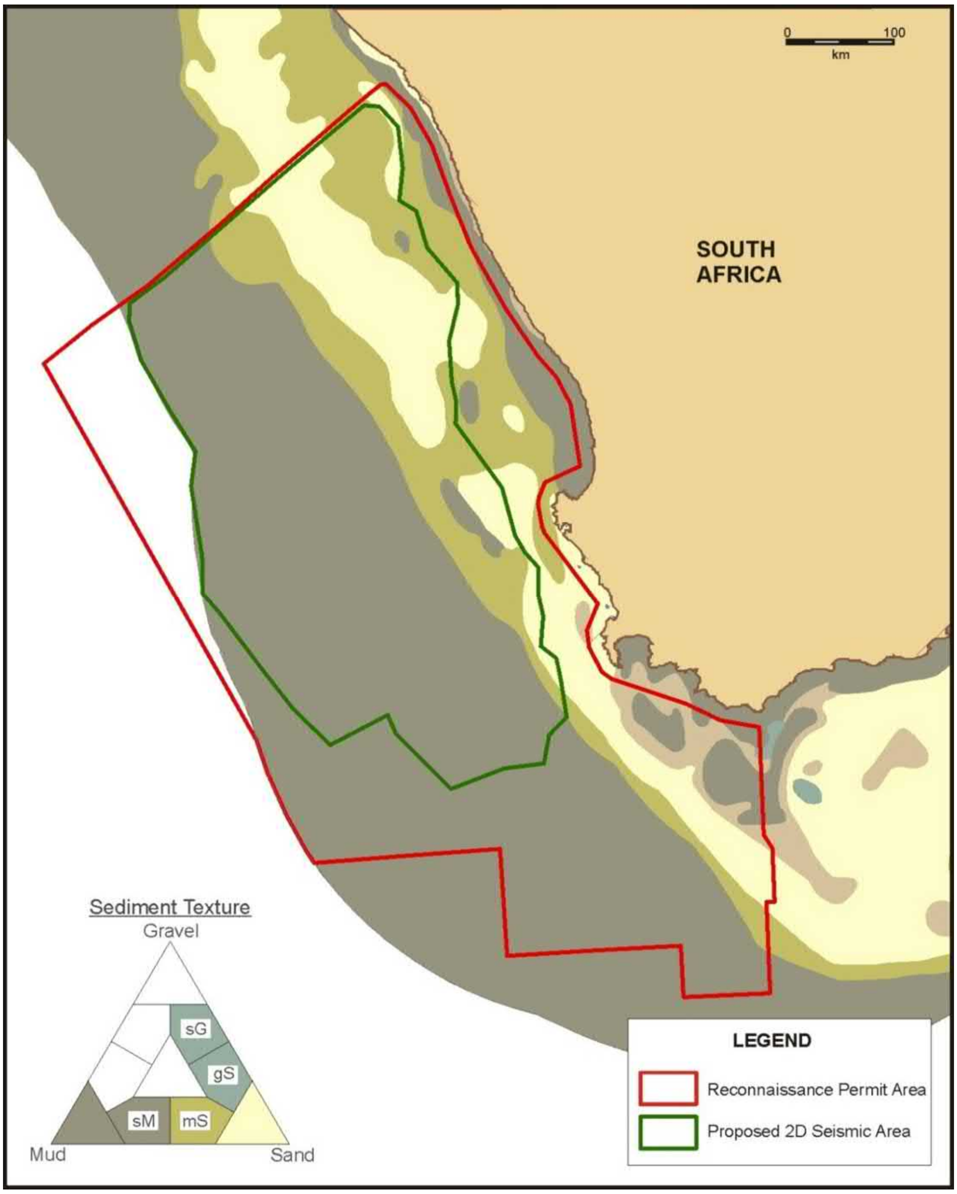

Figure 7-5: Distribution of sediment types along the West Coast in relation to the Reconnaissance Permit Area and proposed survey area.

Source: adapted from Sink *et al.* 2019

Present day sedimentation is limited to input from the Orange River. This sediment is generally transported northward. Most of the sediment in the area is therefore considered to be relict deposits by now ephemeral rivers active during wetter climates in the past. The Orange River, when in flood, still contributes largely to the mud belt as suspended sediment is carried southward by poleward flow. In this context, the absence of large sediment bodies on the inner shelf reflects on the paucity of terrigenous sediment being introduced by the few rivers that presently drain the South African West Coast coastal plain.

The benthic habitat types of the West Coast were classified and mapped in detail through the 2011 National Biodiversity Assessment (NBA) (Sink *et al.* 2012a). These were refined in the 2018 NBA (Sink *et al.* 2019) to provide substratum types (see Figure 7-6). In the Reconnaissance Permit Area the water depth ranges from approximately 120 m to over 4 000 m. The Southeast Atlantic Unclassified Slopes and Southeast Atlantic Unclassified and Rocky Abyss substrata dominate across the area. The shallower portions of the Reconnaissance Permit Area boast a diversity of substrata (Sink *et al.* 2019).

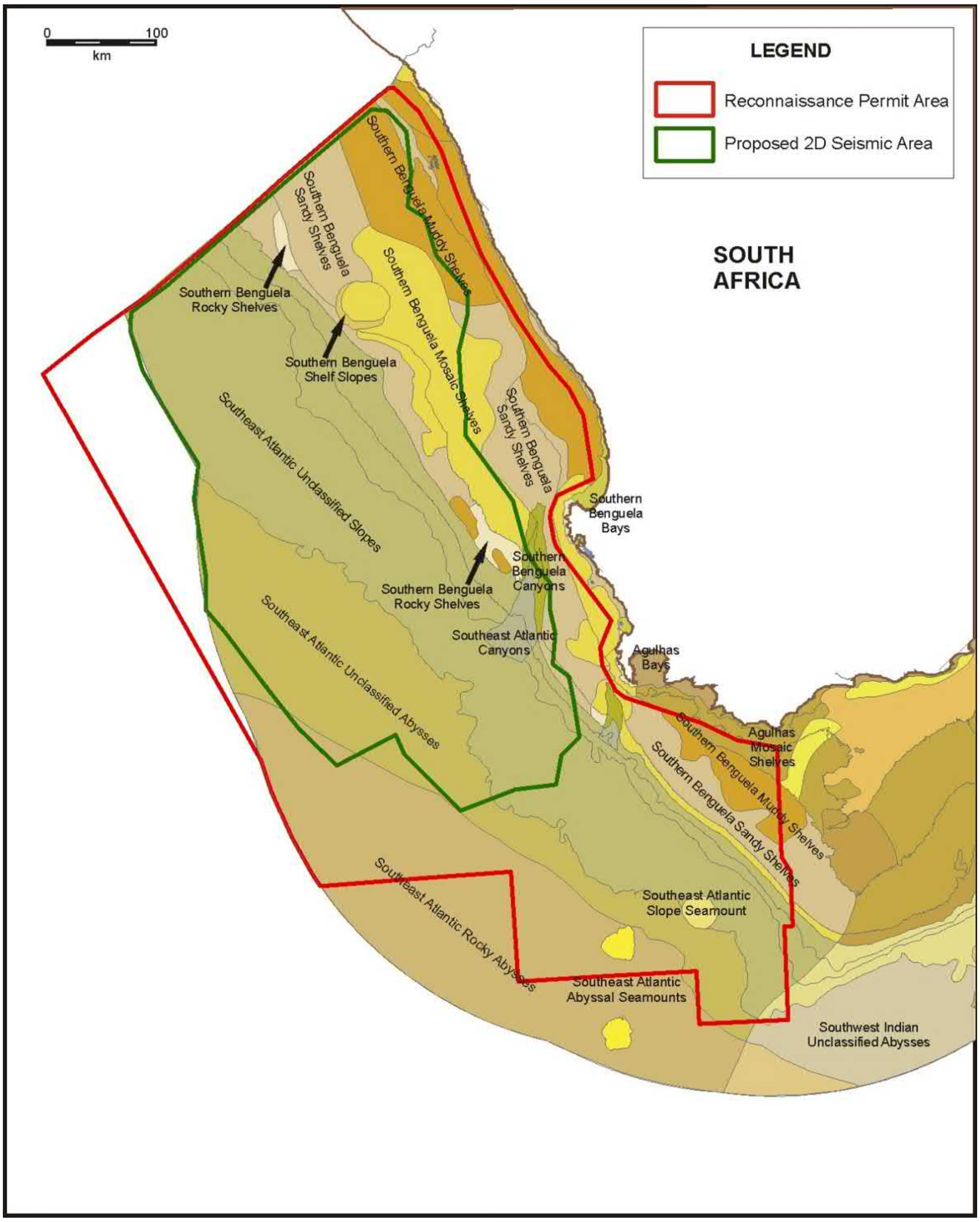

Figure 7-6: Distribution of substratum types along the West Coast in relation to the Reconnaissance Permit Area and proposed survey area.

Source: adapted from Sink *et al.* 2019

7.3.2 Large-Scale Circulation and Coastal Currents

The southern African West Coast is strongly influenced by the Benguela Current system. Current velocities in continental shelf areas generally range between 10 to 30 cm/s (Boyd & Oberholster, 1994) although localised flows in excess of 50 cm/s occur associated with eddies (PRDW 2013). In the south the Benguela current has a width of 200 km, widening rapidly northwards to 750 km. The flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington *et al.,* 1990; Nelson & Hutchings, 1983) (see Figure 7-7). Fluctuation periods of these flows are 3 - 10 days, although the long-term mean current residual is in an approximate northwest (alongshore) direction. Current speeds decrease with depth, while directions rotate from predominantly north-westerly at the surface to south-easterly near the seabed. Near bottom shelf flow is mainly poleward with low velocities of typically <5 cm/s (Nelson 1989; PRDW 2013). The poleward flow becomes more consistent in the southern Benguela.

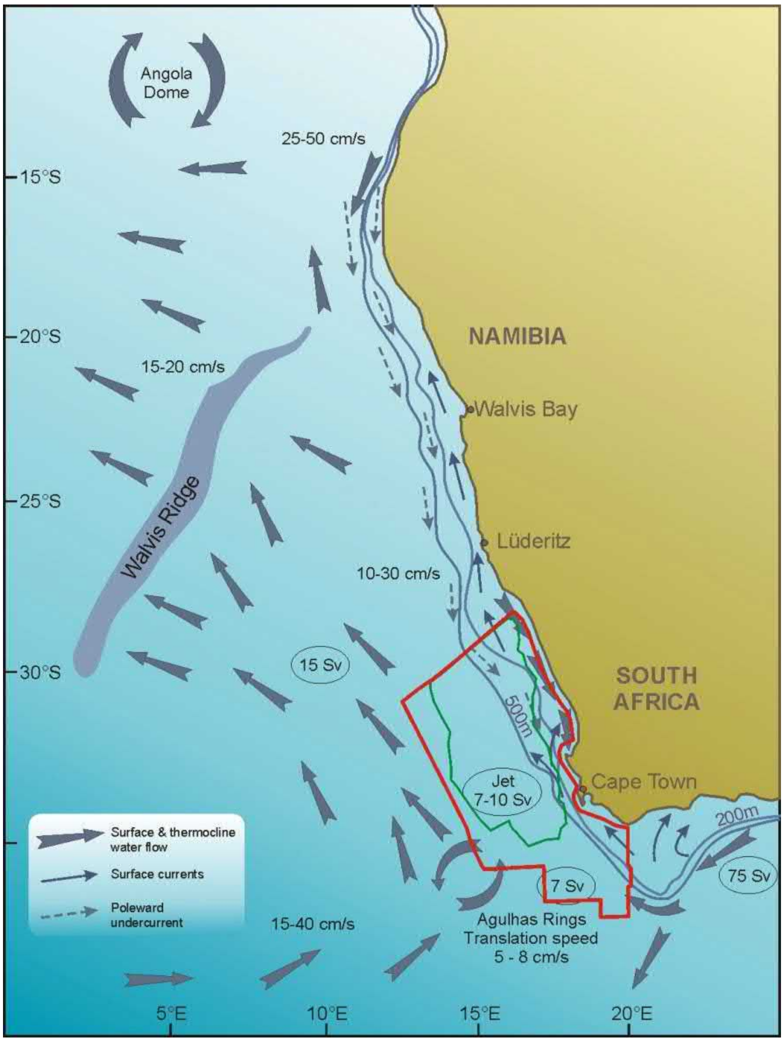

Figure 7-7: The Permit and survey area in relation to major features of the predominant circulation patterns and volume flows in the Benguela System

Source: adapted from Shannon & Nelson, 1996

The major feature of the Benguela Current is coastal upwelling and the consequent high nutrient supply to surface waters leads to high biological production and large fish stocks. The prevailing longshore, equatorward winds move nearshore surface water northwards and offshore. To balance the displaced water, cold, deeper water wells up inshore. Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest. There are three upwelling centres in the southern Benguela, namely the Namaqua (30°S), Cape Columbine (33°S) and Cape Point (34°S) upwelling cells (Taunton-Clark 1985). The proposed 2D survey area is located on the western edge of these upwelling events.

7.3.3 Waves and Tides

Most of the southern African West Coast is classified as exposed, experiencing strong wave action rating from 13-17 on the 20-point exposure scale (McLachlan, 1980). Much of the coastline is, therefore, influenced by heavy south-westerly swells generated in the roaring forties, as well as significant sea waves generated locally by the prevailing moderate to strong southerly winds. Monthly surface current roses in area of interest are shown in Figure 7-8.

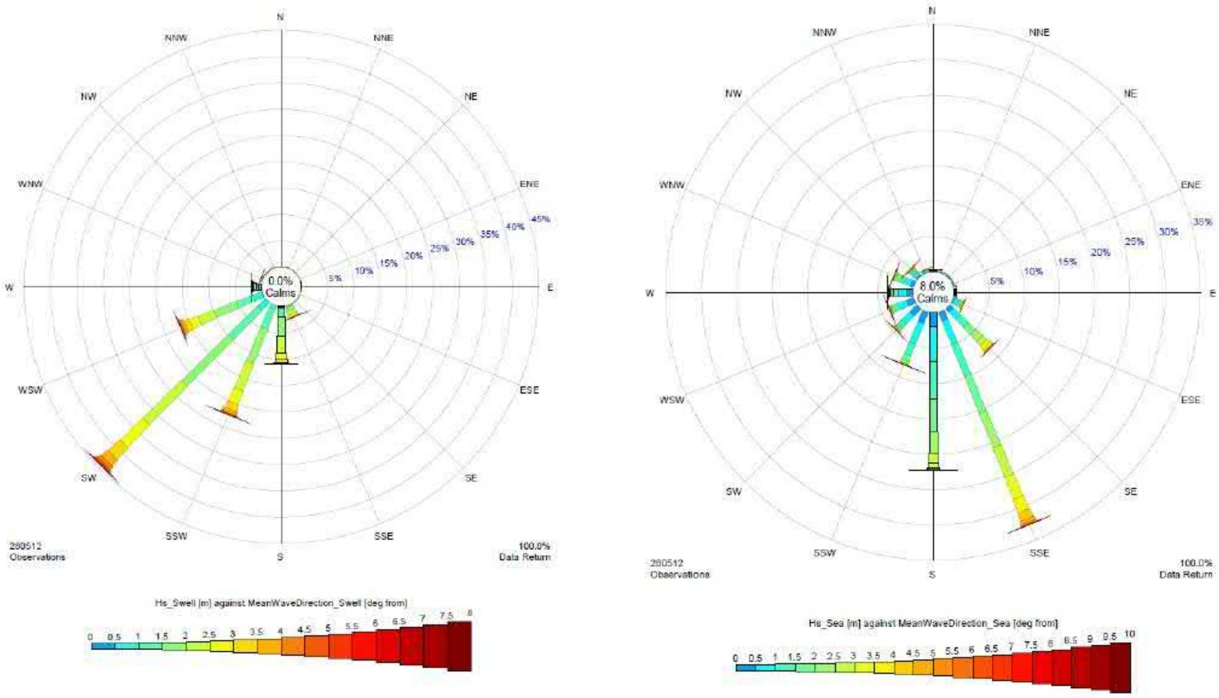

Figure 7-8: Annual rose plots of significant wave height partitions of swell (left) and wind-sea (right) for GROW1012 hind cast data at location 15°E, 31°S.

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

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

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.

7.3.4 Water

South Atlantic Central Water (SACW) comprises the bulk of the seawater in the study area, either in its pure form in the deeper regions, or mixed with previously upwelled water of the same origin on the continental shelf (Nelson & Hutchings 1983). Salinities range between 34.5% and 35.5% (Shannon 1985).

Seawater temperatures on the continental shelf of the southern Benguela typically vary between 6°C and 16°C. Well-developed thermal fronts exist, demarcating the seaward boundary of the upwelled water. Upwelling filaments are characteristic of these offshore thermal fronts, occurring as surface streamers of cold water, typically 50 km wide and extending beyond the normal offshore extent of the upwelling cell. Such fronts typically have a lifespan of a few days to a few weeks, with the filamentous mixing area extending up to 625 km offshore. South and east of Cape Agulhas, the Agulhas retroflection area is a global "hot spot" in terms of temperature variability and water movements.

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations, especially on the bottom. SACW itself has depressed oxygen concentrations (approximately 80% saturation value), but lower oxygen concentrations (<40% saturation) frequently occur (Bailey *et al.* 1985; Chapman & Shannon 1985).

Nutrient concentrations of upwelled water of the Benguela system attain 20 µM nitrate-nitrogen, 1.5 µM phosphate and 15-20 µM silicate, indicating nutrient enrichment (Chapman & Shannon 1985). This is mediated by nutrient regeneration from biogenic material in the sediments (Bailey *et al.* 1985). Modification of these peak concentrations depends upon phytoplankton uptake which varies according to phytoplankton biomass and production rate. The range of nutrient concentrations can thus be large but, in general, concentrations are high.

7.3.5 Upwelling & Plankton Production

The cold, upwelled water is rich in inorganic nutrients, the major contributors being various forms of nitrates, phosphates and silicates (Chapman & Shannon 1985). During upwelling the comparatively nutrient-poor surface waters are displaced by enriched deep water, supporting substantial seasonal primary phytoplankton production. This, in turn, serves as the basis for a rich food chain up through zooplankton, pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (hake and snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). High phytoplankton productivity in the upper layers again depletes the nutrients in these surface waters. This results in a wind-related cycle of plankton production, mortality, sinking of plankton detritus and eventual nutrient re-enrichment occurring below the thermocline as the phytoplankton decays.

Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest. There are three upwelling centres in the southern Benguela, namely the Namaqua (30°S), Cape Columbine (33°S) and Cape Point (34°S) upwelling cells (Taunton-Clark 1985) (Figure 7-9). Upwelling in these cells is seasonal, with maximum upwelling occurring between September and March. An example of one such strong upwelling event in December 1996, followed by relaxation of upwelling and intrusion of warm Agulhas waters from the south, is shown in the satellite images in Figure 7-9. The proposed 2D survey area is located on the western edge of these upwelling events. Although waters are expected to be comparatively warm and nutrient poor, seasonal upwelling can be expected.

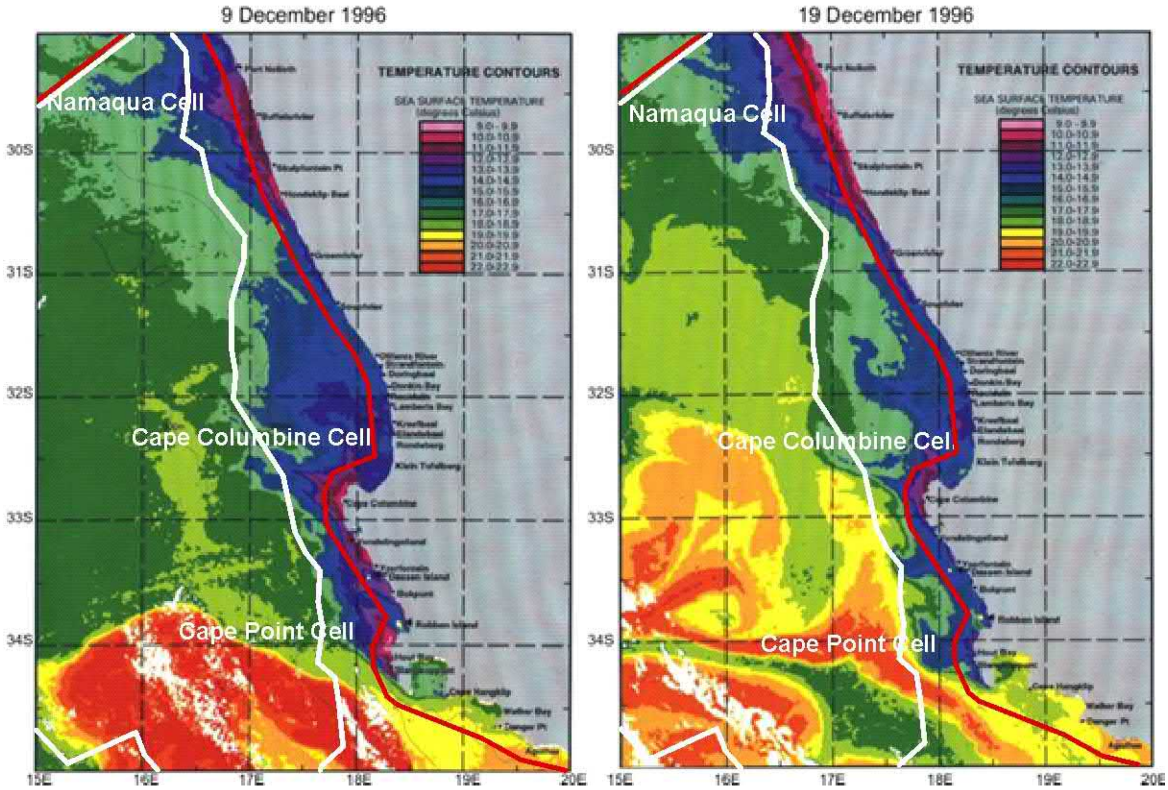

Figure 7-9: Satellite sea-surface temperature images showing upwelling intensity along the West Coast on two days in December 1996 (Lane & Carter 1999) in relation to the Reconnaissance Permit area (red line) and the proposed survey area (white line)

7.3.6 Organic Inputs

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

Balanced multispecies ecosystem models have estimated that during the 1990s the Benguela region supported biomasses of 76.9 tons/km^2 of phytoplankton and 31.5 tons/km^2 of zooplankton alone (Shannon et al. 2003). Thirty six percent of the phytoplankton and 5% of the zooplankton are estimated to be lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the southern African West Coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters.

An associated phenomenon ubiquitous to the Benguela system are red tides (dinoflagellate and/or ciliate blooms) (see Shannon & Pillar 1985; Pitcher 1998). Also referred to as Harmful Algal Blooms (HABs), these red tides can reach very large proportions, extending over several square kilometres of ocean. Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water. Being associated primarily with upwelling cells, HABs may occur in the inshore portions of the proposed 2D survey area.

7.3.7 Low Oxygen Events

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations with <40% saturation occurring frequently (e.g. Visser 1969; Bailey et al. 1985). The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman & Shannon 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches (see Figure 7-5), there are corresponding preferential areas for the formation of oxygen-poor water. The two main areas of low-oxygen water formation in the southern Benguela region are in the Orange River Bight and St Helena Bay (Chapman & Shannon 1985; Bailey 1991; Shannon & O'Toole 1998; Bailey 1999; Fossing *et al*. 2000). The spatial distribution of oxygen-poor water in each of the areas is subject to short- and medium-term variability in the volume of hypoxic water that develops. De Decker (1970) showed that the occurrence of low oxygen water off Lambert's Bay is seasonal, with highest development in summer/autumn. Bailey & Chapman (1991), on the other hand, demonstrated that in the St Helena Bay area daily variability exists as a result of downward flux of oxygen through thermoclines and short-term variations in upwelling intensity. Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

Periodic low oxygen events in the nearshore region can have catastrophic effects on the marine communities leading to large-scale stranding of rock lobsters, and mass mortalities of marine biota and fish (Newman & Pollock 1974; Matthews & Pitcher 1996; Pitcher 1998; Cockcroft *et al*. 2000). The development of anoxic conditions as a result of the decomposition of huge amounts of organic matter generated by phytoplankton blooms is the main cause for these mortalities and walkouts. The blooms develop over a period of unusually calm wind conditions when sea surface temperatures where high. Algal blooms usually occur during summer-autumn (February to April) but can also develop in winter during the 'berg' wind periods, when similar warm windless conditions occur for extended periods.

7.3.8 Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) can be divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. Off Namaqualand, the PIM loading in nearshore waters is strongly related to natural inputs from the Orange River or from 'berg' wind events. Although highly variable, annual discharge rates of sediments by the Orange River is estimated to vary from 8 - 26 million tons/yr (Rogers 1979). 'Berg' wind events can potentially contribute the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Shannon & Anderson 1982; Zoutendyk 1992, 1995; Shannon & O'Toole 1998; Lane & Carter 1999). For example, a 'berg' wind event in May 1979 described by Shannon and Anderson (1982) was estimated to have transported in the order of 50 million tons of sand out to sea, affecting an area of 20 000 km^2.

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/ℓ to several tens of mg/ℓ (Berg & Newell 1986; Fegley *et al.* 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/ℓ, showing significant long-shore variation (Zoutendyk 1995). Considerably higher concentrations of PIM have, however, been reported from southern African West Coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions. In the vicinity of the Orange River mouth, where river outflow strongly influences the turbidity of coastal waters, measured concentrations ranged from 14.3 mg/ℓ at Alexander Bay just south of the mouth (Zoutendyk 1995) to peak values of 7 400 mg/ℓ immediately upstream of the river mouth during the 1988 Orange River flood (Bremner *et al.* 1990).

The major source of turbidity in the swell-influenced nearshore areas off the West Coast is the redistribution of fine inner shelf sediments by long-period Southern Ocean swells. The current velocities typical of the Benguela (10-30 cm/s) are capable of resuspending and transporting considerable quantities of sediment equatorwards. Under relatively calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow poleward undercurrent (Rogers & Bremner 1991).

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This northward, nearshore transport is generated by the predominantly south-westerly swell and wind-induced waves. Longshore sediment transport varies considerably in the shore-perpendicular dimension, being substantially higher in the surf-zone than at depth, due to high turbulence and convective flows associated with breaking waves, which suspend and mobilise sediment (Smith & Mocke 2002).

On the inner and middle continental shelf, the ambient currents are insufficient to transport coarse sediments typical of those depths, and re-suspension and shoreward movement of these by wave-induced currents occur primarily under storm conditions (see also Drake *et al.* 1985; Ward 1985). Data from a Waverider buoy at Port Nolloth have indicated that 2-m waves are capable of re-suspending medium sands (200 µm diameter) at approximately 10 m depth, whilst 6 m waves achieve this at approximately 42 m depth. Low-amplitude, long-period waves will, however, penetrate even deeper. Most of the sediment shallower than 90 m can therefore be subject to re-suspension and transport by heavy swells (Lane & Carter 1999). Offshore of the continental shelf, the oceanic waters are typically clear as they are beyond the influence of aeolian and riverine inputs. The waters in the proposed 2D survey area are thus expected to be comparatively clear.

7.4 BIOLOGICAL OCEANOGRAPHY

7.4.1 Introduction

Biogeographically, the study area falls into the cold temperate Namaqua Bioregion, which extend from Sylvia Hill, north of Lüderitz in Namibia to Cape Columbine (Emanuel *et al.* 1992; Lombard *et al.* 2004). The Reconnaissance Permit area and proposed 2D survey area fall primarily into the Southern Benguela and Southeast Atlantic Deep Ocean Ecoregion (Sink *et al.* 2019) (see Figure 7-10). The coastal, wind-induced upwelling characterising the western Cape coastline, is the principle physical process which shapes the marine ecology of the southern Benguela region. The Benguela system is characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions.

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

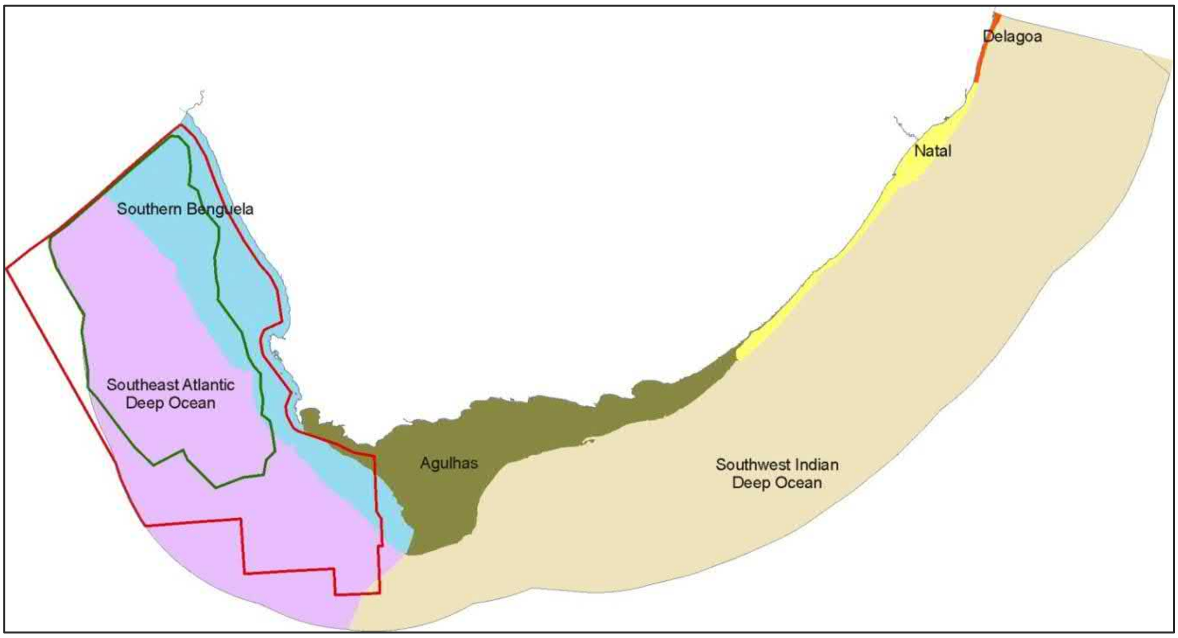

Figure 7-10: The inshore and offshore ecoregions of the South African coast in relation to the Reconnaissance Permit (red outline) and proposed survey area (green outline)
Adapted from Sink *et al*. 2019

7.4.2 Benthic Invertebrate Macrofauna Communities

The seabed communities in the Reconnaissance Permit area lie within the Namaqua sub-photic and continental slope biozones, which extend from a 30 m depth to the shelf edge, and beyond to the lower deepsea slope, respectively. 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 7-11) and assigned an ecosystem threat status based on their level of protection (see Figure 7-12). The majority of the Deep Western Orange Basin block is characterised by Southeast Atlantic Lower Slope habitat, with some representation by Southeast Atlantic Mid and Upper Slope, and Cape Basin Abyss habitats.

The benthic biota of unconsolidated marine sediments constitutes invertebrates that live on (epifauna) or burrow within (infauna) the sediments and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm).

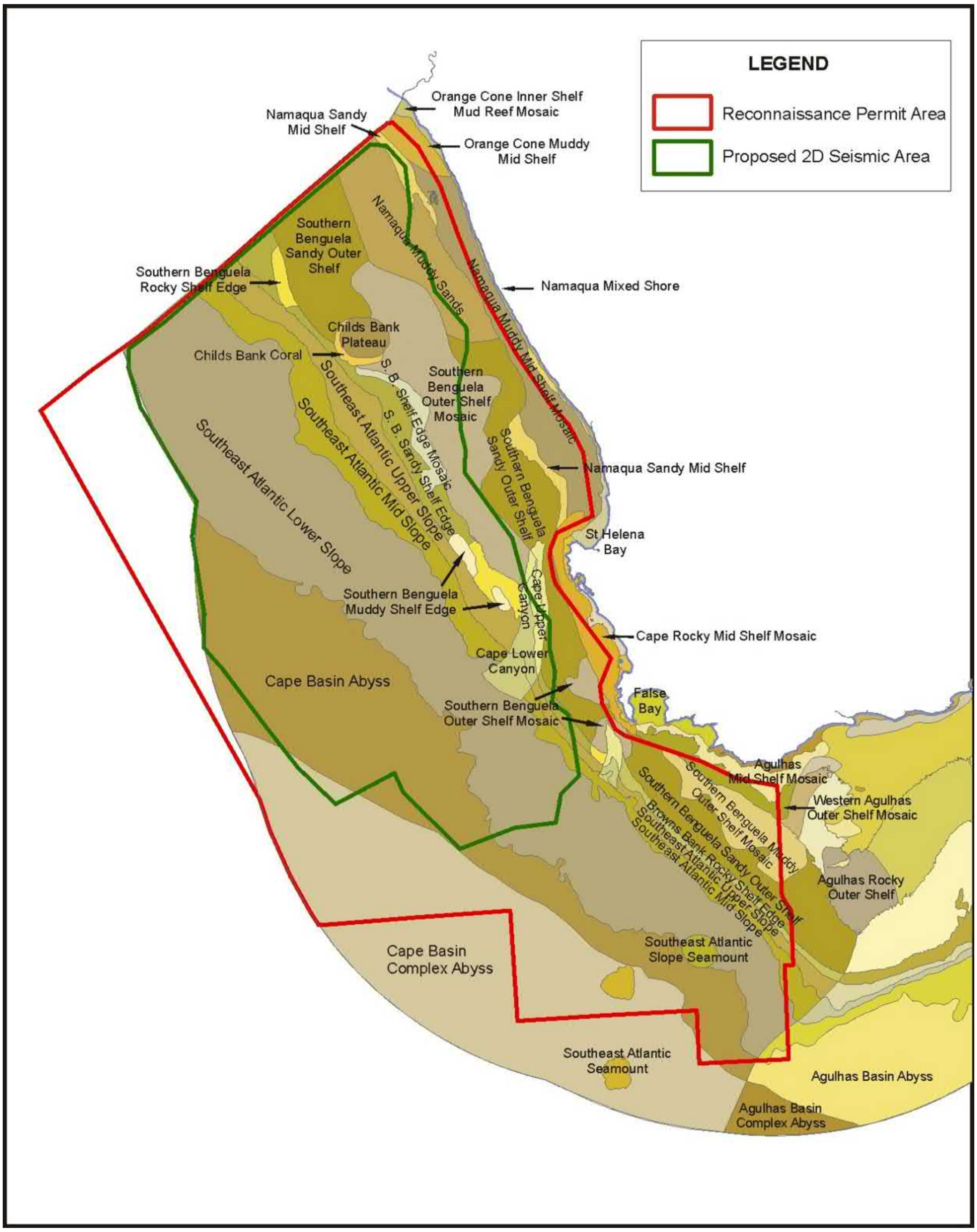

Figure 7-11: The project area in relation to the distribution of ecosystem types along the West Coast.
Source: adapted from Sink *et al.* 2019

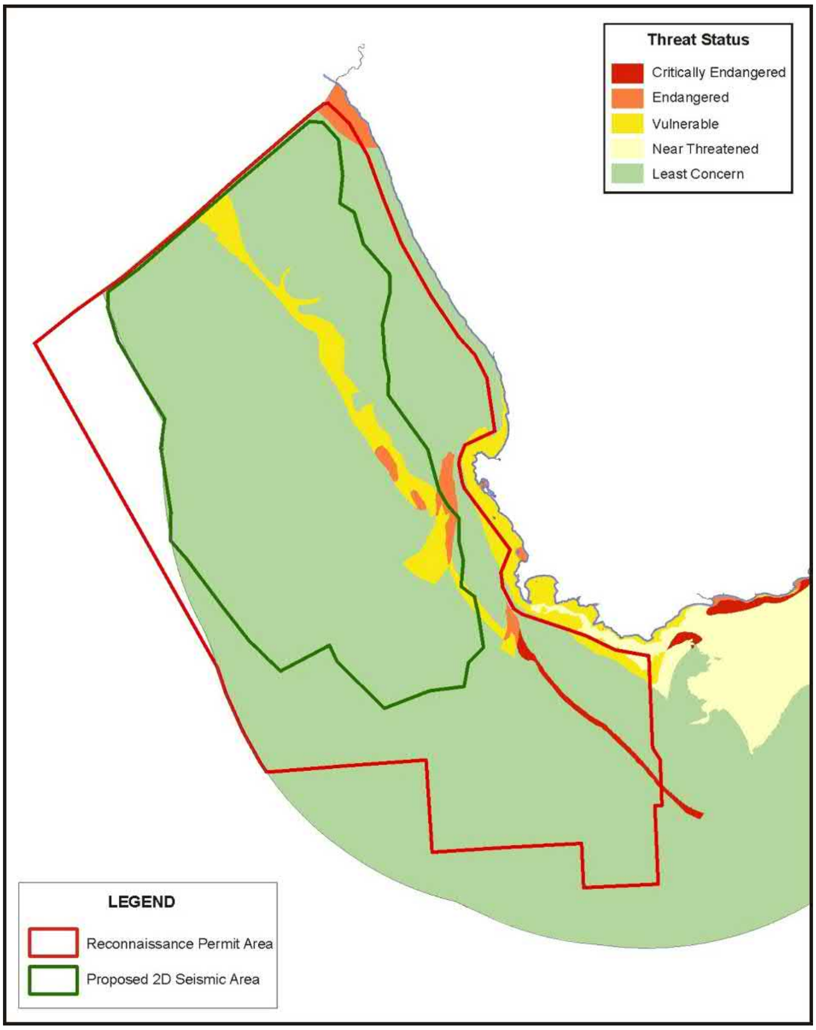

Figure 7-12: The project area in relation to the ecosystem threat status for coastal and offshore benthic and pelagic habitat types on the South African West Coast
Source: adapted from Sink *et al.* 2019

Numerous studies have been conducted on the southern African West Coast continental shelf benthos, concentrating on the nearshore regions. Consequently, the benthic fauna of the outer shelf and continental slope (beyond 450 m depth) are very poorly known. This is primarily due to limited opportunities for sampling as well as the lack of access to Remote Operated Vehicles (ROVs) for visual sampling of hard substrata.

To date very few areas on the continental slope off the West Coast have been biologically surveyed. Although sediment distribution studies (Rogers & Bremner 1991) suggest that the outer shelf is characterised by unconsolidated sediments (see Figure 7-5), recent surveys conducted between 180 m and 480 m depth offshore of the Northern Cape coast revealed high proportions of hard ground rather than unconsolidated sediment, although this requires further verification (Karenyi unpublished data).

Due to the lack of information on benthic macrofaunal communities beyond the shelf break, no description can be provided for the Reconnaissance Permit Area. The description below for areas on the continental shelf, offshore of the Northern Cape coast is drawn from recent surveys by Karenyi (2014), Duna *et al.* (2016), Mostert *et al.* (2016), and Giwhala *et al.* (2018, 2019).

Three macro-infauna communities have been identified on the inner- (0-30 m depth) and mid-shelf (30-150 m depth, Karenyi *et al*. 2016). Polychaetes, crustaceans and molluscs make up the largest proportion of individuals, biomass and species on the west coast. The inner-shelf community, which is affected by wave action, is characterised by various mobile gastropod and polychaete predators and sedentary polychaetes and isopods. The mid-shelf community inhabits the mudbelt and is characterised by mud prawns. A second mid-shelf community occurring in sandy sediments, is characterised by various deposit-feeding polychaetes. The distribution of species within these communities are inherently patchy reflecting the high natural spatial and temporal variability associated with macro-infauna of unconsolidated sediments (e.g. Kenny *et al*. 1998; Kendall & Widdicombe 1999; van Dalfsen *et al.* 2000; Zajac *et al*. 2000; Parry *et al*. 2003), with evidence of mass mortalities and substantial recruitments recorded on the South African West Coast (Steffani & Pulfrich 2004).

Despite the current lack of knowledge of the community structure and endemicity of South African macro-infauna off the edge of the continental shelf, the marine component of the 2018 National Biodiversity Assessment (Sink *et al.* 2019), rated the South Atlantic bathyal and abyssal unconsolidated habitat types that characterise depths beyond 500 m, as being of 'Least concern' (refer to Figure 7-12), with only those communities occurring along the shelf edge (500 m) being considered 'Vulnerable'. This primarily reflects the great extent of these habitats in the EEZ.

Generally species richness increases from the inner-shelf across the mid-shelf and is influenced by sediment type. The highest total abundance and species diversity was measured in sandy sediments of the mid-shelf. Biomass is highest in the inshore (± 50 g/m^2 wet weight) and decreases across the mid-shelf averaging around 30 g/m^2 wet weight. This is contrary to Christie (1974) who found that biomass was greatest in the mudbelt at 80 m depth off Lamberts Bay, where the sediment characteristics and the impact of environmental stressors (such as low oxygen events) are likely to differ from those off the northern Namaqualand coast.

Benthic communities are structured by the complex interplay of a large array of environmental factors. Water depth and sediment grain size are considered the two major factors that determine benthic community structure and distribution on the South African west coast (Christie 1974, 1976; Steffani & Pulfrich 2004; 2007; Steffani 2007a; 2007b) and elsewhere in the world (e.g. Gray 1981; Ellingsen 2002; Bergen *et al.* 2001; Post *et al.* 2006). However, studies have shown that shear bed stress - a measure of the impact of current velocity on sediment – oxygen concentration (Post *et al.* 2006; Currie *et al.* 2009; Zettler *et al.* 2009, 2013), productivity (Escaravage *et al.* 2009), organic carbon and seafloor temperature (Day *et al.* 1971) may also strongly influence the structure of benthic communities. There are clearly other natural processes operating in the deep water shelf areas of the West Coast that can over-ride the suitability of sediments in determining benthic community structure, and it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro & van der Plas 2006; Pulfrich *et al.* 2006). In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure.

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

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

Information on the benthic fauna of the lower continental slope and abyss (beyond 1 800 m depth) is largely lacking due to limited opportunities for sampling. However, deep water benthic sampling was undertaken (Benthic Solutions Ltd 2019) just to the north of the Deep Western Orange Basin area and provided valuable information on the benthic infaunal communities in such deep water habitats. From this sampling, the macrofauna were found to be generally impoverished but fairly consistent, which is typical for deep water sediments. The 105 species recorded, were dominated by polychaetes, which accounted for 64.1% of the total individuals. Molluscs were represented by 11 species (19.6% of total individuals), whilst 20 species of crustaceans were recorded (contributing to only 9.8% of total individuals). Echinoderms were represented by only 3 species (5.8% of total individuals), whilst all other groups (Actiniaria, Nemertea, Nematoda, Ascidiacea and Priapulida) accounted for the remaining 5.9% of individuals. The deposit-feeding polychaete *Spiophanes* sp. was the most abundant species recorded. This small bristleworm can either be a passive suspension feeder or a surface deposit feeder, living off sediment particles, planktonic organisms and meiobenthic organisms. The bivalve mollusc *Microgloma mirmidina* was the second most common species, with the polychaete tentatively identified as a *Leiocapitellide* being the third most abundant. With the exception of the carnivorous polychaete *Glycera capitata*, most species were suspension or deposit feeders typical of soft unconsolidated sediments.

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.

7.4.3 Deep-water coral communities

There has been increasing interest in deep-water corals in recent years because of their likely sensitivity to disturbance and their long generation times. These benthic filter-feeders generally occur at depths in below 150 m with some species being recorded from as deep as 3 000 m. Some species form reefs while others are smaller and remain solitary. Corals add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze *et al.* 1997; MacIssac *et al.* 2001). Deep water corals establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current over special topographical formations which cause eddies to form. Nutrient seepage from the substratum might also promote a location for settlement (Hovland *et al.* 2002). In the productive Benguela region, substantial areas on and off the edge of the shelf should thus potentially be capable of supporting rich, cold water, benthic, filter-feeding communities and various species of scleractine and stylastrine corals have been reported from depths beyond 200 m in the Orange Basin.

7.4.4 Seamount Communities

Features such as banks, knolls and seamounts (referred to collectively here as “seamounts”), which protrude into the water column, are subject to, and interact with, the water currents surrounding them. The effects of such seabed features on the surrounding water masses can include the upwelling of relatively cool, nutrient-rich water into nutrient-poor surface water thereby resulting in higher productivity (Clark *et al.,* 1999), which can in turn strongly influence the distribution of organisms on and around seamounts. Evidence of enrichment of bottom-associated communities and high abundances of demersal fishes has been regularly reported over such seabed features.

The enhanced fluxes of detritus and plankton that develop in response to the complex current regimes lead to the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Seamounts provide an important habitat for commercial deep-water fish stocks such as orange roughy, oreos, alfonsino and Patagonian toothfish, which aggregate around these features for either spawning or feeding (Koslow, 1996).

Such complex benthic ecosystems in turn enhance foraging opportunities for many other predators, serving as mid-ocean focal points for a variety of pelagic species with large ranges (turtles, tunas and billfish, pelagic sharks, cetaceans and pelagic seabirds) that may migrate large distances in search of food or may only congregate on seamounts at certain times (Hui, 1985; Haney *et al.*, 1995). Seamounts thus serve as feeding grounds, spawning and nursery grounds and possibly navigational markers for a large number of species (SPRFMA, 2007).

Enhanced currents, steep slopes and volcanic rocky substrata, in combination with locally generated detritus, favour the development of suspension feeders in the benthic communities characterising seamounts (Rogers, 1994). Deep- and cold-water corals (including stony corals, black corals and soft corals) are a prominent component of the suspension-feeding fauna of many seamounts, accompanied by barnacles, bryozoans, polychaetes, molluscs, sponges, sea squirts, basket stars, brittle stars and crinoids (reviewed in Rogers, 2004). There is also associated mobile benthic fauna that includes echinoderms (sea urchins and sea cucumbers) and crustaceans (crabs and lobsters) (reviewed by Rogers, 1994). Some of the smaller cnidarians species remain solitary while others form reefs thereby adding structural complexity to otherwise uniform seabed habitats. 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. Compared to the surrounding deep-sea environment, seamounts typically form biological hotspots with a distinct, abundant and diverse fauna, many species of which remain unidentified. Consequently, the fauna of seamounts is usually highly unique and may have a limited distribution restricted to a single geographic region, a seamount chain or even a single seamount location (Rogers *et al.,* 2008). Levels of endemism on seamounts are also relatively high compared to the deep sea. As a result of conservative life histories (*i.e*. very slow growing, slow to mature, high longevity, low levels of recruitment) and sensitivity to changes in environmental conditions, such biological communities have been identified as Vulnerable Marine Ecosystems (VMEs). They are recognised as being particularly sensitive to anthropogenic disturbance (primarily deep-water trawl fisheries and mining), and once damaged are very slow to recover, or may never recover (FAO, 2008).

Geological features of note in the vicinity of the project area are Child’s Bank, Tripp Seamount and the Southeast Atlantic Seamounts, as well as the Cape Canyon and Cape Point Valley (refer to Figure 7-3). Child’s Bank, which is situated at about 31°S, was described by Dingle *et al.* (1987) to be a carbonate mound (bioherm). The top of this feature is a sandy plateau with dense aggregations of brittle stars, while the steeper slopes have dense invertebrate assemblages including unidentified cold-water corals/rugged limestone feature, bounded at outer edges by precipitous cliffs at least 150 m high (Birch & Rogers 1973). Composed of sediments and the calcareous deposits from an accumulation of carbonate skeletons of sessile organisms (e.g. cold-water coral, foraminifera or marl), such features typically have topographic relief, forming isolated seabed knolls in otherwise low profile homogenous seabed habitats (Kopaska-Merkel & Haywick 2001; Kenyon *et al.* 2003, Wheeler *et al.* 2005, Colman *et al.* 2005). Tripp Seamount situated at about 29°40'S, lies approximately 30 km north of the northern boundary of the Reconnaissance Permit area. It rises from the seabed at approximately 1 000 m to a depth of 150 m and is roughly circular with a flat apex that drops steeply on all sides. There is reference to decapods crustaceans from Tripp Seamount (Kensley 1980, 1981) and exploratory deepwater trawl fishing (Hampton 2003), but otherwise knowledge of benthic communities characterising this seamount is lacking.

It is not always the case that seamount habitats are VMEs, as some seamounts may not host communities of fragile animals or be associated with high levels of endemism. Evidence from video footage taken on hard-substrate habitats in 100 - 120 m depth off southern Namibia and to the south-east of Child's Bank (see Figure 7-13), and in 190 – 527 m depth on Child's Bank (Sink *et al*. 2019) suggest that vulnerable communities including gorgonians, octocorals and reef-building sponges and hard-corals do occur on the continental shelf, some of which are thought to be VME indicator species. The distribution of 22 potential VME indicator taxa for the South African EEZ were recently mapped, with those from the northern West Coast listed in Table 7-1 (Atkinson & Sink 2018; Sink *et al.* 2019).

Figure 7-13: Gorgonians and bryozoans communities recorded on deep-water reefs (100-120 m) off the southern African West Coast

Source: De Beers Marine

Sediment samples collected at the base of Norwegian cold-water coral reefs revealed high interstitial concentrations of light hydrocarbons (methane, propane, ethane and higher hydrocarbons C4+) (Hovland & Thomsen 1997), which are typically considered indicative of localised light hydrocarbon micro-seepage through the seabed. Bacteria and other micro-organisms thrive on such hydrocarbon pore-water seepages, thereby providing suspension-feeders, including corals and gorgonians, with a substantial nutrient source. Some scientists believe there is a strong correlation between the occurrence of deep-water coral reefs and the relatively high values of light hydrocarbons (methane, ethane, propane and n-butane) in near-surface sediments (Hovland *et al.* 1998, Duncan & Roberts 2001, Hall-Spencer *et al.* 2002, Roberts & Gage 2003). A recent study by

January (2018) identified that hydrocarbon seeps and gas escape structures have been identified in the Orange Basin area.

Table 7-1: Potential VME species from the continental shelf and shelf edge on the West Coast (Atkinson & Sink 2018)

Phylum	Name	Common Name
Porifera	*Suberites dandelenae*	Amorphous solid sponge
	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
	Stylaster spp.	Fine-branching hydrocoral
Bryozoa	*Adeonella* spp.	Sabre bryozoan
	Phidoloporidae spp.	Honeycomb false lace coral
Hemichordata	*Cephalodiscus gilchristi*	Agar animal

7.4.5 Plankton

Plankton is particularly abundant in the shelf waters off the West Coast, being associated with the upwelling characteristic of the region. Plankton range from single-celled bacteria to jellyfish of 2 m diameter and include bacterio-plankton, phytoplankton, zooplankton, and ichthyoplankton.

Off the West Coast, phytoplankton are the principle primary producers with mean annual productivity being comparatively high at 2.5 – 3.5 g C/m^2/day for the midshelf region and decreasing to 1 g C/m^2/day inshore of 130 m (Shannon & Field 1985; Mitchell-Innes & Walker 1991; Walker & Peterson 1991). The phytoplankton is dominated by diatoms, which are adapted to the turbulent sea conditions. Diatom blooms occur after upwelling events, whereas dinoflagellates are more common in blooms that occur during quiescent periods.

Zooplankton biomass varies with phytoplankton abundance and, accordingly, seasonal minima will exist during non-upwelling periods when primary production is lower (Brown 1984; Brown & Henry 1985), and during winter when predation by recruiting anchovy is high. More intense variation will occur in relation to the upwelling cycle; newly upwelled water supporting low zooplankton biomass due to paucity of food, whilst high biomasses develop in aged upwelled water subsequent to significant development of phytoplankton. Irregular pulsing of the upwelling system, combined with seasonal recruitment of pelagic fish species into West Coast shelf waters during winter, thus results in a highly variable and dynamic balance between plankton replenishment and food availability for pelagic fish species.

Although ichthyoplankton (fish eggs and larvae) comprise a minor component of the overall plankton, it remains significant due to the commercial importance of the overall fishery in the region. Various pelagic and demersal fish species are known to spawn in the inshore regions of the southern Benguela, (including pilchard, round herring, chub mackerel lanternfish and hakes (Crawford *et al.* 1987), and their eggs and larvae form an important contribution to the ichthyoplankton in the region (see Section 7.4.7). Ichthyoplankton abundance in the offshore oceanic waters of the proposed survey area are, however, expected to be low.

7.4.6 Cephalopods

The major cephalopod resource in the southern Benguela is cuttlefish with up to 14 species being recorded (Lipinski, 1992; Augustyn *et al.,* 1995). Most of the cephalopod resource is distributed on the mid-shelf with *Sepia australis* being most abundant at depths between 60 - 190 m, whereas *S. hieronis* densities were higher at depths between 110 - 250 m. *Rossia enigmatica* occurs more commonly on the edge of the shelf to depths of 500 m. Biomass of these species was generally higher in the summer than in winter. Cuttlefish are largely epi-benthic and occur on mud and fine sediments in association with their major prey item; mantis shrimps (Augustyn *et al.,* 1995). They form an important food item for demersal fish.

Pelagic invertebrates that may be encountered in the proposed survey area are the colossal squid, *Mesonychoteuthis hamiltoni,* and the giant squid, *Architeuthis sp*. Both are deep dwelling species, with the colossal squid's distribution confined to the entire circum-Antarctic Southern Ocean (see Figure 7-14), while the giant squid is usually found near continental and island slopes all around the world's oceans (see Figure 7-15). Both species could thus potentially occur in the licence area, although the likelihood of encounter is extremely low. Growing to in excess of 10 m in length, they are the principal prey of the sperm whale, and are also taken by beaked whaled, pilot whales, elephant seals and sleeper sharks. Nothing is known of their vertical distribution, but data from trawled specimens and sperm whale diving behaviour suggest they may span a depth range of 300 to 1 000 m. They lack gas-filled swim bladders and maintain neutral buoyancy through an ammonium chloride solution occurring throughout their bodies.

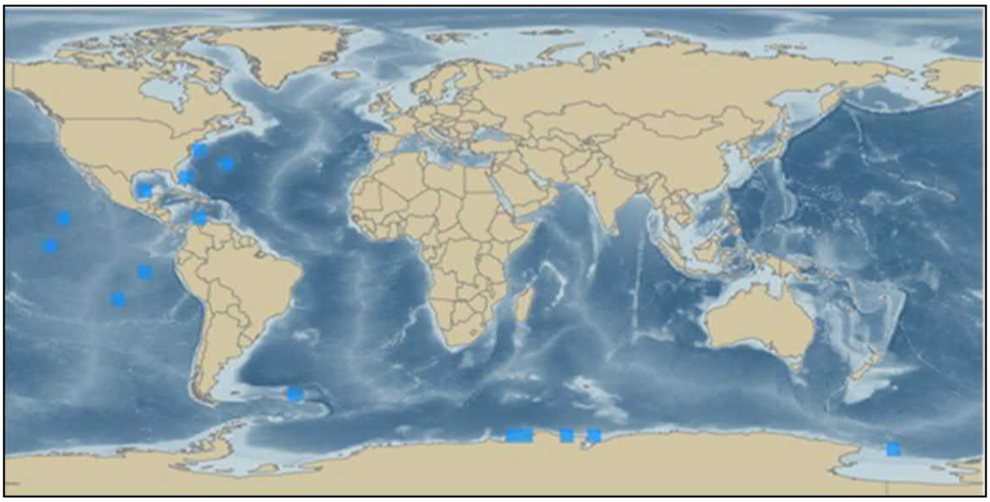

Figure 7-14: Distribution of the colossal squid. key: blue <5 observations

Source: http://iobis.org

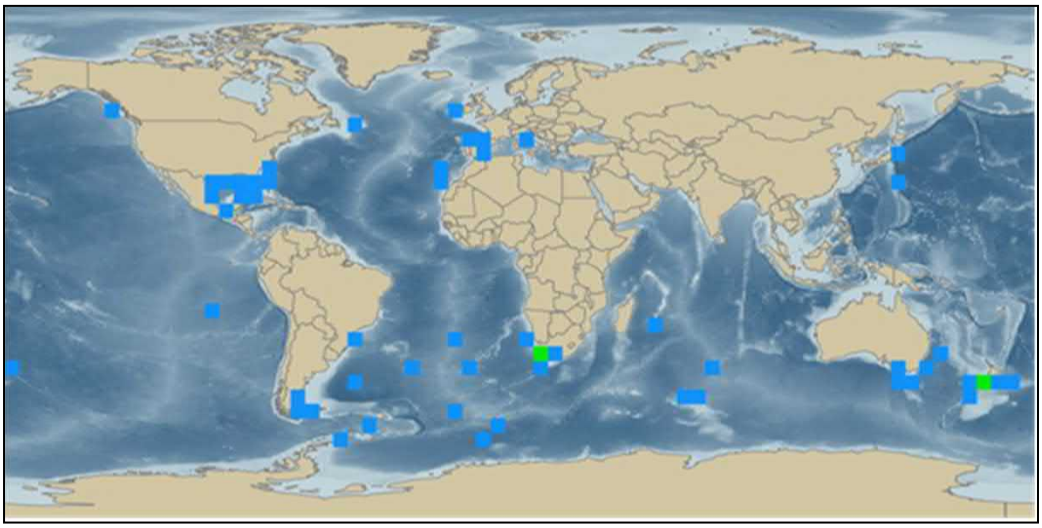

Figure 7-15: Distribution of the giant squid. Key: Blue <5 observations; Green 5-10 observations

Source: http://iobis.org

7.4.7 Fish

7.4.7.1 Pelagic fish

Marine fish can generally be divided in three different groups, namely demersal (those associated with the substratum), pelagic (those species associated with water column) or meso-pelagic (fish found generally in deeper water and may be associated with both the seafloor and the pelagic environment). Pelagic species include two major groups, the planktivorous clupeid-like fishes such as anchovy or pilchard and piscivorous predatory fish. Demersal fish can be grouped according to the substratum with which they are associated, for example rocky reef or soft substrata. It must be noted that such divisions are generally simplistic, as certain species associate with more than one community.

Small pelagic species include the sardine/pilchard (*Sadinops ocellatus*), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes (Crawford *et al.* 1987), and generally occur within the 200 m contour and thus unlikely to be encountered in the project area. Most of the pelagic species exhibit similar life history patterns involving seasonal migrations between the west and south coasts. The spawning areas of the major pelagic species are distributed on the continental shelf and along the shelf edge extending from south of St Helena Bay to Mossel Bay on the South Coast (Shannon & Pillar 1986) (see Figure 7-16). They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried around Cape Point and up the coast in northward flowing surface waters.

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

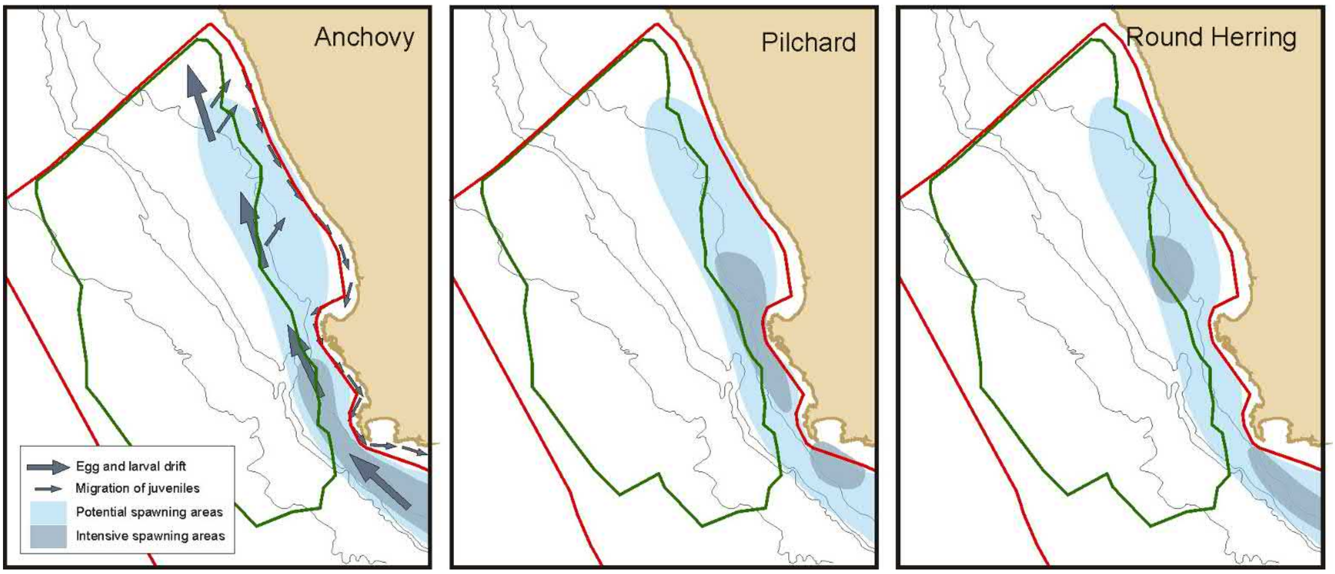

Figure 7-16: The project area in relation to major spawning areas in the southern Benguela region
Source: adapted from Cruikshank, 1990

Two species that migrate along the West Coast following the shoals of anchovy and pilchards are snoek *Thyrsites atun* and chub mackerel *Scomber japonicas*. Both these species have been rated as 'Least concern' on the national assessment (Sink *et al.* 2019). Their appearance along the West and South-West coasts are highly seasonal. Snoek migrating along the southern African West Coast reach the area between St Helena Bay and the Cape Peninsula between May and August. They spawn in these waters between July and October before moving offshore and commencing their return northward migration (Payne & Crawford 1989). They are voracious predators occurring throughout the water column, feeding on both demersal and pelagic invertebrates and fish. Chub mackerel similarly migrate along the southern African West Coast reaching South-Western Cape waters between April and August. They move inshore in June and July to spawn before starting the return northwards offshore migration later in the year. Their abundance and seasonal migrations are thought to be related to the availability of their shoaling prey species (Payne & Crawford 1989).

The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of the proposed 2D survey area are the large migratory pelagic species, including various tunas, billfish and sharks, many of which are considered threatened by the International Union for the Conservation of Nature (IUCN), primarily due to overfishing (Table 7-2). 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.

These large pelagic species migrate throughout the southern oceans, between surface and deep waters (>300 m) and have a highly seasonal abundance in the Benguela. Species occurring off western southern Africa include the albacore/longfin tuna *Thunnus alalunga*, yellowfin *T. albacares*, bigeye *T. obesus*, and skipjack *Katsuwonus pelamis tunas*, as well as the Atlantic blue marlin *Makaira nigricans*, the white marlin *Tetrapturus albidus* and the broadbill swordfish *Xiphias gladius* (Payne & Crawford 1989). The distributions of these species are dependent on food availability in the mixed boundary layer between the Benguela and warm central Atlantic waters. Concentrations of large pelagic species are also known to occur associated with underwater feature such as canyons and seamounts as well as meteorologically induced oceanic fronts (Penney *et al.* 1992).

Table 7-2: Important large migratory pelagic fish likely to occur in the offshore region of the West Coast

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

Seasonal association with Child's Bank (off Namaqualand) and Tripp Seamount (off southern Namibia approximately 25 km north of the proposed 2D survey area) occurs between October and June, with commercial catches often peaking in March and April (www.fao.org/fi/fcp/en/ NAM/body.htm; see CapMarine 2021 – Fisheries Specialist Study). The South Atlantic Seamounts, which lie on and adjacent to the southern boundary of the Reconnaissance Permit Area and within the Agulhas Current retroflection zone, also serve as an important aggregation site for migratory species, such as sharks and tuna.

A number of species of pelagic sharks are also known to occur on the West and South-West Coast, including blue *Prionace glauca*, short-fin mako *Isurus oxyrinchus* and oceanic whitetip sharks *Carcharhinus longimanus*. Occurring throughout the world in warm temperate waters, these species are usually found further offshore on the West Coast. Great whites *Carcharodon carcharias* and whale sharks *Rhincodon typus* may also be encountered in coastal and offshore areas, although the latter occurs more frequently along the South and East coasts.

7.4.7.2 Demersal Fish Species

Demersal fish are those species that live and feed on or near the seabed. As many as 110 species of bony and cartilaginous fish have been identified in the demersal communities on the continental shelf of the West Coast (Roel 1987). Changes in fish communities occur both latitudinally (Shine 2006, 2008; Yemane *et al*. 2015) and with increasing depth (Roel 1987; Smale *et al*. 1993; Macpherson & Gordoa 1992; Bianchi *et al*. 2001; Atkinson 2009; Yemane *et al*. 2015), with the most substantial change in species composition occurring in the shelf break region between 300 m and 400 m depth (Roel 1987; Atkinson 2009). The shelf community (<380 m) is dominated by the Cape hake (*M. capensis*), and includes jacopever (*Helicolenus dactylopterus*), Izak catshark (*Holohalaelurus regain*), soupfin shark (*Galeorhinus galeus*) and whitespotted houndshark (*Mustelus palumbes*). The more diverse deeper water community is dominated by the deepwater hake (*Merluccius paradoxus*), monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*), bronze whiptail (*Lucigadus ori*) and hairy conger (*Bassanago albescens*) and various squalid shark species. There is some degree of species overlap between the depth zones.

Seasonal variations in the distribution ranges shelf communities have been shown (Roel, 1987), with species such as the pelagic goby (*Sufflogobius bibarbatus*), and West Coast sole (*Austroglossus microlepis*) occurring in shallow water north of Cape Point during summer only. The deep-sea community was found to be homogenous both spatially and temporally. In a more recent study, however, Atkinson (2009) identified two long-term community shifts in demersal fish communities; the first (early to mid-1990s) being associated with an overall increase in density of many species, whilst many species decreased in density during the second shift (mid-2000s). These community shifts correspond temporally with regime shifts detected in environmental forcing variables (Sea Surface Temperatures and upwelling anomalies) (Howard *et al.* 2007) and with the eastward shifts observed in small pelagic fish species and rock lobster populations (Coetzee *et al*. 2008, Cockcroft *et al*. 2008). The species that may occur in the general project area and on the continental shelf inshore thereof, and their approximate depth range, are listed in Table 7-3.

Table 7-3: Demersal cartilaginous species found on the continental shelf along the West Coast, with approximate depth range at which the species occurs (Compagno *et al.* 1991).

Common Name	Scientific name	Depth Range (m)
Frilled shark	*Chlamydoselachus anguineus*	200-1 000
Six gill cowshark	*Hexanchus griseus*	150-600
Gulper shark	*Centrophorus granulosus*	480
Leafscale gulper shark	*Centrophorus squamosus*	370-800
Bramble shark	*Echinorhinus brucus*	55-285
Black dogfish	*Centroscyllium fabricii*	>700
Portuguese shark	*Centroscymnus coelolepis*	>700
Longnose velvet dogfish	*Centroscymnus crepidater*	400-700
Birdbeak dogfish	*Deania calcea*	400-800
Arrowhead dogfish	*Deania profundorum*	200-500
Longsnout dogfish	*Deania quadrispinosum*	200-650
Sculpted lanternshark	*Etmopterus brachyurus*	450-900
Brown lanternshark	*Etmopterus compagnoi*	450-925
Giant lanternshark	*Etmopterus granulosus*	>700
Smooth lanternshark	*Etmopterus pusillus*	400-500
Spotted spiny dogfish	*Squalus acanthias*	100-400
Shortnose spiny dogfish	*Squalus megalops*	75-460
Shortspine spiny dogfish	*Squalus mitsukurii*	150-600
Sixgill sawshark	*Pliotrema warreni*	60-500
Goblin shark	*Mitsukurina owstoni*	270-960
Smalleye catshark	*Apristurus microps*	700-1 000
Saldanha catshark	*Apristurus saldanha*	450-765
“grey/black wonder” catsharks	*Apristurus* spp.	670-1 005

Common Name	Scientific name	Depth Range (m)
Tigar catshark	*Halaelurus natalensis*	50-100
Izak catshark	*Holohalaelurus regani*	100-500
Yellowspotted catshark	*Scyliorhinus capensis*	150-500
Soupfin shark/Vaalhaai	*Galeorhinus galeus*	<10-300
Houndshark	*Mustelus mustelus*	<100
Whitespotted houndshark	*Mustelus palumbes*	>350
Little guitarfish	*Rhinobatos annulatus*	>100
Atlantic electric ray	*Torpedo nobiliana*	120-450
African softnose skate	*Bathyraja smithii*	400-1 020
Smoothnose legskate	*Cruriraja durbanensis*	>1 000
Roughnose legskate	*Crurirajaparcomaculata*	150-620
African dwarf skate	*Neoraja stehmanni*	290-1 025
Thorny skate	*Raja radiata*	50-600
Bigmouth skate	*Raja robertsi*	>1 000
Slime skate	*Raja pullopunctatus*	15-460
Rough-belly skate	*Raja springeri*	85-500
Yellowspot skate	*Raja wallacei*	70-500
Roughskin skate	*Raja spinacidermis*	1 000-1 350
Biscuit skate	*Raja clavata*	25-500
Munchkin skate	*Raja caudaspinosa*	300-520
Bigthorn skate	*Raja confundens*	100-800
Ghost skate	*Raja dissimilis*	420-1 005
Leopard skate	*Raja leopardus*	300-1 000
Smoothback skate	*Raja ravidula*	500-1 000
Spearnose skate	*Raja alba*	75-260
St Joseph	*Callorhinchus capensis*	30-380
Cape chimaera	*Chimaera* sp.	680-1 000
Brown chimaera	*Hydrolagus* sp.	420-850
Spearnose chimaera	Rhinochimaera atlantica	650-960

7.4.8 Seabirds

Large numbers of pelagic seabirds exploit the pelagic fish stocks of the Benguela system. Of the 49 species of seabirds that occur in the Benguela region, 14 are defined as resident, 10 are visitors from the northern hemisphere and 25 are migrants from the Southern Ocean. The species classified as being common in the southern Benguela are listed in Table 7-4. The area between Cape Point and the Orange River supports 38% and 33% of the overall population of pelagic seabirds in winter and summer, respectively. Most of the species in the region reach highest densities offshore of the shelf break (200 – 500 m depth), well inshore of the Licence Block, with highest population levels during their non-breeding season (winter). Pintado petrels and Prion spp. show the most marked variation here.

Fourteen species of seabirds breed in southern Africa; Cape Gannet, African Penguin, four species of Cormorant, White Pelican, three Gull and four Tern species (Table 7-5). The breeding areas are distributed around the coast with islands being especially important. The closest breeding islands to the project area are Bird Island at Lambert's Bay and the Saldanha Bay islands. The number of successfully breeding birds at the particular breeding sites varies with food abundance. Most of the breeding seabird species forage at sea with most birds being found relatively close inshore (10 30 km). Cape Gannets, however, are known to forage within 200 km offshore (Dundee 2006; Ludynia 2007; Grémillet *et al*. 2008), and African Penguins have also been recorded as far as 60 km offshore. The proposed 2D survey area lies on the western extent of gannet foraging areas (see Figure 7-17).

Table 7-4: Pelagic seabirds common in the southern Benguela region

Common Name	Species name	Regional Assessment	Global IUCN
Shy Albatross	*Thalassarche cauta*	Near Threatened	Near Threatened
Black browed Albatross	*Thalassarche melanophrys*	Endangered	Least concern
Yellow-nosed Albatross	*Thalassarche chlororhynchos*	Endangered	Endangered
Giant Petrel sp.	*Macronectes halli/giganteus*	Near Threatened	Least concern
Pintado Petrel	*Daption capense*	Least concern	Least concern
Greatwinged Petrel	*Pterodroma macroptera*	Near Threatened	Least concern
Soft-plumaged Petrel	*Pterodroma mollis*	Near Threatened	Least concern
Arctic Prion	*Pachyptila desolata*	Least concern	Least concern
Broad-billed Prion	*Pachyptila* vittata	Least concern	Least concern
White-chinned Petrel	*Procellaria aequinoctialis*	Vulnerable	Vulnerable
Cory's Shearwater	*Calonectris diomedea*	Least concern	Least concern
Great Shearwater	*Puffinus gravis*	Least concern	Least concern
Sooty Shearwater	*Puffinus griseus*	Near Threatened	Near Threatened
European Storm Petrel	*Hydrobates pelagicus*	Least concern	Least concern
Leach's Storm Petrel	*Oceanodroma leucorhoa*	Critically Endangered	Vulnerable
Wilson's Storm Petrel	*Oceanites oceanicus*	Least concern	Least concern
Blackbellied Storm Petrel	*Fregetta tropica*	Near Threatened	Least concern
Subantarctic Skua	*Catharacta antarctica*	Endangered	Least concern
Sabine's Gull	*Larus sabini*	Least concern	Least concern

Source: Crawford *et al.,* 1991; Sink *et al.* 2019

Table 7-5: Breeding resident seabirds present along the West Coast

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

Common Name	Species Name	National Assessment	Global Assessment
Swift Tern	*Sterna bergii*	Least Concern	Least Concern
Roseate Tern	*Sterna dougallii*	Endangered	Least Concern
Damara Tern	*Sterna balaenarum*	Vulnerable	Vulnerable

Source: CCA & CMS, 2001; Sink *et al.,* 2019

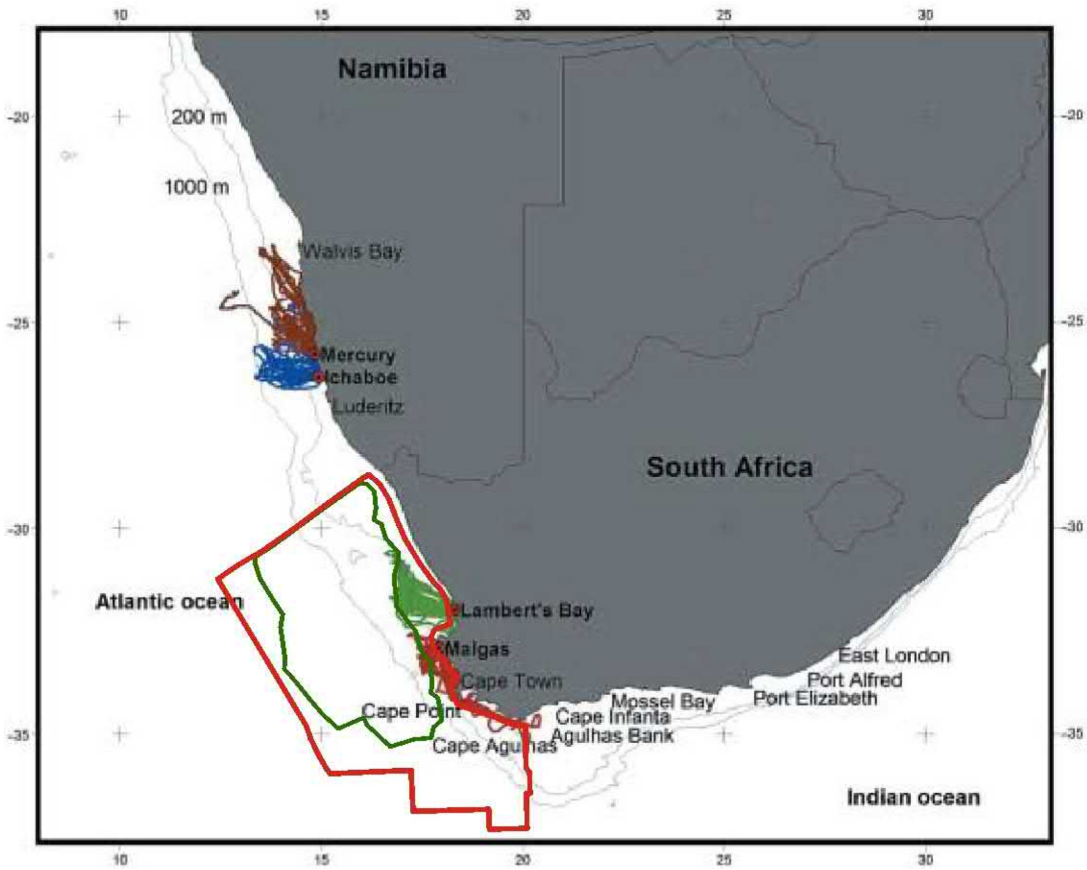

Figure 7-17: The proposed project area in relation to GPS tracks recorded for 93 Cape Gannets foraging off four breeding colonies in South Africa and Namibia

Source: adapted from Grémillet *et al.,* 2008

7.4.9 Turtles

Three species of turtle occur along the West Coast, namely the Leatherback (*Dermochelys coriacea*), and occasionally the Loggerhead (*Caretta caretta*) and the Green (*Chelonia mydas*) turtle. Loggerhead and Green turtles are expected to occur only as occasional visitors along the West Coast.

The Leatherback is the only turtle likely to be encountered in the offshore waters of west South Africa. The Benguela ecosystem, especially the northern Benguela where jelly fish numbers are high, is increasingly being recognized as a potentially important feeding area for leatherback turtles from several globally significant nesting populations in the south Atlantic (Gabon, Brazil) and south east Indian Ocean (South Africa) (Lambardi *et al.* 2008, Elwen & Leeney 2011; SASTN 2011[5]). Leatherback turtles from the east South Africa population have been

[5] *SASTN Meeting - Second meeting of the South Atlantic Sea Turtle Network, Swakopmund, Namibia, 24-30 July 2011.*

satellite tracked swimming around the West Coast of South Africa and remaining in the warmer waters west of the Benguela ecosystem (Lambardi *et al.* 2008) (Figure 7-18).

Leatherback turtles inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey (primarily jellyfish). While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al.* 2004). Their abundance in the study area is unknown but expected to be low. Leatherbacks feed on jellyfish and are known to have mistaken plastic marine debris for their natural food. Ingesting this can obstruct the gut, lead to absorption of toxins and reduce the absorption of nutrients from their real food. Leatherback Turtles are listed as 'Critically endangered' worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and Convention on Migratory Species (CMS). The 2017 South African list of Threatened or Protected Species (TOPS) similarly lists the species as 'Critically endangered', whereas on the National Assessment (Hughes & Nel 2014) leatherbacks were listed as 'Endangered', whereas Loggerhead and green turtles are listed globally as 'Vulnerable' and 'Endangered', respectively, whereas on TOPS both species are listed as 'Endangered'. As a signatory of CMS, South Africa has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles. South Africa is thus committed to conserve these species at an international level.

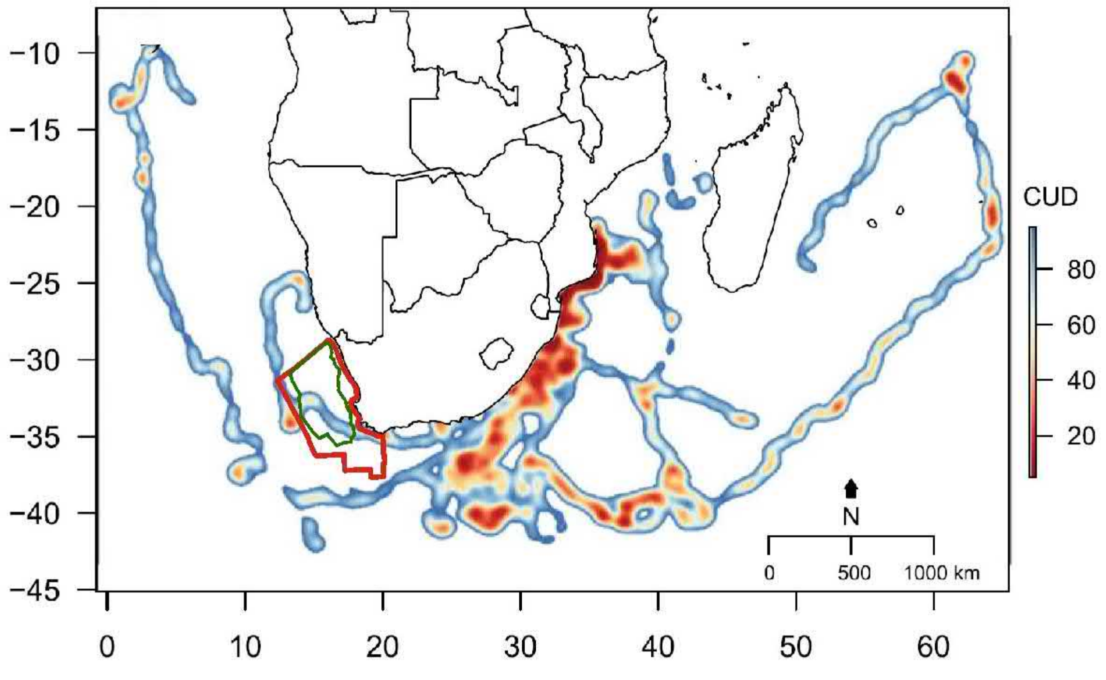

Figure 7-18: The proposed survey area (green polygon) in relation to the migration corridors of leatherback turtles in the south-western Indian Ocean. Relative use of corridors is shown through intensity of shading: light, low use; dark, high use

Source: adapted from Harris *et al.*, 2018.

7.4.10 Marine Mammals

The marine mammal fauna occurring off the southern African coast includes several species of whales and dolphins and one resident seal species.

7.4.10.1 Cetaceans

Thirty three species of whales and dolphins are known (based on historic sightings or stranding records) or likely (based on habitat projections of known species parameters) to occur in these waters. A list of these species and their known seasonality is provided in Table 7-6. Of the species listed, the blue whale is considered 'Critically endangered', fin and sei whales are 'Endangered' and one is considered vulnerable (IUCN Red Data list Categories). Altogether 17 species are listed as "data deficient" underlining how little is known about cetaceans, their distributions and population trends. The offshore areas have been particularly poorly studied with almost all available information from deeper waters (>200 m) arising from historic whaling records prior to 1970. Current information on the distribution, population sizes and trends of most cetacean species occurring on the West Coast of southern Africa is lacking. Information on smaller cetaceans in deeper waters is particularly poor and the precautionary principal must be used when considering possible encounters with cetaceans in this area. Unpublished sighting records held by Sea Search and sourced from Marine Mammal Observer records from previous seismic surveys in relation to the proposed survey area are displayed in Figure 7-19 and Figure 7-20.

The proposed survey area extends from the Namibian border to south of Cape Point and from roughly the 200 m isobath to between 3 000 m and 4 000 m water depth. Oceanographically this area lies largely outside the cool waters of the Benguela Ecosystem and receives some input from the warm Agulhas Current as well as the warm waters of the South Atlantic. In terms of cetacean distribution patterns, the area thus covers a broad range of habitats and species associated with each of those water masses may occur within the target area. Records from stranded specimens show that the area between St Helena Bay (~32° S) and Cape Agulhas (~34° S, 20° E) is an area of transition between Atlantic and Indian Ocean species, and includes records from Benguela associated species such as dusky dolphins, Heaviside's dolphins and long finned pilot whales, and those of the warmer east coast such as striped and Risso's dolphins (Findlay *et al.* 1992). Species such as rough toothed dolphins, Pan-tropical spotted dolphins and short finned pilot whales are known from the southern Atlantic. Owing to the uncertainty of species occurrence offshore, species that may occur there have been included here for the sake of completeness.

The distribution of cetaceans can largely be split into those associated with the continental shelf and those that occur in deep, oceanic water. Importantly, species from both environments may be found on the continental slope (200 – 2 000 m) making this the most species rich area for cetaceans. Cetacean density on the continental shelf is usually higher than in pelagic waters as species associated with the pelagic environment tend to be wide ranging across thousands of kilometres. The most common species within the project area (in terms of likely encounter rate not total population sizes) are likely to be the long-finned pilot whale, sperm whale and humpback whale.

Cetaceans can be divided into two major groups, the mysticetes or baleen whales which are largely migratory, and the toothed whales or odontocetes which may be resident or migratory.

Table 7-6: Cetaceans occurrence off the West Coast of South Africa, their seasonality, likely encounter frequency with proposed exploration activities and South African and global IUCN Red List conservation status

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	South African Regional Assessment	IUCN Global Assessment
Delphinids (Odontocetes)							
Dusky dolphin	*Lagenorhynchus obscurus*	HF	Yes (0- 800 m)	No	Year round	Least Concern	Least Concern
Heaviside’s dolphin	*Cephalorhynchus heavisidii*	VHF	Yes (0-200 m)	No	Year round	Least Concern	Near Threatened
Common bottlenose dolphin	*Tursiops truncatus*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Common dolphin	*Delphinus delphis*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Southern right whale dolphin	*Lissodelphis peronii*	HF	Yes	Yes	Year round	Least Concern	Least Concern
Striped dolphin	*Stenella coeruleoalba*	HF	No	Yes	Year round	Least Concern	Least Concern
Pantropical spotted dolphin	*Stenella attenuata*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Long-finned pilot whale	*Globicephala melas*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Short-finned pilot whale	*Globicephala macrorhynchus*	HF	Edge	Yes	Year round	Least Concern	Least Concern
Rough-toothed dolphin	*Steno bredanensis*	HF	No	Yes	Year round	Least Concern	Least Concern
Killer whale	*Orcinus orca*	HF	Occasional	Yes	Year round	Least Concern	Data deficient
False killer whale	*Pseudorca crassidens*	HF	Occasional	Yes	Year round	Least Concern	Near Threatened
Pygmy killer whale	*Feresa attenuata*	HF	No	Yes	Year round	Least Concern	Least Concern
Risso’s dolphin	*Grampus griseus*	HF	Edge	Yes	Year round	Data deficient	Least Concern
Sperm whales (Odontocetes)							
Pygmy sperm whale	*Kogia breviceps*	VHF	Edge	Yes	Year round	Data Deficient	Data Deficient
Dwarf sperm whale	*Kogia sima*	VHF	Edge	Yes	Year round	Data Deficient	Data Deficient
Sperm whale	*Physeter macrocephalus*	HF	Edge	Yes	Year round	Vulnerable	Vulnerable
Beaked whales (Odontocetes)							
Cuvier’s	*Ziphius cavirostris*	HF	No	Yes	Year round	Data Deficient	Least Concern
Arnoux’s	*Beradius arnuxii*	HF	No	Yes	Year round	Data Deficient	Data Deficient
Southern bottlenose	*Hyperoodon planifrons*	HF	No	Yes	Year round	Least Concern	Least Concern
Layard’s / Strap-toothed	*Mesoplodon layardii*	HF	No	Yes	Year round	Data Deficient	Data Deficient
True’s	*Mesoplodon mirus*	HF	No	Yes	Year round	Data Deficient	Data Deficient
Gray’s	*Mesoplodon grayi*	HF	No	Yes	Year round	Data Deficient	Data Deficient

Common Name	Species	Hearing Frequency	Shelf (<200 m)	Offshore (>200 m)	Seasonality	South African Regional Assessment	IUCN Global Assessment
Blainville's	*Mesoplodon densirostris*	HF	No	Yes	Year round	Data Deficient	Data Deficient
Baleen whales (Mysticetes)							
Antarctic Minke	*Balaenoptera bonaerensis*	LF	Yes	Yes	>Winter	Least Concern	Near Threatened
Dwarf minke	*B. acutorostrata*	LF	Yes	Yes	Year round	Least Concern	Least Concern
Fin whale	*B. physalus*	LF	Yes	Yes	MJJ & ON	Endangered	Vulnerable
Blue whale (Antarctic)	*B. musculus intermedia*	LF	No	Yes	Winter peak	Critically Endangered	Endangered
Sei whale	*B. borealis*	LF	Yes	Yes	MJ & ASO	Endangered	Endangered
Bryde's (inshore)	*B brydei (sub spp)*	LF	Yes	Yes	Year round	Vulnerable	Least Concern
Bryde's (offshore)	*B brydei*	LF	Edge	Yes	Summer, JFM	Data deficient	Least Concern
Pygmy right	*Caperea marginata*	LF	Yes	?	Year round	Least Concern	Least Concern
Humpback sp.	*Megaptera novaeangliae*	LF	Yes	Yes	Year round, SONDJF	Least Concern	Least Concern
Humpback B2 population	*Megaptera novaeangliae*	LF	Yes	Yes	Spring Summer peak ONDJF	Vulnerable	Not Assessed
Southern Right	*Eubalaena australis*	LF	Yes	No	Year round, ONDJFMA	Least Concern	Least Concern
VHF = Very High Frequency; HF = High Frequency; LF = Low Frequency							

Adapted from Child *et al.* 2016

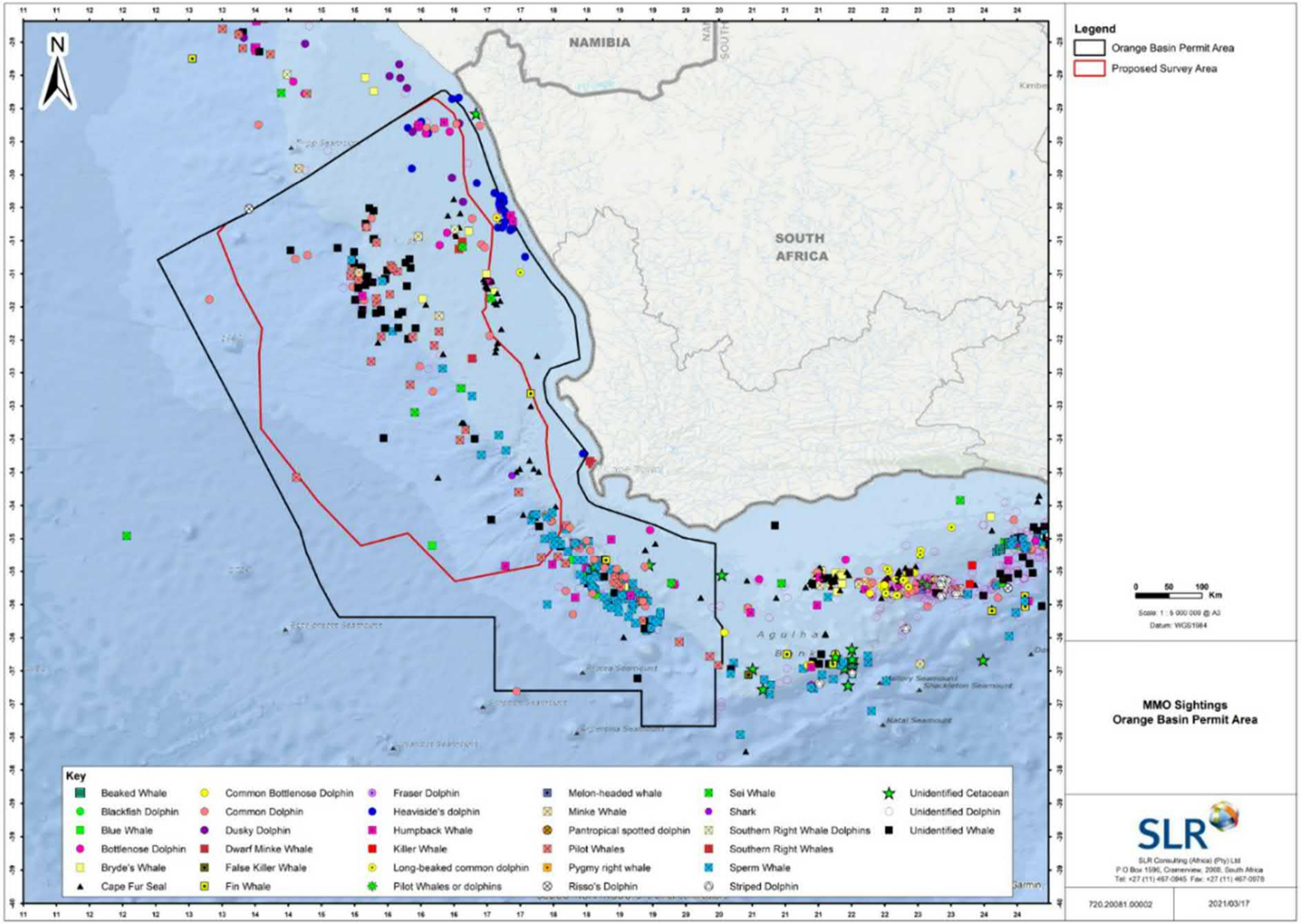

Figure 7-19: Distribution and movement of cetaceans off the West Coast of South Africa collated between 2008 (mostly>2015) and March 2021

Source: Unpublished SLR MMO sightings database.

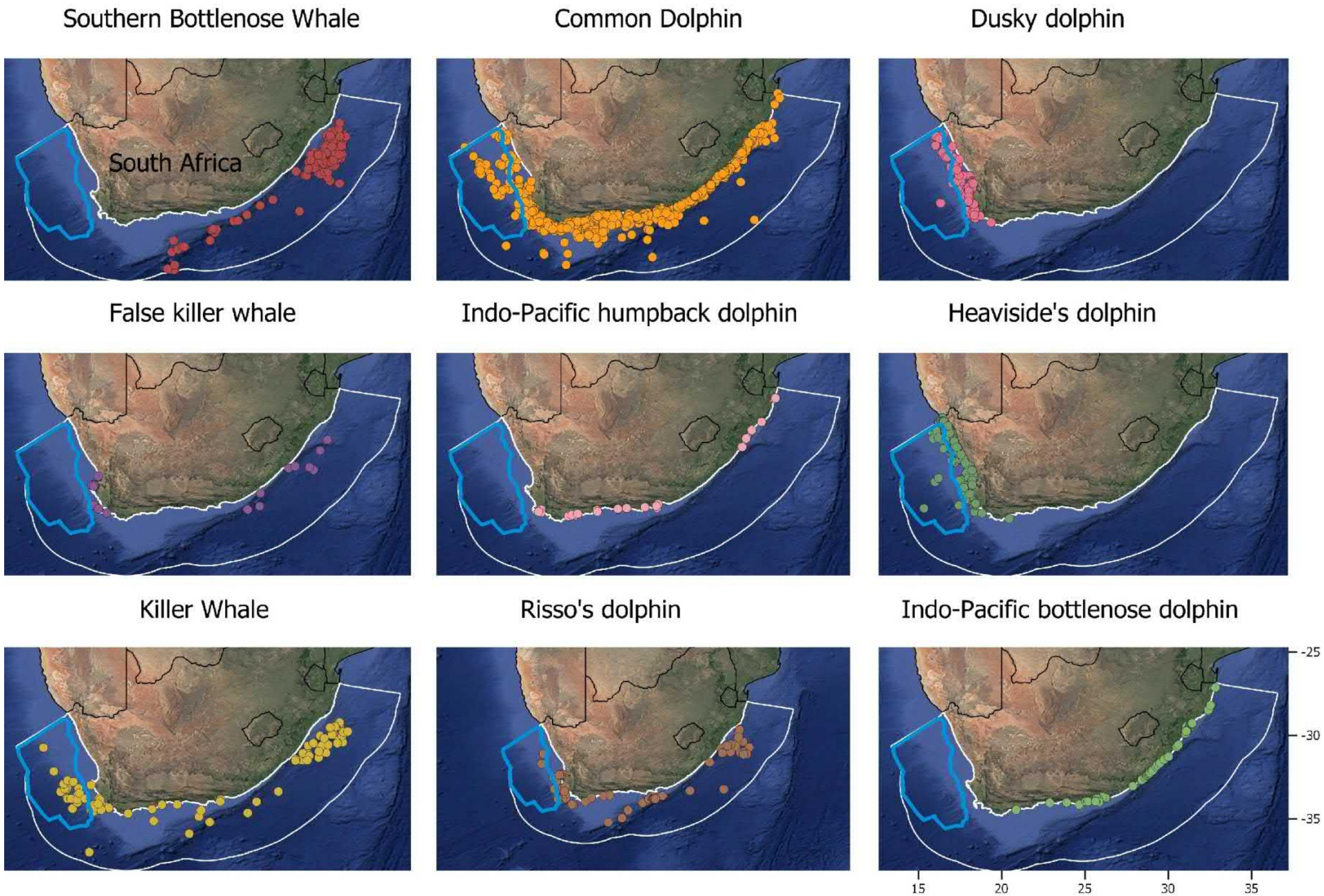

Figure 7-20: Predicted distributions for nine odontocete species off the West Coast of South Africa in relation to the proposed survey area (light blue outline)
Adapted from: Purdon *et al.* 2020.

The most abundant baleen whales in the Benguela are southern right whales and humpback whales (Figure 7-21). Both species have long been known to feed in the Benguela Ecosystem and numbers since 2000 have grown substantially. The peak of timing in the Benguela is spring and early summer (October – February) and follows the 'traditional' South African breeding season (June – November) and it's associated migrations. Some individual right whales are known to move directly from the south coast breeding area into the west coast feeding area where they remained for several months (Barendse *et al*. 2011; Mate *et al*. 2011). Increasing numbers of summer records of both species, from the southern half of Namibia suggest that animals may also be feeding in the Lüderitz upwelling cell (NDP unpubl. data).

Figure 7-21: The humpback whale (left) and the southern right whale (right) which migrate through South African waters during winter

Photo Left - www.divephotoguide.com; Photo Right - www.aad.gov.au

Southern Right Whales: The southern African population of southern right whales historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baie dos Tigres) and is considered to be a single population within this range (Roux *et al.* 2011). The most recent abundance estimate for this population is available for 2017 which estimated the population at ~6 100 individuals including all age and sex classes, and still growing at ~6.5% per annum (Brandaõ *et al.* 2017). When the population numbers crashed in 1920, the range contracted down to just the south coast of South Africa, but as the population recovers, it is repopulating its historic grounds including Namibia (Roux *et al.* 2001, 2015; de Rock *et al.* 2019) and Mozambique (Banks *et al.* 2011).

Some southern right whales move from the south coast breeding ground directly to the west coast feeding ground in the Southern Benguela where they feed between Table Bay and St Helena Bay (Mate *et al.* 2011). When departing from feeding ground all satellite tagged animals in that study took a direct south-westward track, which would take them directly across the target area. Mark-recapture data from 2003-2007 estimated roughly one third of the South African right whale population at that time were using St Helena Bay for feeding (Peters *et al.* 2011). The South African right whale population has undergone substantial changes in demography, and numbers of animal using our coast since those studies were done – notably a significant decrease in the numbers non-mothers at the coast and variable presence of mother-calf pairs in any year (Roux *et al.* 2015; Vermeulen *et al.* 2020). Recent sightings (2018-2021) confirm that there is still a clear peak in numbers on the West Coast (Table Bay to St Helena Bay) between <u>February and April.</u> Given this high proportion of the population known to feed in the southern Benguela, and current numbers reported, it is highly likely that several hundreds of right whales can be expected to pass through the Reconnaissance Permit Area when migrating southwards from the feeding areas between April and June. Figure 7-22 **shows locations of Southern right whale sightings recorded during seismic surveys along the West Coast** (SLR MMO database).

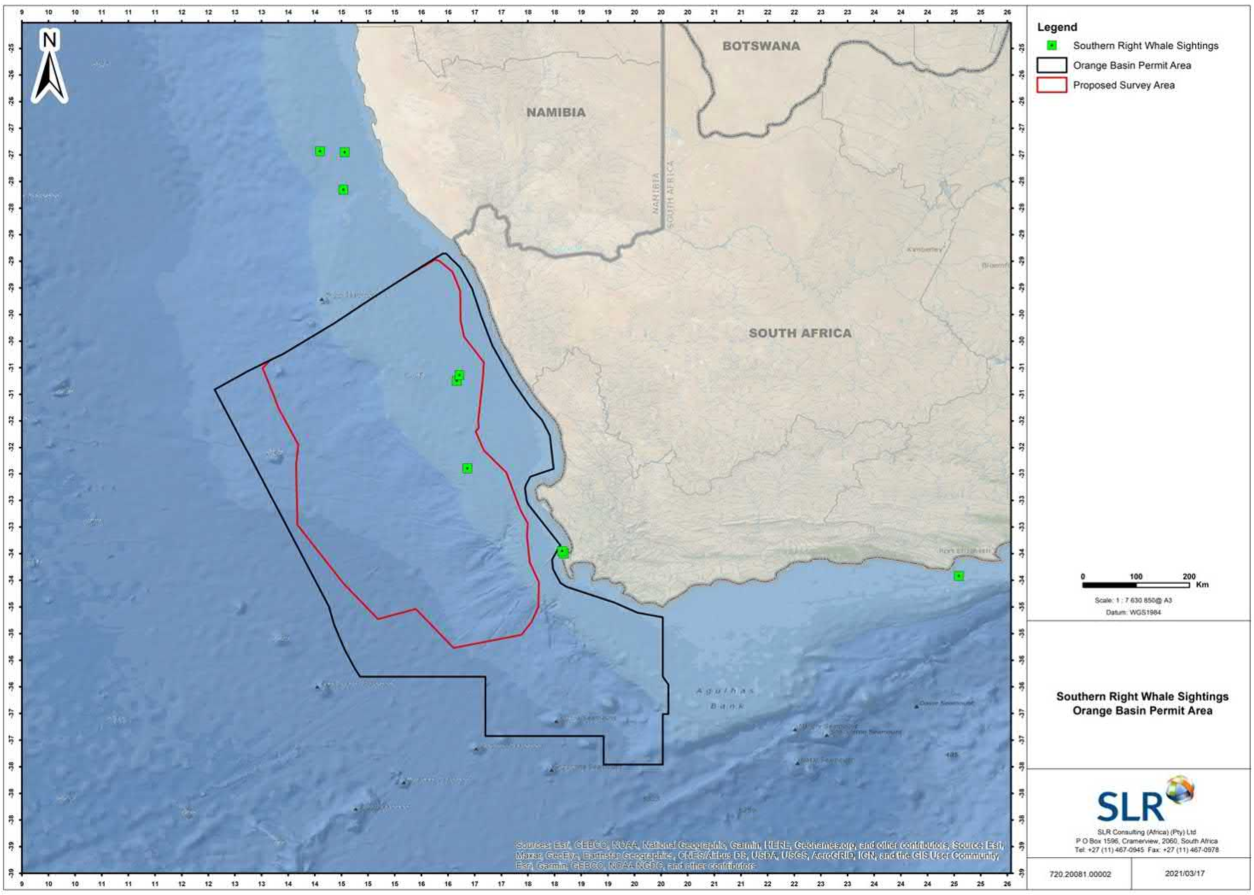

Figure 7-22: Southern right whale sightings recorded during seismic surveys between 2001 and 2020
Source: Unpublished SLR MMO sightings database

Humpback Whales: The majority of humpback whales passing through the Benguela are migrating to breeding grounds off tropical west Africa, between Angola and the Gulf of Guinea (Rosenbaum *et al*. 2009; Barendse *et al*. 2010). In coastal waters, the northward migration stream is larger than the southward peak (Best & Allison 2010; Elwen *et al.* 2014), suggesting that animals migrating north strike the coast at varying places north of St Helena Bay, resulting in increasing whale density on shelf waters and into deeper pelagic waters as one moves northwards. On the southward migration, many humpbacks follow the Walvis Ridge offshore then head directly to high latitude feeding grounds, while others follow a more coastal route (including the majority of mother-calf pairs) possibly lingering in the feeding grounds off west South Africa in summer (Elwen *et al.* 2014; Rosenbaum *et al.* 2014). Although migrating through the Benguela, there is no existing evidence of a clear 'corridor' and humpback whales appear to be spread out widely across the shelf and into deeper pelagic waters, especially during the southward migration (Barendse *et al.* 2010; Best & Allison 2010; Elwen *et al.* 2014). The only available abundance estimate put the number of animals in the west African breeding population (Gabon) to be in excess of 9 000 individuals in 2005 (IWC 2012) and it is likely to have increased substantially since this time at about 5% per annum (IWC 2012). Humpback whales are thus likely to be the most frequently encountered baleen whale in the project area, ranging from the coast out beyond the shelf, with year-round presence but numbers peaking in July – February and a smaller peak with the southern breeding migration around September – October but with regular encounters until February associated with subsequent feeding in the Benguela ecosystem.

Humpbacks have been recorded on occasion in the proposed survey area (See Figure 7-23; SLR MMO Unpublished Data).

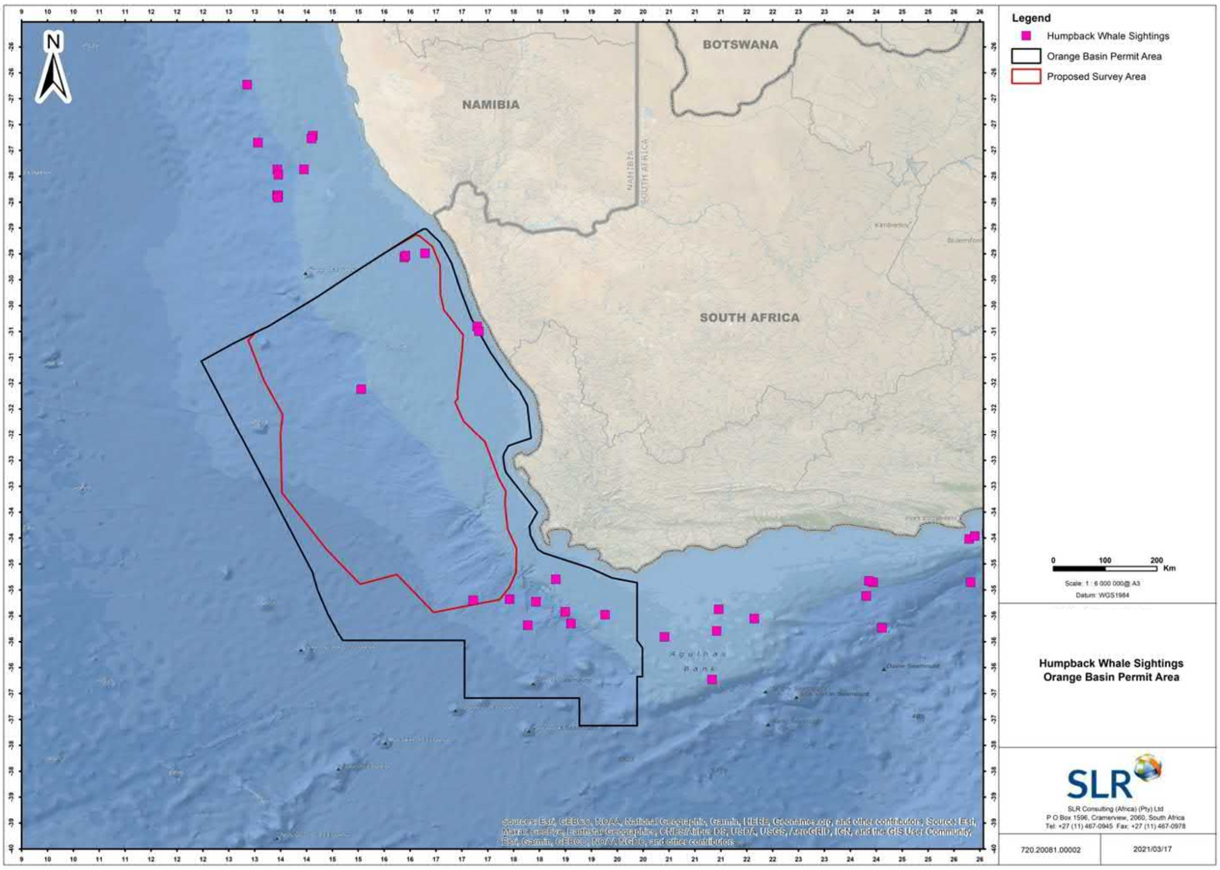

Figure 7-23: Humpback whale sightings recorded during seismic surveys between 2001 and 2020
Source: Unpublished SLR MMO sightings database

Pygmy Right Whales: The smallest of the baleen whales, the pygmy right whale reaches only 6 m total length as an adult (Best 2007). The species is typically associated with cool temperate waters between 30°S and 55°S with records from southern and central Namibia being the northern most for the species (Leeney *et al.* 2013). Its distribution off the west coast of South Africa is thus likely to be limited to the cooler shelf waters of the main Benguela upwelling areas. **Density in the project area is likely to be low**.

Minke Whales: Two forms of minke whale (Figure 7-24, right) occur in the southern Hemisphere, the Antarctic minke whale (*Balaenoptera bonaerensis*) and the dwarf minke whale (*B. acutorostrata* subsp.); both species occur in the Benguela (Best 2007). Antarctic minke whales range from the pack ice of Antarctica to tropical waters and are usually seen more than ~50 km offshore. Although adults migrate from the Southern Ocean (summer) to tropical/temperate waters (winter) to breed, some animals, especially juveniles, are known to stay in tropical/temperate waters year-round. Recent data available from passive acoustic monitoring over a two-year period off the Walvis Ridge shows acoustic presence in June - August and November - December (Thomisch *et al.* 2016), supporting a bimodal distribution in the area. The dwarf minke whale has a more temperate distribution than the Antarctic minke and they do not range further south than 60-65°S. Dwarf minkes have a similar migration pattern to Antarctic minkes with at least some animals migrating to the Southern Ocean during summer. Dwarf minke whales occur closer to shore than Antarctic minkes and have been seen <2 km from shore on several occasions around South Africa. Both species are generally solitary and **densities are likely to be low in the project area,** although sightings have been reported (MMO sightings data).

Bryde's Whales: Two genetically and morphologically distinct populations of Bryde's whales (Figure 7-24, left) live off the coast of southern Africa (Best 2001; Penry 2010). The "offshore population" lives beyond the shelf

(>200 m depth) off west Africa and migrates between wintering grounds off equatorial west Africa (Gabon) and summering grounds off western South Africa. Its seasonality on the West Coast is thus opposite to the majority of the balaenopterids with abundance likely to be highest in the area in January - March. The "inshore population" of Bryde's whale, live mainly on the continental shelf and Agulhas Bank, and are unique amongst baleen whales in the region by being non-migratory. The published range of the population is the continental shelf and Agulhas Bank of South Africa ranging from Durban in the east to at least St Helena Bay off the west coast with possible movements further north up the West Coast and into Namibia during the winter months (Best 2007). The offshore stock was subjected to heavy whaling in the mid-20th century (Best 2001) and there are no current data on population size or stock recovery therefrom and is currently listed as "Data deficient" on the South African Red List. The inshore stock is regarded as extremely vulnerable and listed as such on the SA red list as it regularly suffers losses from entanglement in trap fisheries and has been subject to significant changes in its prey base due to losses and shifts in the sardine and small pelagic stocks around South Africa. **The species has been recorded within the proposed survey area** (MMO sightings data).

Sei Whales: Almost all information is based on whaling records 1958-1963, most from shore-based catchers operating within a few hundred km of Saldanha Bay. At this time the species was not well differentiated from Bryde's whales and records and catches of the two species intertwined. There is no current information on population recovery, abundance or much information on distribution patterns outside of the whaling catches and the species remains listed as 'Endangered' on the SA Red List. Sei whales feed at high latitudes (40-50˚S) during summer months and migrate north through South African waters to unknown breeding grounds further north (Best 2007). Their migration pattern thus shows a bimodal peak with numbers west of Saldanha Bay being highest in May and June, and again in August, September and October. All whales were caught in waters deeper than 200 m with most deeper than 1 000 m (Best & Lockyer 2002). A recent survey to Vema Seamount ~1 000km west of Cape Town during Oct-Nov 2019, encountered a broadly spread feeding aggregation of over 30 sei and fin whales at around 200 m water depth (Elwen *et al.* in prep). This poorly surveyed area (roughly 32˚S, 15˚E) is just to the northwest of the historic whaling grounds suggesting this region remains an important feeding area for the species. **The proposed survey area overlaps with this feeding area.**

Figure 7-24: The Bryde's whale *Balaenoptera brydei* (left) and the Minke whale *Balaenoptera bonaerensis* (right)

Photos: www.dailymail.co.uk; www.marinebio.org.

Fin Whales: Fin whales were historically caught off the West Coast of South Africa, with a bimodal peak in the catch data suggesting animals were migrating further north during May-June to breed, before returning during August-October *en route* to Antarctic feeding grounds. However, the location of the breeding ground (if any) and how far north it is remains a mystery (Best 2007). Some juvenile animals may feed year round in deeper waters off the shelf (Best 2007). Aggregations of up to 8 animals have been seen on multiple occasions on the coast either side of Lüderitz in Apr-May of 2014 and January 2015 (Sea Search unpubl. Data), the occasional single whale has been reported during humpback whale research in November in the southern Benguela, and a feeding aggregation of ~30 animals was observed in Nov 2019 ~200 km west of St Helena Bay in ~2 000m of water (see above). Current sightings records support the bimodal peak in presence observed from whaling data (but with some chance of year-round sightings) with animals apparently feeding in the nutrient rich Benguela during their southward migration as is observed extensively for humpback and right whales (see below) there is clearly a chance of encounters year round. There are no recent data on abundance or distribution of fin whales off western South Africa.

Blue Whales: Although Antarctic blue whales were historically caught in high numbers off the South African West Coast, with a single peak in catch rates during July in Namibia and Angola suggesting that these latitudes are close to the northern migration limit for the species in the eastern South Atlantic (Best 2007). Although there were only two confirmed sightings of the species in the area between 1973 and 2006 (Branch *et al.* 2007), evidence of blue whale presence off Namibia is increasing. Recent acoustic detections of blue whales in the Antarctic peak between December and January (Thomisch *et al.* 2016) and off western South Africa (Shabangu *et al.* 2019) and in northern Namibia between May and July (Thomisch 2017) supporting observed timing from whaling records. Several recent (2014-2015) sightings of blue whales during seismic surveys off the southern part of Namibia (water depth >1 000 m) confirm their existence in the area and occurrence in Autumn months. **The chance of encountering the species in the proposed survey area is considered low.**

<u>In summary</u>, of the mysticetes, **humpback whales are the most likely to be encountered in the proposed survey area**. Humpback whales are likely to be encountered during December to February. Members of the BSB2 group may, however, be encountered year-round.

7.4.10.1 Odontocetes (Toothed) Whales

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader project area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site specific to oceanic and wide ranging (Figure 7-19 and Figure 7-20). Those in the region can range in size from 1.9 m long (spinner dolphin) to 17 m (bull sperm whale).

Sperm Whales: All information about Sperm Whales in the southern African subregion results from data collected during commercial whaling activities prior to 1985 (Best 2007). Sperm whales are the largest of the toothed whales and have a complex, well-structured social system with adult males behaving differently from younger males and female groups (see Figure 7-25, left). They live in deep ocean waters usually >1 000 m, but occasionally come inshore on the shelf into depths of 500-200 m (Best 2007). 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). They are considered to be relatively abundant globally (Whitehead 2002), although no estimates are available for South African waters. Seasonality of catches suggests that medium and large sized males are more abundant in winter months while female groups are more abundant in autumn (March - April), although animals occur year round (Best 2007). Analysis of recent passive acoustic monitoring data from the edge of the SA continental shelf (800 - 1 000 m water depth, roughly 80 km WSW of Cape Point) confirms year-round presence. Sperm whales have also been regularly identified by MMOs working in this area (SLR data). Sperm whales feed at great depths during dives in excess of 30 minutes making them difficult to detect visually, however the regular echolocation clicks made by the species when diving make them relatively easy to detect acoustically using Passive Acoustic Monitoring (PAM).

Figure 7-25: 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

There are almost no data available on the abundance, distribution or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters (>200 m) off the shelf of the southern African West Coast. Beaked whales are all considered to be true deep-water species usually being seen in waters in excess of 1 000 – 2 000 m deep (see various species accounts in Best 2007). Presence in the project area may fluctuate seasonally, but insufficient data exist to define this clearly. Sightings of beaked whales in the project area are expected to be very low. **Sperm whales have been encountered during seismic surveys off the West Coast and are likely to be encountered in waters deeper than ~1 000 m** (see Figure 7-26; SLR MMO database).

Pygmy and Dwarf Sperm Whales: The genus *Kogia* currently contains two recognised species, the pygmy (*K. breviceps*) and dwarf (*K. sima*) sperm whales, both of which most frequently occur in pelagic and shelf edge waters, although their seasonality is unknown. Due to their small body size, cryptic behaviour, low densities and small school sizes, these whales are difficult to observe at sea, and morphological similarities make field identification to species level problematic. The majority of what is known about Kogiid whales in the southern African subregion results from studies of stranded specimens (e.g. Ross 1979; Findlay *et al.* 1992; Plön 2004; Elwen *et al.* 2013). *Kogia* species are classified as VHF hearing species. Dwarf sperm whales are associated with warmer tropical and warm-temperate waters, being recorded from both the Benguela and Agulhas ecosystem (Best 2007) in **waters deeper than ~1 000 m**. **Abundance of pygmy and dwarf sperm whales in the proposed survey area is likely to be low**.

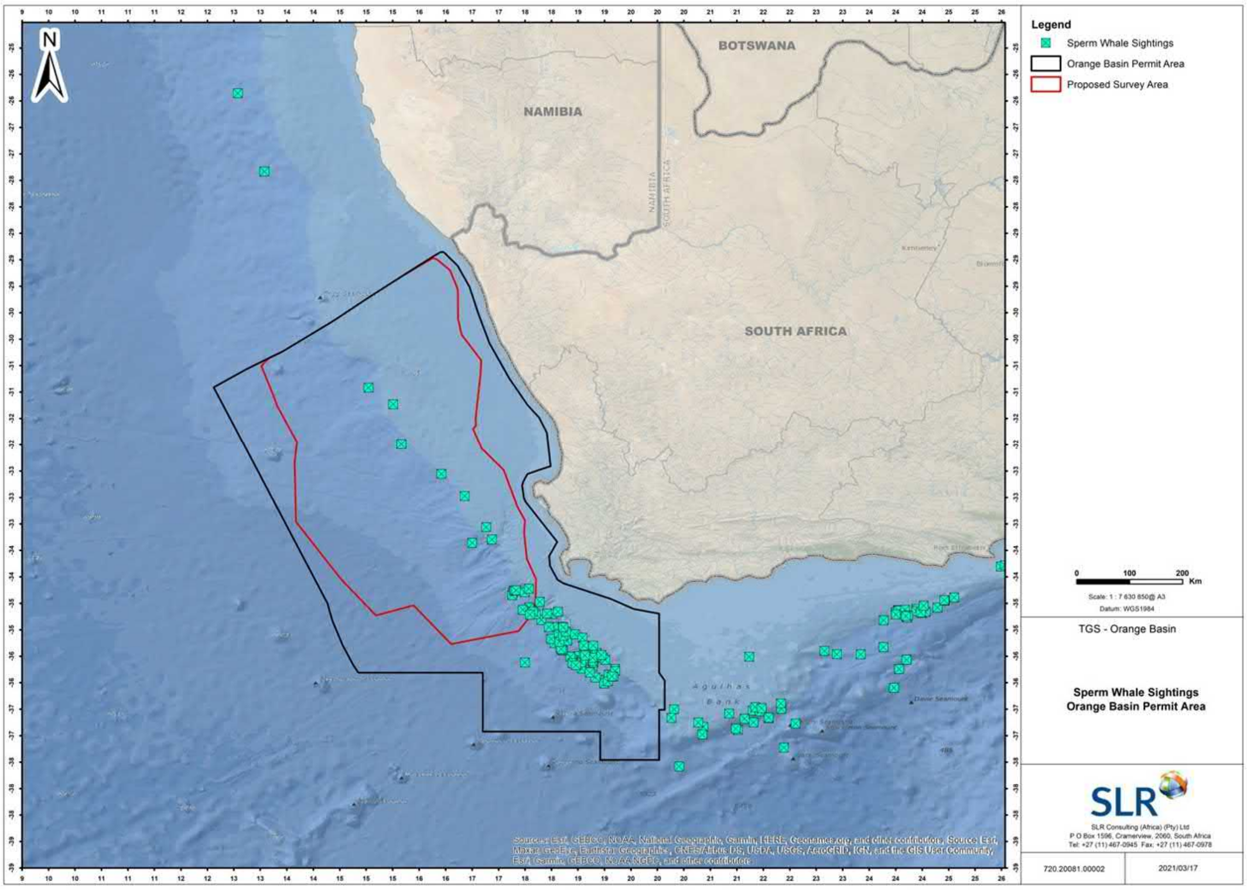

Figure 7-26: Sperm whale sightings recorded during seismic surveys between 2001 and 2020

Source: Unpublished SLR MMO sightings database

Killer whales (Orcas): Killer whales have a circum-global distribution being found in all oceans from the equator to the ice edge (Best 2007) (see Figure 7-25, right). Killer whales in South African waters were referred to a single morphotype, Type A, although recently a second 'flat-toothed' morphotype that seems to specialise in an elasmobranch diet has been identified but only 5 records are known, all from strandings (Best *et al.* 2014). Killer whales occur year-round in low densities off South Africa (Best *et al.* 2010, Elwen *et al.* in prep), Namibia (Elwen & Leeney 2011) and in the Eastern Tropical Atlantic (Weir *et al.* 2010). Off South Africa they are reported most frequently along the continental shelf edge, especially in association with long-line fisheries off Cape Point (overlapping with the planned survey area) and along the eastern Agulhas bank. **Killer whales are found in all depths from the coast to deep open ocean environments and may thus be encountered in the proposed survey area at low levels.**

Although the **false killer whale** is globally recognized as one species, clear differences in morphological and genetic characteristics between different study sites show that there is substantial difference between populations and a revision of the species taxonomy may be needed (Best 2007). False killer whales are more likely to be confused with the smaller melon-headed or pygmy killer whales with which they share all-black colouring and a similar head-shape, than with killer whales. The species has a tropical to temperate distribution and most sightings off southern Africa have occurred in water deeper than 1 000 m, but with a few recorded close to shore (Findlay *et al.* 1992). They usually occur in groups ranging in size from 1 - 100 animals (Best 2007). The strong bonds and matrilineal social structure of this species makes it vulnerable to mass stranding (8 instances of 4 or more animals stranding together have occurred in the western Cape, all between St Helena Bay and Cape Agulhas). There is no information on population numbers or conservation status and no evidence of seasonality in the region (Best 2007).

Pilot whales: Long-finned pilot whales display a preference for temperate waters and are usually associated with the continental shelf or deep water adjacent to it (Mate *et al.* 2005; Findlay *et al.* 1992; Weir 2011). They are regularly seen associated with the shelf edge by marine mammal observers (MMOs) and fisheries observers and researchers operating off southern Africa. The distinction between long-finned and short finned pilot whales is difficult to make at sea. As the latter are regarded as more tropical species (Best 2007), it is likely that most pilot whales encountered in the proposed survey area will be long-finned. **Pilot whales have been frequently encountered during seismic surveys along the shelf edge in South African and Namibian waters, including within the proposed survey area** (Unpublished SLR MMO database).

Common Dolphins: Two forms of common dolphins occur around southern Africa, a long-beaked and short-beaked form (Findlay *et al.* 1992; Best 2007), although they are currently considered part of a single global species (Cunha *et al.* 2015). The long-beaked common dolphin lives on the continental shelf of south Africa rarely being observed north of St Helena Bay on the west coast or in waters more 500 m deep (Best 2007), although more recent sightings including those om MMOs suggest sightings regularly out to 1000 m or more (SLR data, Sea Search data). Group sizes of common dolphins can be large, averaging 267 (± SD 287) for the South Africa region (Findlay et al. 1992). Far less is known about the short-beaked form which is challenging to differentiate at sea from the long-beaked form even with photographs (which are highly recommended). Group sizes are also typically large. It is likely that common dolphins encountered in the Northern Cape or deeper than 2 000 m are of the short-beaked form. **Common dolphins have been encountered during seismic surveys off the West Coast and may be encountered in the proposed survey area** (see Figure 7-19 and Figure 7-20).

Dusky dolphin: In water <500 m deep, dusky dolphins (Figure 7-27, right) are likely to be the most frequently encountered small cetacean as they are very “boat friendly” and often approach vessels to bowride. The species is resident year-round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay *et al.* 1992). A recent abundance estimate from southern Namibia calculated roughly ~3 500 dolphins in the ~400 km long Namibian Islands Marine Protected area (Martin *et al.* 2020), at a density of 0.16 dolphins/km^2 and similar density is expected to occur off the South African coast where they are regularly encountered in near shore waters between Cape Town and Lamberts Bay (Elwen *et al.* 2010; NDP unpubl. data) with group sizes of up to 800 having been reported (Findlay *et al*. 1992). **Dusky dolphins are resident year-round in the Benguela.**

Heaviside’s dolphins: Heaviside’s dolphins (Figure 7-27, left) are relatively abundant in the Benguela ecosystem region with 10 000 animals estimated to live in the 400 km of coast between Cape Town and Lamberts Bay (Elwen *et al.* 2009) and ~1 600 in the ~4 00km lonf Namibian Islands Marine Protected Area (Martin *et al.* 2020). This species occupies waters from the coast to at least 200 m depth, (Elwen *et al*. 2006; Best 2007; Martin *et al*. 2020), and may show a diurnal onshore-offshore movement pattern (Elwen *et al.* 2010a, 2010b), as they feed offshore at night. **Heaviside’s dolphins are resident year-round but will mostly occur inshore of the proposed survey area.**

Figure 7-27: The dusky dolphin *Lagenorhynchus obscurus* (left) and endemic Heaviside's Dolphin *Cephalorhynchus heavisidii* (right) (Photos: Simon Elwen, Sea Search Research and Conservation).

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

Beaked Whales: Beaked whales were never targeted commercially and their pelagic distribution makes them largely inaccessible to most researchers making them the most poorly studied group of cetaceans. They 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). With recorded dives of well over an hour to depths in excess of 2 km, beaked whales are amongst the most extreme divers of air breathing animals (Tyack *et al.* 2011). All the beaked whales that may be encountered in the exploration area are pelagic species that tend to occur in small groups of usually less than five individuals, although larger aggregations of some species are known (MacLeod & D'Amico 2006, Best 2007). The long, deep dives of beaked whales make them both difficult to detect visually, but PAM will increase the probability of detection as animals are frequently echo-locating when on foraging dives. Beaked whales are particularly vulnerable to certain types of anthropogenic noise sources, particularly mid-frequency naval sonar. The exact reason why is not yet fully understood, but necropsy of stranded animals has revealed gas embolisms and hemorrhage in the brain, ears and acoustic fat - injuries consistent with decompression sickness (acoustically mediated bubble formation may also play a role) (Fernandez *et al.* 2005). Beyond decompression sickness, the fear/flee response may be the first stage in a multi-stage process ultimately resulting in stranding (Southall *et al*. 2008; Jepson *et al*. 2013). This type of stranding event has been linked to both naval sonar and multi-beam echosounders used for commercial scale side scan sonar (Southall *et al*. 2008).

In summary, **long-finned pilot whales are likely to be the most frequently encountered odontocetes in the proposed survey area**. **Beyond the 1 000 m depth contour, sperm whales may also be encountered.** Although animals occur year-round, males are typically more abundant during winter, while female groups are more abundant in summer.

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[6], 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.

7.4.10.2 Cape Fur Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) (see Figure 7-28) is the only species of seal resident along the West Coast, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs (see Figure 7-29). Vagrant records from four other species of seal more usually associated with the subantarctic environment have also been recorded: southern elephant seal (*Mirounga leoninas),* subantarctic fur seal (*Arctocephalus tropicalis),* crabeater *(Lobodon carcinophagus)* and leopard seals (*Hydrurga leptonyx)* (David 1989).

There are a number of Cape fur seal colonies within the broader study area: at Bucchu Twins near Alexander Bay, at Cliff Point (~17 km north of Port Nolloth), at Kleinzee (incorporating Robeiland), Strandfontein Point (south of Hondeklipbaai), Paternoster Rocks and Jacobs Reef at Cape Columbine, Vondeling Island, Robbesteen near Koeberg, Seal Island in False Bay and Geyser Rock at Dyer Island, Quoin Point and Seal Island in Mossel Bay. The colony at Kleinzee has the highest seal population and produces the highest seal pup numbers on the South African Coast (Wickens 1994). The colony at Buchu Twins and Cliff Point, formerly non-breeding colonies, have also attained breeding status (M. Meyer, SFRI, pers. comm.). Non-breeding colonies and haul-out sites occur occur at Doringbaai south of Cliff Point, Rooiklippies, Swartduin and Noup between Kleinzee and Hondeklipbaai, at Spoeg River and Langklip south of Hondeklip Bay, on Bird Island at Lambert's Bay, at Paternoster Point at Cape Columbine and Duikerklip in Hout Bay. **These colonies all fall well inshore and to the east of the proposed survey area.**

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. Their diet varies with season and availability and includes pelagic species such as horse mackerel, pilchard, and hake, as well as squid and cuttlefish.

Figure 7-28: Colony of cape fur seals
Photo: Dirk Heinrich

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

The timing of the annual breeding cycle is very regular, occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991).

Historically the Cape Fur Seal was heavily exploited for its luxurious pelt. Sealing restrictions were first introduced to southern Africa in 1893, and harvesting was controlled until 1990 when it was finally prohibited. The protection of the species has resulted in the recovery of the populations, and numbers continue to increase. Consequently, their conservation status is not regarded as threatened. The Cape Fur Seal population in South Africa is regularly monitored by DFFE (e.g. Kirkman *et al.* 2013). The overall population is considered healthy and stable in size, although there has been a westward and northward shift in the distribution of the breeding population (Kirkman *et al.* 2013).

7.5 MARINE PROTECTED AREAS AND POTENTIAL VULNERABLE MARINE ECOSYSTEMS

Several marine protected areas (MPAs) and other recently identified sensitive marine areas which exist along the West Coast are discussed below.

7.5.1 Marine Protected Areas (MPAs)

South Africa boasts 42 MPAs, 20 of which were only proclaimed in 2019. Of these, 3 are located within, 2 adjacent and another 3 inshore of the proposed survey area (see Figure 7-29). The degree of protection offered in each MPA varies between them, with some offering blanket no-take regulations, while others restrict fishing to recreational shore angling. Many however are zoned and allow different intensities of use to take place in different portions of the MPAs (SANBI 2020). The MPAs within the proposed survey area are discussed below.

The **Orange Shelf Edge MPA** covers depths of between 250 m and 1 500 m along the northern boundary of the proposed survey area and is unique as it has to date never been trawled. Proclaimed in 2019, this MPA provides a glimpse into what a healthy seabed should look like, what animals live there and how the complex relationships between them support important commercial fish species such as hake, thereby contributing fundamentally towards sustainable fisheries development. This MPA also protects the pelagic habitats that are home to predators such as blue sharks, as well as surface waters where thousands of seabirds such as Atlantic yellow-nosed albatrosses feed.

The 1 335 km^2 **Child's Bank MPA**, located within the proposed survey area, supports seabed habitats inhabited by a diversity of starfish, brittle stars and basket stars, many of which feed in the currents passing the bank's steep walls. Although trawling has damaged coral in the area, some pristine coral gardens remain on the steepest slopes. The Child's Bank area was first proposed for protection in 2004 but was only proclaimed in 2019, after reducing its size to avoid petroleum wellheads and mining areas. The MPA provides critical protection to these deep sea habitats (180 - 450 m) as they allow for the recovery of important nursery areas for young fish.

The **Benguela Muds MPA**, is the smallest of the South African offshore MPAs. At only 72 km^2 the muddy habitats located in this area are created by sediment washed down the Orange River and out to sea. These mud habitats are of limited extent and were considered 'critically endangered' on South Africa's deep continental margin of the west coast (Sink *et al.* 2014). The MPA represents the least trawled stretch of muddy seabed on the west coast and is located within the inshore area of the proposed survey area along the 300 m depth contour.

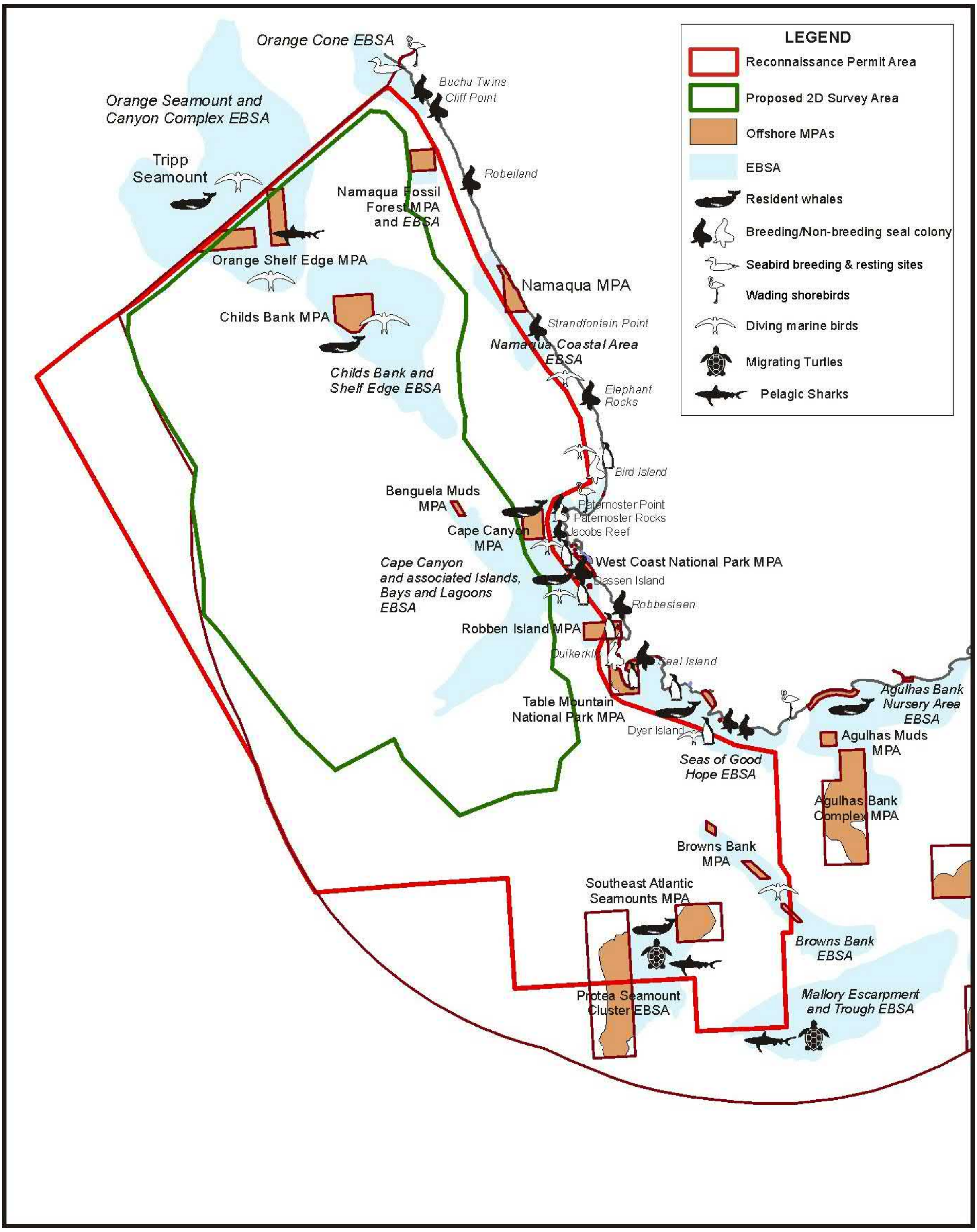

Figure 7-29: Marine Protected Areas and location of seabird and seal colonies in relation to the proposed survey area (green outline)

The **Namaqua Fossil Forest MPA** provides evidence of age-old temperate yellowwood forests from a hundred million years ago when the sea-level was more than 200 m below what it is today; trunks of fossilized yellowwood trees covered in delicate corals. These unique features stand out against surrounding mud, silt and gravel habitats. The fossilized trees are not known to be found anywhere else in our oceans and are valuable for research into past climates. In 2014 this area was recognised as globally important and declared as an Ecologically and Biologically Significant Area (EBSA). The 1 200 km^2 MPA protects the unique fossil forests and the surrounding seabed ecosystems and including a new species of sponge previously unknown to science. The Namaqua Fossil Forest MPA is located along the northeastern boundary of the proposed survey area.

The **Cape Canyon** is a deep and dramatic submarine canyon carved into the continental shelf and extending to a maximum depth of 3,600 m. The 580 km^2 MPA was proclaimed in 2019 and protects the upper part of the canyon where depths range from 180 to 500 m. Underwater footage has revealed a rich diversity of seafans, hermit crabs and mantis shrimps, with hake, monk and john dory resident on the soft canyon floor. Rocky areas in the west of the canyon support fragile rocky habitat, but the area also includes sandy and muddy habitats, which have been trawled in the past. Interaction of nutrient-rich bottom water with a complex seascape results in upwelling, which in turn provides productive surface waters in which seabirds, humpback whales and Cape fur seals feed. The proposed survey area is located along the western boundary of the Cape Canyon MPA.

The **Namaqua National Park MPA** provides the first protection to habitats in the Namaqua bioregion, including several 'critically endangered' coastal ecosystem types. The area is a nursery area for Cape hakes, and the coastal areas support kelp forests and deep mussel beds, which serve as important habitats for the West Coast rock lobster. This 500 km^2 MPA was proclaimed in 2019, both to boost tourism to this remote area and to provide an important baseline from which to understand ecological changes (e.g. introduction of invasive alien marine species, climate change) and human impacts (harvesting, mining) along the West Coast. Protecting this stretch of coastline is part of South Africa's climate adaptation strategy. The proposed survey area is located 40 km offshore of the Namaqua National Park MPA.

The 612 km^2 **Robben Island MPA** was proclaimed in 2019 to protect the surrounding kelp forests - one of the few areas that still supports viable stocks of abalone. The island harbours the 3rd largest penguin colony, with the breeding population peaking in 2004 at 8 524, but declining since. The island also holds the largest numbers of breeding Bank Cormorant in the Western Cape (120 pairs in 2000) and significant populations of Crowned Cormorant, African Black Oystercatcher (35 breeding pairs in 2000), Hartlaub's Gull and Swift Tern. The proposed survey area is located approximately 25 km offshore of the western boundary of the MPA.

The **Table Mountain National Park (TMNP) MPA** was declared in 2004, and includes 996 km^2 of the sea area and 137 km of coastline around the Cape Peninsula from Mouille Point in the North to Muizenberg in the south. Although fishing is allowed in the majority of the MPA (subject to Department of Agriculture, Forestry and Fisheries (DAFF) permits, regulations and seasons), the MPA includes six 'no-take' zones where no fishing or extractive activities are allowed. These 'no-take' zones are important breeding and nursery areas for a wide variety of marine species thereby providing threatened species with a chance to recover form over-exploitation. The proposed survey area is located approximately 32 km offshore of the western boundary of the MPA.

7.5.1 Ecologically or Biologically Significant Areas (EBSAs)

As part of a regional Marine Spatial Management and Governance Programme (MARISMA 2014-2020) the Benguela Current Commission (BCC) and its member states have identified a number of EBSAs spanning the border between Namibia and South Africa 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 12 EBSAs identified solely within its national jurisdiction with a further three having been proposed[7]. It also shares eight trans-boundary EBSAs with other countries (Namibia (3) and Mozambique (2)) and/or high seas (3). The principal objective of these EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. The impact management and conservation zones within the EBSAs are currently being reviewed and additional zones may be proposed. The text and figures below are based on the EBSA status as of July 2020. The EBSAs do not yet carry a legal status.

The proposed survey area overlaps with the Orange Seamount and Canyon Complex EBSA, Child's Bank and Shelf Edge EBSA and the Cape Canyon and associated Islands, Bays and Lagoons EBSA and is located west of the Orange Cone, Namaqua Fossil Forest and Namaqua Coastal Area EBSAs (see details below and Figure 7-30).

The **Orange Seamount and Canyon Complex**, occurs at the western continental margin of southern Africa, spanning the border between South Africa and Namibia and overlaps with the northern portion of the proposed survey area. On the Namibian side, it includes Tripp Seamount and a shelf-indenting canyon. The EBSA comprises shelf and shelf-edge habitat with hard and unconsolidated substrates, including at least eleven offshore benthic habitat types of which four habitat types are 'Threatened', one is 'Critically endangered' and one 'Endangered'.

The Orange Shelf Edge EBSA is one of few places where these threatened habitat types are in relatively natural/pristine condition. The local habitat heterogeneity is also thought to contribute to the Orange Shelf Edge being a persistent hotspot of species richness for demersal fish species. Although focussed primarily on the conservation of benthic biodiversity and threatened benthic habitats, the EBSA also considers the pelagic habitat, which is characterized by medium productivity, cold to moderate Atlantic temperatures (SST mean = 18.3°C) and moderate chlorophyll levels related to the eastern limit of the Benguela upwelling on the outer shelf.

The **Child's Bank and Shelf Edge** EBSA, is a unique submarine bank feature rising from 400 m to -180 m on the western continental margin on South Africa. This area includes five benthic habitat types, including the bank itself, the outer shelf and the shelf edge, supporting hard and unconsolidated habitat types. Child's Bank and associated habitats are known to support structurally complex cold-water corals, hydrocorals, gorgonians and glass sponges; species that are particularly fragile, sensitive and vulnerable to disturbance, and recover slowly.

The **Cape Canyon and Associated Islands** EBSA lies within the southeastern portion of the proposed survey area. The EBSA includes the Benguela Muds MPA and the Cape Canyon, which is thought to hosts fragile habitat-forming species. The area is considered important for pelagic fish, foraging marine mammals and several threatened seabird species and serves to protect nine 'Endangered' and 12 'Vulnerable' ecosystem types, and two that are 'Near Threatened'. There are several small coastal MPAs within the EBSA, well inshore of the proposed survey area.

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[7] The delineations are final and currently under review with Oceans and Coasts. Once signed off there they will be submitted to the subsidiary body on scientific, technical and technological advice (SBSTTA) of the CBD. The original boundaries have already been internationally adopted (*pers. comm*. Harris & Holness, MARISMA).

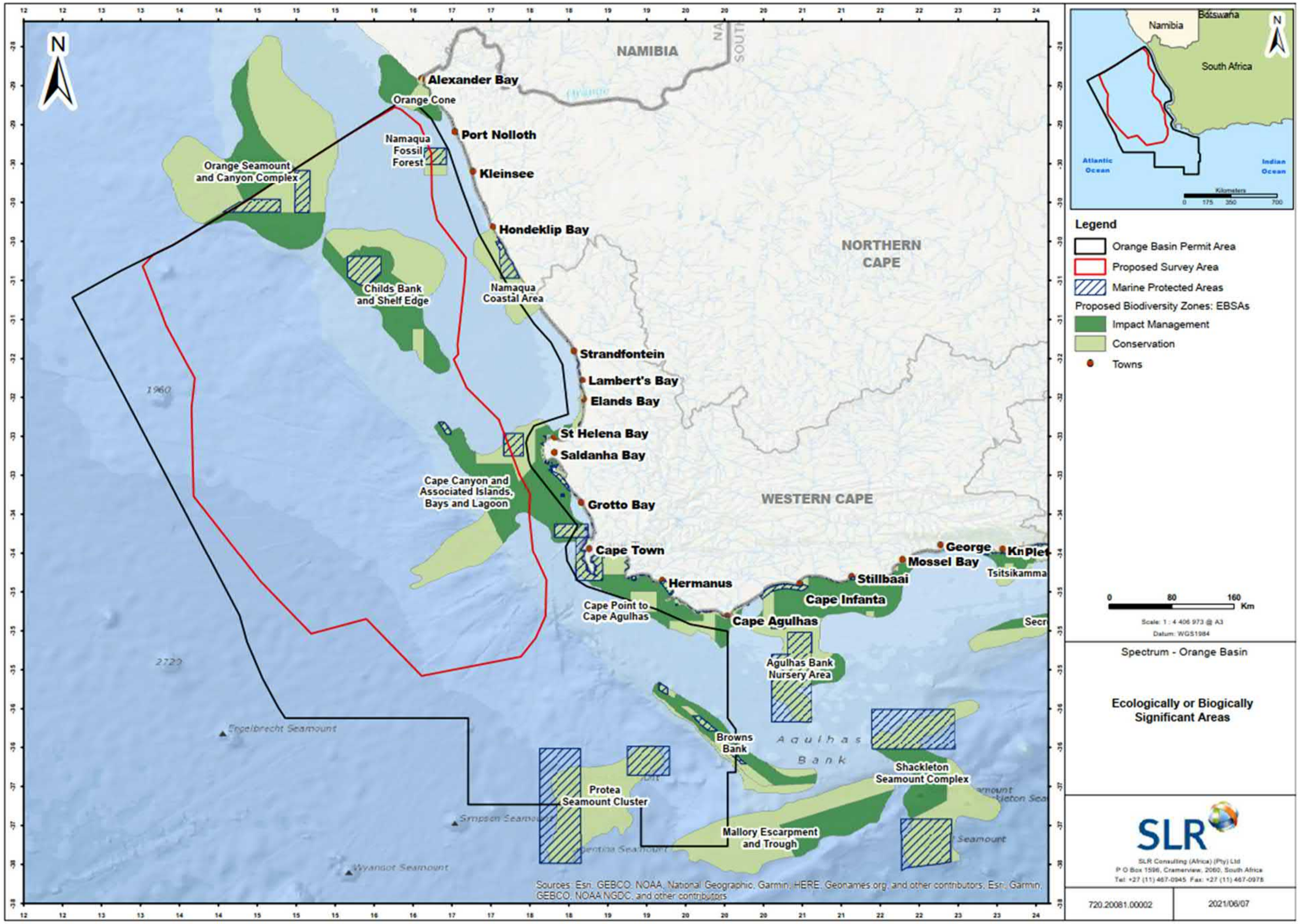

Figure 7-30: Proposed Ecologically and Biologically Significant Areas on the West Coast in relation to the proposed survey area (including turning circles).

The **Orange Cone** transboundary EBSA lies inshore of the proposed survey area and spans the mouth of the Orange River. The estuary is biodiversity-rich but modified, and the coastal area includes many 'Critically endangered', 'Endangered' and 'Vulnerable' habitat types (with the area being particularly important for the 'Critically Endangered' Namaqua Sandy Inshore, Namaqua Inshore Reef and Hard Grounds and Namaqua Intermediate and Reflective Sandy Beach habitat types). The marine environment experiences slow, but variable currents and weaker winds, making it potentially favourable for reproduction of pelagic species. An ecological dependence for of river outflow for fish recruitment on the inshore Orange Cone is also likely. The Orange River Mouth is a transboundary Ramsar site and falls within the Tsau//Khaeb (Sperrgebiet) National Park. It is also under consideration as a protected area by South Africa, and is an Important Bird and Biodiversity Area.

The **Namaqua Fossil Forest** EBSA lies inshore of the proposed survey area and is a small seabed outcrop composed of fossilized yellowwood trees at 136-140 m depth, approximately 30 km offshore on the west coast of South Africa. A portion of the EBSA comprises the Namaqua Fossil Forest MPA. The fossilized tree trunks form outcrops of laterally extensive slabs of rock have been colonized by fragile, habitat-forming scleractinian corals and a newly described habitat-forming sponge species. The EBSA thus encompasses a unique feature with substantial structural complexity that is highly vulnerable to benthic impacts.

The **Namaqua Coastal Area** EBSA, inshore of the proposed survey area, encompasses the Namaqua Coastal Area MPA and is characterized by high productivity and community biomass along its shores. The area is important for several threatened ecosystem types represented there, including two 'Endangered' and four 'Vulnerable' ecosystem types, and is important for conservation of estuarine areas and coastal fish species.

The **Benguela Upwelling System,** a transboundary EBSA is globally unique as the only cold-water upwelling system to be bounded in the north and south by warm-water current systems, and is characterized by very high primary production (>1 000 mg $C.m^{-2}.day^{-1}$). It includes important spawning and nursery areas for fish as well as foraging areas for threatened vertebrates, such as sea- and shorebirds, turtles, sharks, and marine mammals. Another key characteristic feature is the diatomaceous mud-belt in the Northern Benguela, which supports regionally unique low-oxygen benthic communities that depend on sulphide oxidising bacteria.

Although no specific management actions have as yet been formulated for the EBSAs, two biodiversity zones have recently been defined within each EBSA as part of the marine spatial planning process. The management objective in the zones marked for 'Conservation' is "*strict place-based biodiversity protection aimed at securing key biodiversity features in a natural or semi-natural state, or as near to this state as possible*". The management objective in the zones marked for 'Impact Management' is "*management of impacts on key biodiversity features in a mixed-use area to keep key biodiversity features in at least a functional state*" (https://cmr.mandela.ac.za/EBSA-Portal/South-Africa/SA-EBSA-Status-Assessment-Management).

The latest version of the 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.

The biodiversity priority areas and management objectives of each category have been defined and mapped as part of the marine spatial planning process and largely correspond with the latest identified EBSAs. 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 have been proposed for these areas, 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 Marine Spatial Plan Conservation Zones and management regulations, respectively.

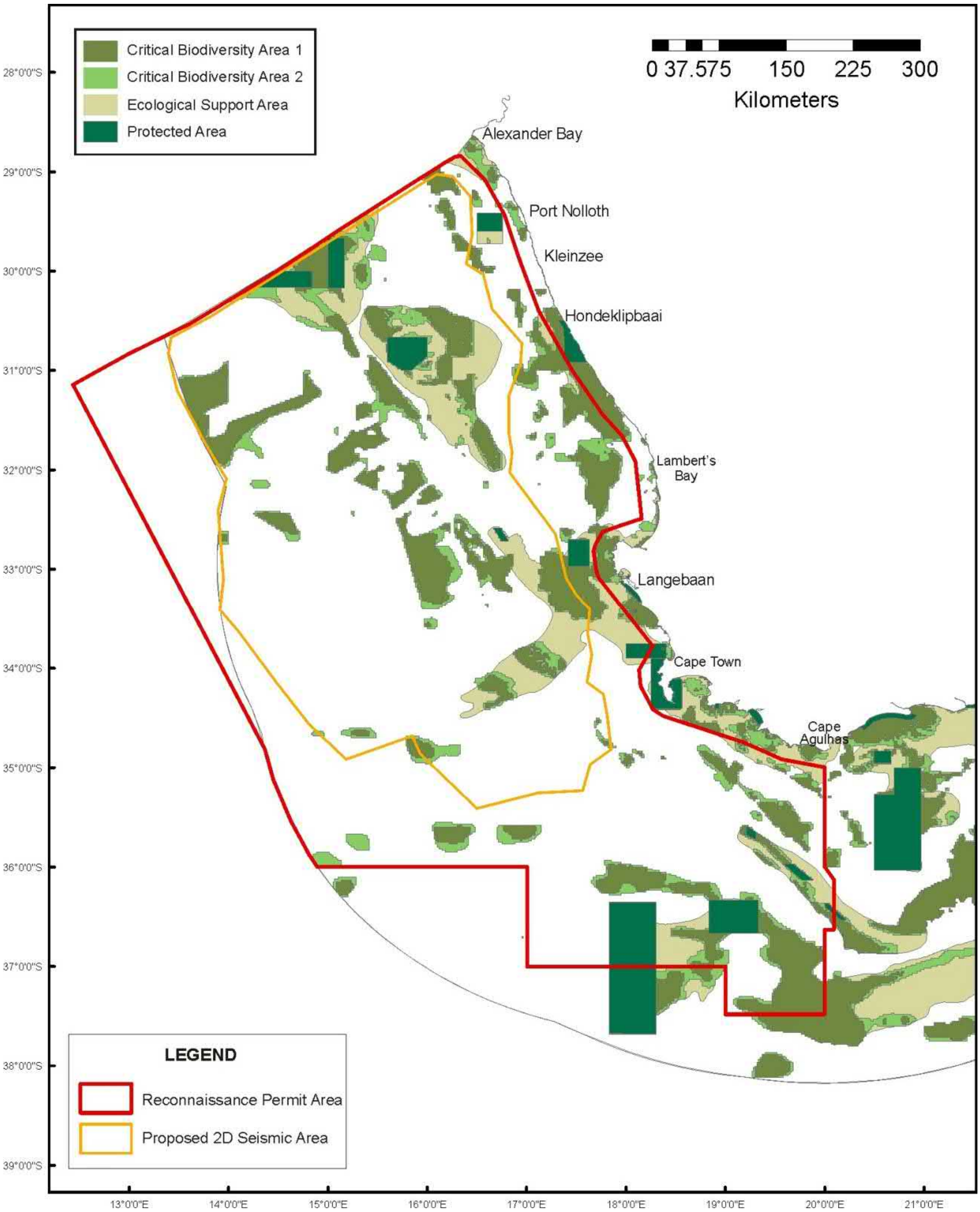

Figure 7-31: Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) in relation to the proposed survey area (version 1.1 June 2021)

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.

Non-destructive petroleum exploration is compatible in ESAs and may be compatible, subject to certain conditions, in CBAs. Destructive exploration activities with localised impact, e.g. exploration wells, may be compatible, subject to certain conditions, in CBAs and ESAs. Petroleum production is classified as incompatible in CBAs but may be compatible, subject to certain conditions, in ESAs (Harris *et.al*. 2020).

These zones have been incorporated into the most recent iteration of the national Coastal and Marine CBA Map (v1.1 released in June 2021) (Harris *et al.* 2020) (see Figure 7-31). This indicates that CBA1 and CBA2 regions extend across much of the proposed survey area. 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. 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.

7.5.2 Important Bird Areas (IBAs) and Ramsar Sites

Various marine IBAs have been proposed in South African and Namibian territorial waters, with a candidate trans-boundary marine IBA suggested off the Orange River mouth (Figure 7-32).

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 survey area overlaps with the proposed Bird Island / Dassen Island / Heuningnes River and estuary system / Lower Berg River wetlands marine IBA.**

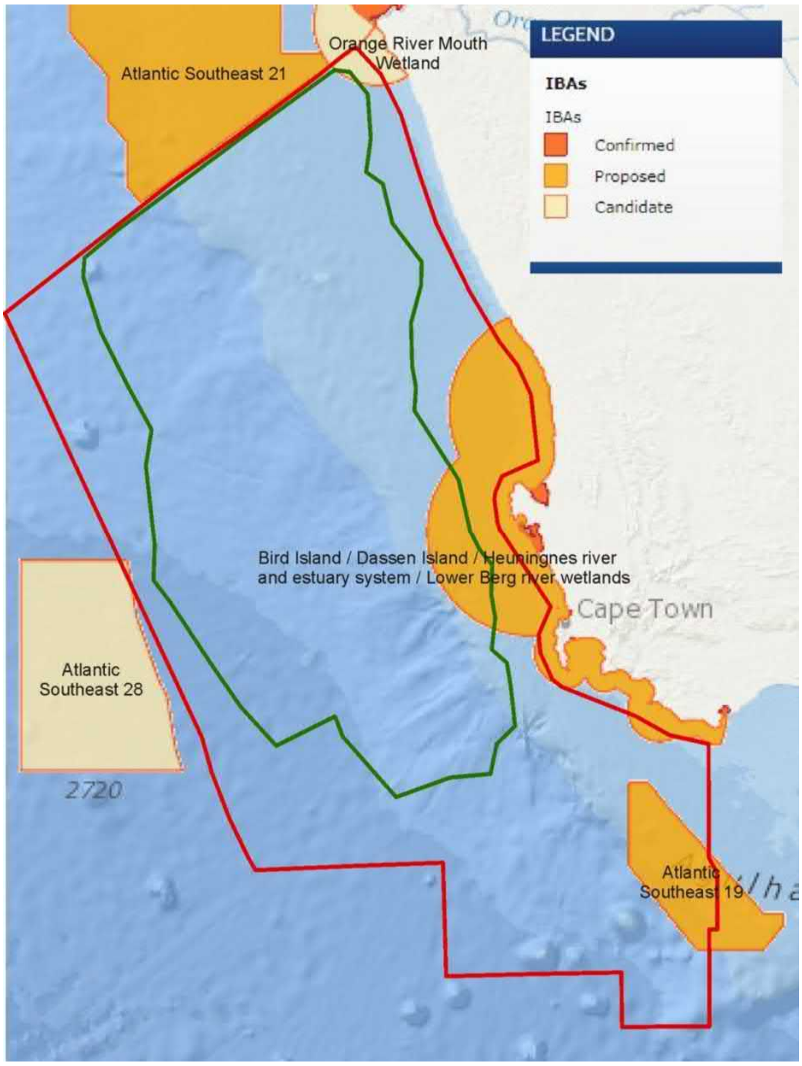

Figure 7-32: Proposed and confirmed coastal and marine IBAs in the Western and Northern Cape in relation to the proposed survey area (green outline)

Source: https://maps.birdlife.org/marineIBAs

7.6 SOCIO-ECONOMIC ENVIRONMENT

This section provides an overview of the regional context of the project area covering the administrative boundaries; settlements and population demography; education, employment, health and poverty; economic and industrial profile; tourism and recreation and artisanal fishing along the West Coast. The fishing sectors are discussed under Section 7.7.

7.6.1 Regional Context

7.6.1.1 Administrative Areas

The study area, referred to as the West Coast of South Africa, includes three districts, namely the City of Cape Town Metropolitan Municipality (Western Cape Province), the West Coast District Municipality (Western Cape Province) and the Namakwa District Municipality (Northern Cape Province).

The Cape Town Metropolitan Municipality is a single unified metropolitan area that includes the City of Cape Town and surrounding suburbs. The West Coast District Municipality is however further divided into five local municipalities, all of which are located along the West Coast, and include Swartland, Saldanha Bay, Berg River, Cederberg, and Matzikama. The Namakwa District is separated into seven local municipalities, three of which are located along the west coast, namely: the Richtersveld, Nama Khoi, and Kamiesberg Local Municipalities. The distribution of the various administrative districts is shown in Figure 7-33.

Table 7-7: Coastal administrative structures along the West Coast

Province	District Municipalities (Coastal only)	Local Municipalities (Coastal only)
Western Cape	City of Cape Town MM	City of Cape Town
	West Coast	Swartland
		Saldanha Bay
		Berg River
		Cederberg
		Matzikama
Northern Cape	Namakwa	Kamiesberg
		Nama Khoi
		Richtersveld

7.6.1.2 Settlements and Population Demographics

The City of Cape Town Metropolitan Municipality encompasses the second largest city in South Africa, which supports a projected population of 4 488 546 people as of 2019 (Statistics South Africa, 2020). The remainder of the West Coast coastline is characterised by sparse development with sporadic settlements and limited infrastructure. The exception is the West Coast Peninsula, which is located just over 100 kilometres north of Cape Town. This area which includes the active port of Saldanha Bay, and several historic and fishing towns, including Vredenburg, Langebaan, Paternoster and St Helena Bay. Several other small towns are scattered along the coastline between Cape Town (in the south) and Alexander Bay (in the north), which have small populations (averaging between 300 – 2000 people).

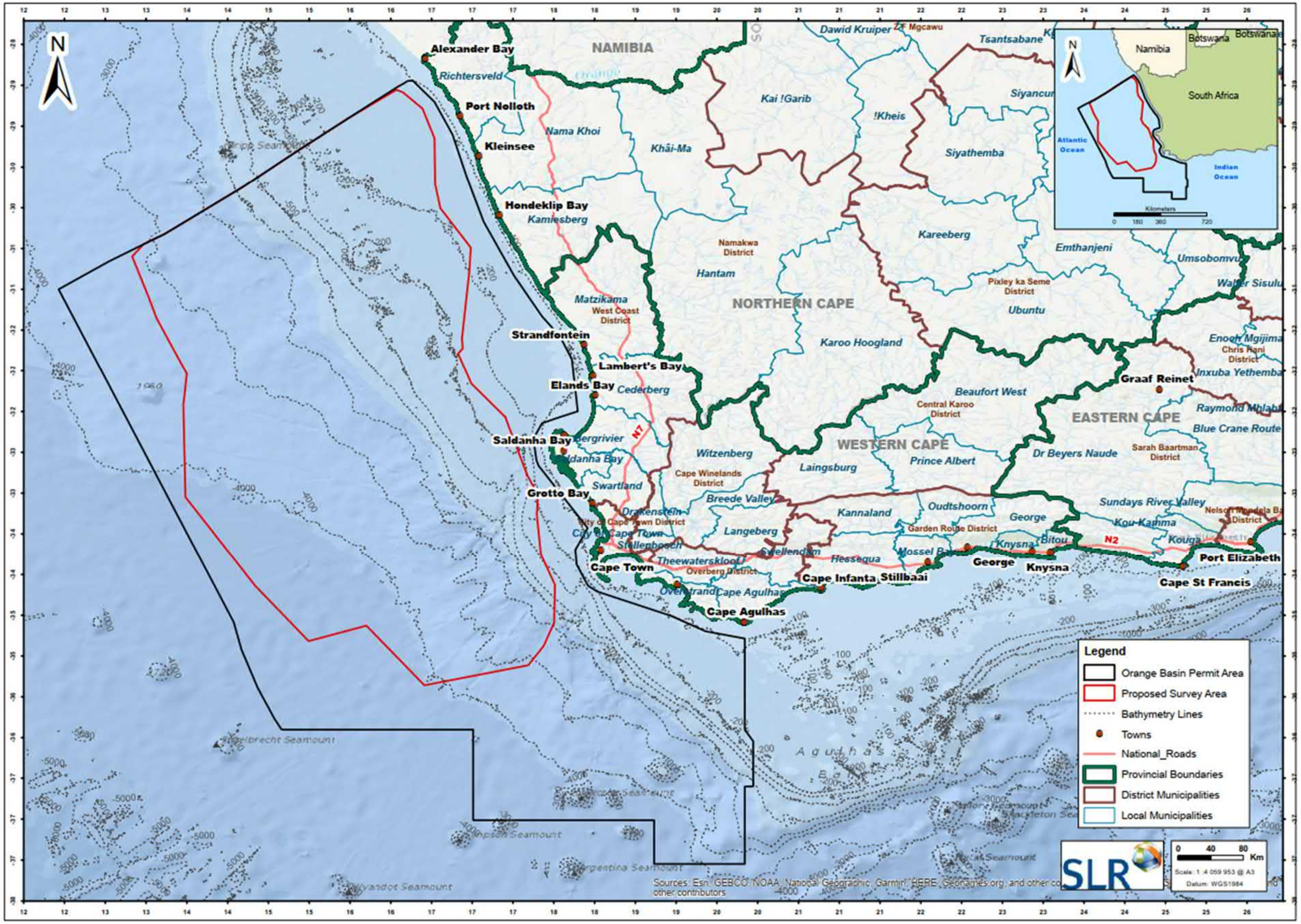

Figure 7-33: Provincial and district administrative structures of the southwestern South African coast.

The population size of the entire West Coast District Municipality is estimated at 455 881 persons (West Coast District Municipality, 2020), and the Namakwa District has a projected population of 132 000 (Namakwa District Municipality, 2020). In total the three municipalities have a total population of just over 5.1 million people, most of which is concentrated in Cape Town.

The population density of the City of Cape Town is estimated at 1,530 persons per square kilometre, while in contrast the West Coast District has a significantly lower density at 14.6 people per square kilometre, while the largely rural Namakwa District is the lowest at 1.1 persons per square kilometre.

Age profiles across the districts are similar although the Namakwa District has a higher proportion of older people (+65 years) at 14% compared to Cape Town and West Coast with 6%, and a lower proportion of adults between 35-64 years at 31% compared to Cape Town with 34% and West Coast with 33%, respectively. This potentially relates to greater access to employment opportunities in towns of the Western Cape than in the Northern Cape.

The gender ratio for South Africa of 51% female and 49% male is similar for the coastal districts although there are 49.6% females and 50.4% males for the Namakwa Districts which may possibly be due to the significant number of mining activities in the inland areas of district which would attract a higher proportion of men for employment.

7.6.1.3 Education, Employment, Health and Poverty

Education, employment, health and poverty indicators are inextricably linked and summarised below.

Education

The more densely populated urban centre of the City of Cape Town has a higher proportion of people who have completed secondary schooling or have a tertiary education than the population of the more rural West Coast District. Only 20% of the population of the latter has completed secondary school compared to 35% in the more urbanised districts. Namakwa District has a higher level of education attainment than the West Coast District, but still lower than the City of Cape Town.

Employment

Unemployment and underemployment are chronic issues in South Africa. In the third quarter of 2019, the national unemployment rate for South Africa was estimated at 29.1%, which rises to 41.1% when discouraged work seekers are included. Although current estimates are not yet available, the unemployment rate is expected to rise due to the impacts of the COVID-19 national lockdown.

Unemployment in the Western Cape has been steadily rising over the last decade, partly due to in migration of work seekers from other areas (particularly the Eastern Cape) but also linked to the poor performance of the economy as a whole. In the Western Cape the recorded narrow unemployment rate for 2019 was 19.3% (City of Cape Town 24.8%) and for West Coast District Municipality it was 10.7% in 2018. In contrast, unemployment in the Northern Cape is 26%, increasing to 41.5% when discouraged work seekers are included. The overall unemployment rate in 2018 for the Namakwa District is estimated at 25%.

Health

Similar to educational profiles, people living in the larger urban centres of the Western Cape have greater access to health care. Based on 2017 data, the City of Cape Town have 132 primary healthcare facilities (81 fixed primary healthcare clinics, 42 community day centres as well as 9 community health centres). In comparison, the West

Coast District had 62 primary healthcare clinics in 2018 (including 7 district hospitals and one community day centre).

Poverty

In general, poverty levels in South Africa are increasing, as reflected by deteriorating financial health of households and individuals under the weight of economic pressures (Statistics South Africa (SSA) 2017). The Poverty Trends report (SSA 2017) cites rising unemployment levels, low commodity prices, higher consumer prices, lower investment levels, household dependency on credit, and policy uncertainty as the key contributors to the economic decline in recent times. It is measured against the poverty line set at R1 227 per person per month (SSA 2019). In 2016, the Western Cape fared better than the national average of 49.2% with 33.2% living in poverty (640 000 people). The National Development Plan (2013) has set a target of reducing income inequality in South Africa from a Gini coefficient of 0.7 in 2010 to 0.6 by 2030. In 2016 it was recorded nationally as being 0.628 while the city of Cape Town retained Gini coefficient is 0.61 (2016). Income inequality in the West Coast District has increased between 2012 and 2018, with the Gini coefficient increasing from 0.560 in 2012 to 0.595 in 2018 (Western Cape, 2019).

The Gini coefficient for the Namakwa District was 0.566 in 2018, however this remains largely favourable compared to the larger Northern Cape Province and South Africa in general, as both had a more unequal spread of income amongst their residents (at 0.604 and 0.63 respectively) (Namakwa District Municipality, 2020).

7.6.1.4 Economic and Industrial Profile

As the largest urban settlement in the study area (and second largest city in South Africa), the City of Cape Town economy contributed 71.8% to the Western Cape's total Gross Domestic Product (GDP) of R424 billion in 2016 with a growth rate of 3%. The tertiary sector (finances, insurance and real estate) contributed the majority of 74.9% to GDP in 2016, manufacturing 23.6% and the primary sectors (agriculture, forestry and fishing) only 1.3%.

The West Coast District contributed 5.2 % (R29.8 billion) to the Western Cape's economy in 2017 (West Coast District, 2020). The top three contributors to the District GDP in 2019 were (1) agriculture, forestry and fishing (20.9% of District GDP), (2) manufacturing (21.4% of District GDP), and (3) wholesale, retail trade, catering and accommodation (15.2% of District GDP) (West Coast District Municipality, 2020). Combined, these three sectors contributed R17.1 billion (or 57.5%) to the West Coast District's economy, estimated to be worth R29.812 billion in 2017 (West Coast District Municipality, 2020).

The Namakwa District Municipality contributed only 11% to the Northern Cape Province GDP with the main economic sectors being agriculture and tourism, with potential for growth in the mining and aquaculture sectors (Namakwa District Municipality, 2020).

7.6.1.5 Tourism and Recreation

The wider project area covers two broad tourism areas of the Western Cape, namely City of Cape Town, and the West Coast. Coastal tourism along the west coast is concentrated in and around the City of Cape Town but is developing rapidly further up the coastline towards the West Coast Peninsula area. The Namakwa District of Northern Cape, however, has a comparatively poorly developed tourism sector.

In the Western Cape there were an estimated 1.6 million international tourist arrivals in 2016, and 2.1 million domestic tourists, which generated R18.1 billion in foreign spend and R2.5 billion in domestic tourism spend.

(WESGRO undated). Contribution of tourism to the Western Cape economy and employment has grown annually (until 2020, i.e. pre-COVID-19).

The top tourism and recreational activities across both the regions of Cape Town and West Coast include outdoor activities, scenic drives, visits to national parks, culture and heritage, and cuisine. Coastal tourism and recreational activities and services are found primarily in and around Cape Town, while the Langebaan/Saldanha Bay area has the second highest concentration of tourism activities. Small pockets of coastal tourism are found scattered along the entire length of the West Coast in small towns dotted along the coastline.

Coastal destinations within the West Coast District attract 26,3% to 31,3% of foreign tourists visiting the West Coast area, and 68,7% to 71,7% of domestic tourists (West Coast District Municipality , 2019). Key coastal activities include whale watching, water sports at Langebaan Lagoon, and scenic drives and views. The cold Atlantic Ocean waters and often severe weather means that swimming and other water sports (outside of the protected Langebaan Lagoon) are scarce.

The tourism market in the Northern Cape Province is less developed, but is one of the fastest growing contributors to the province's economy with an annual tourism spend of R850 million in 2013 (Northern Cape , 2018). The Namakwa District, with its sparse population and small towns attracts the more adventurous tourists. Inland attractions, such as the wildflowers in the spring, geological and historical landmarks, and cultural features are key for tourism in this area, as the cold and windy coastline deters people from coastal recreational activities. Costal tourism is limited to the fishing towns of Hondeklip Bay, Kleinzee and Port Nolloth, Large distances between centres and a lack of infrastructure, tourist attractions and activities hinders active tourism growth in this area.

7.6.1.6 **Recreational Fishing**

Recreational fishing occurs around the whole South African coastline. It takes many forms from use of ski boats, diving for lobsters, rod and line from beaches, picking mussels, limpets, bait and oysters. The limits by species and areas is clearly legislated and recreational fishers need permits. Recreational fishers are not allowed to sell their catch. Historically recreational line fish was split between "A" and "B" permits where A permits had a different catch limit and could sell their catch – this was done away with and there are only recreational or commercial line fish permits. The number of boats permitted to fish were reduced from thousands to only 450 commercial rights. This was done to "save" the line fish species and help rebuild stocks – the Minister implemented these measures by declaring a "crisis" and effectively largely closing down the exploitation of most line fish species. Within the project's area of influence many small recreational or pleasure vessels are launched from a variety of small harbours and slipways located on the West Coast, such as Lamberts Bay, Laaiplek, St Helena Bay and Saldanha Bay. Harbours at Kalk Bay and Hout Bay also support recreational fishing activity in Cape Town. Beach launches may be used at various other locations. Recreational fishers must comply with maritime legislation as prescribed by the South African Maritime Safety Association (SAMSA, which is part for the Department of Transport).

7.6.1.7 **Artisanal and Subsistence Fishing**

Much of the nearshore and offshore marine environment along the South African coast supports well established commercial fishery. This includes subsistence / artisanal components which are technically non-commercial and meant to sustain livelihoods. These communities, with long family histories of subsistence fishing, prioritise the harvest of nearshore resources (using boats) (making up 44-56% of all fishing) over the intertidal (24-28% of fishing) and subtidal resources (20-30% of fishing) (Clark *et al*. 2002).

Subsistence and artisanal fishers travel long distances to harvest these resources. The average length of coastline utilised by subsistence fishers on the West Coast travel and average of 66.2 km and a maximum of 200 km, compared to other regions of South Africa where fishers only travel up to 20 km (Clark *et al*. 2002). The higher value of many intertidal and subtidal resources (e.g. rock lobster, abalone, mussels) has, however, resulted in an increase in their production through aquaculture and small-scale harvesting in recent years (Clark *et al*. 2002).

With declining stocks and increasing commercialised fishing and increased populations on the coast, there has been increased pressure on fish and other marine resources leading to conflict and a trend towards selling catch for a living. With the introduction of the Small Scale Fisheries Policy – the government (through DFFE) is implementing the SSF policy through identifying fishers along the coast with historical interests in fishing in order to allocate them into logical co-operative groups. The intent is that these co-ops would have a “legal right” to access baskets of species and that they will fall within the broader fisheries management system in South Africa that aims to manage stocks sustainably. Further information on Small-Scale Fisheries is presented in Section 7.7.9.

7.6.1.8 **Supply Port - Port of Cape Town**

Spectrum is proposing to call at the Port of Cape Town for supplies, refuelling and crew changes during the proposed 2D survey. The Port of Cape Town is one of eight commercial seaports and the second largest port in South Africa, which primarily supports the shipment of containerised and bulk goods and is operated by the Transnet National Ports Authority (TNPA). It also plays a key role in supporting local commercial fisheries including several commercial fishing rights holders (CapMarine, 2021).

In addition, the Port of Cape Town contains the Victoria and Alfred (V&A) Waterfront, which is a major international tourism and recreational destination. The V&A Waterfront supports multi-use shopping, marine recreation and tourism activities.

7.7 FISHING SECTOR ACTIVITIES

The South African fishing industry consists of at least 20 commercial sectors operating within the country’s 200 nautical mile(nm) Exclusive Economic Zone (EEZ). Fisheries active in the Orange Basin include:

- Demersal trawl;
- Mid-water trawl
- Small pelagic purse-seine (inshore);
- Demersal long-line (hake- and shark-directed);
- Pelagic long-line (tuna- and shark-directed);
- Tuna Pole;
- Traditional line fish (inshore);
- West Coast rock lobster; and
- Small-scale fisheries; and
- Beach-seine and gillnet fisheries.

Each of these are described in more detail below.

The description of the commercial fisheries is based on a review and collation of existing information. Catch and effort data were sourced from the Fisheries Branch of DFFE based on records for the years 2000 to 2019. All data were referenced to a latitude and longitude position and were redisplayed on a 10x10 or 5x5 minute grid. Additional information was obtained from the Marine Administration System from DFFE and from the South Africa, Namibia and Mozambique Fishing Industry Handbook 2019 (47th Edition).

7.7.1 Demersal Trawl

Demersal trawl is South Africa's most valuable fishery accounting for approximately half of the income generated from commercial fisheries. The fishery is separated into an offshore sector targeting deep-water hake (*Merluccius paradoxus)* and an inshore sector targeting shallow-water hake (*M. capensis*). Secondary species include a large assemblage of demersal fish of which monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*) are the most commercially important. The wholesale value of catch landed by the inshore and offshore demersal trawl sectors, combined, during 2017 was R3.982 billion, or 40.5% of the total value of all fisheries combined. Nominal catch for both sectors combined amounted to 145 088 tons during 2018 and the current Total Allowable Catch (TAC) is set at 146 400 tons. Fishing grounds extend in an almost continuous band along the shelf edge from the Namibian maritime border in the north to Port Elizabeth in the East. The fishery is restricted by permit condition to operating within the confines of an area of approximately 57 300 km^2 and 17 000 km^2 for the offshore and inshore fleets, respectively.

The offshore fishery is comprised of approximately 45 vessels operating from most major harbours on both the West and South Coasts where the fishing grounds extend in a continuous band along the shelf edge between the 200 m and 1 000 m bathymetric contours. Most effort occurs in water of depth between 300 m and 600 m. Monk-directed trawlers tend to fish shallower waters than hake-directed vessels on mostly muddy substrates. Trawl nets are generally towed along depth contours (thereby maintaining a relatively constant depth) running parallel to the depth contours in a north-westerly or south-easterly direction. Trawlers also target fish aggregations around bathymetric features, in particular seamounts and canyons, where there is an increase in seafloor slope and in these cases the direction of trawls follow the depth contours. The deep-sea trawlers may not fish in waters shallower than 110 m or within five nautical miles of the coastline.

The inshore fishery consists of approximately 31 vessels, which operate on the South Coast mainly from the harbours of Mossel Bay and Port Elizabeth. Inshore grounds are located on the Agulhas Bank and extend towards the Great Kei River in the east. The proposed survey area does not overlap with the inshore trawl grounds off the South Coast.

Otter trawling is the main trawling method used in the South African hake fishery. This method of trawling makes use of trawl doors (also known as otter boards) that are dragged along the seafloor ahead of the net, maintaining the horizontal net opening (see Figure 7-34). The configuration of trawling gear is similar for both offshore and inshore vessels however inshore vessels are smaller and less powerful than those operating within the offshore sector. The offshore fleet is segregated into wetfish and freezer vessels which differ in terms of the capacity for the processing of fish at sea and in terms of vessel size and capacity. While freezer vessels may work in an area for up to a month at a time, wetfish vessels may only remain in an area for about a week before returning to port.

The fishery operates continuously throughout the year. Trawling activity coincides with the proposed survey area between the 200 m and 100 m bathymetric contours (see Figure 7-35). Over the period 2008 to 2016 an annual average of 2 530 trawling hours were expended within the proposed survey area, yielding 3 828 tons of hake which is equivalent to 25.2% and 35.1% of the overall effort and catch recorded by the sector, respectively. The proposed survey area coincides with 31 680 km^2 of trawling ground, which amounts to 55.3% of the total extent of the offshore demersal trawling footprint within the South African EEZ. A Namibian-registered fleet of demersal trawl vessels operate on the Namibian side of the maritime border at a depth range of 200 m to 1000 m. As such, fishing activity can be expected along the northern boundary of the proposed survey area, as this extends along the maritime border.

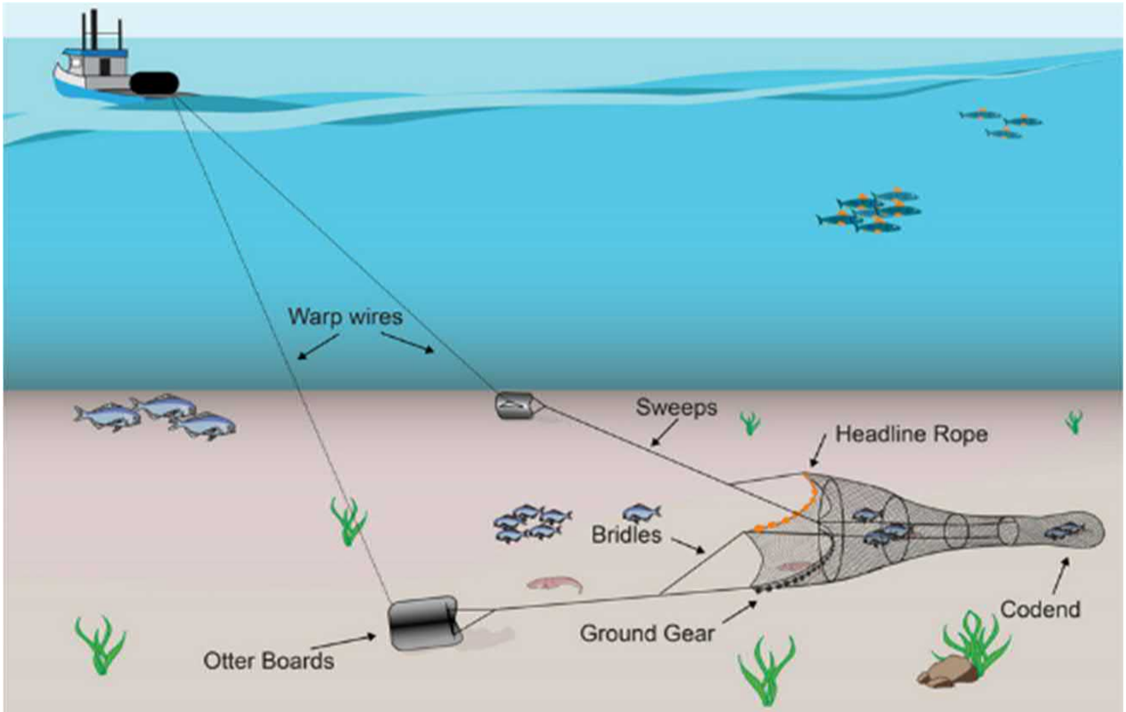

Figure 7-34: Trawl gear typically used by demersal trawlers targeting hake
Source: http://www.afma.gov.au/portfolio-item/trawling

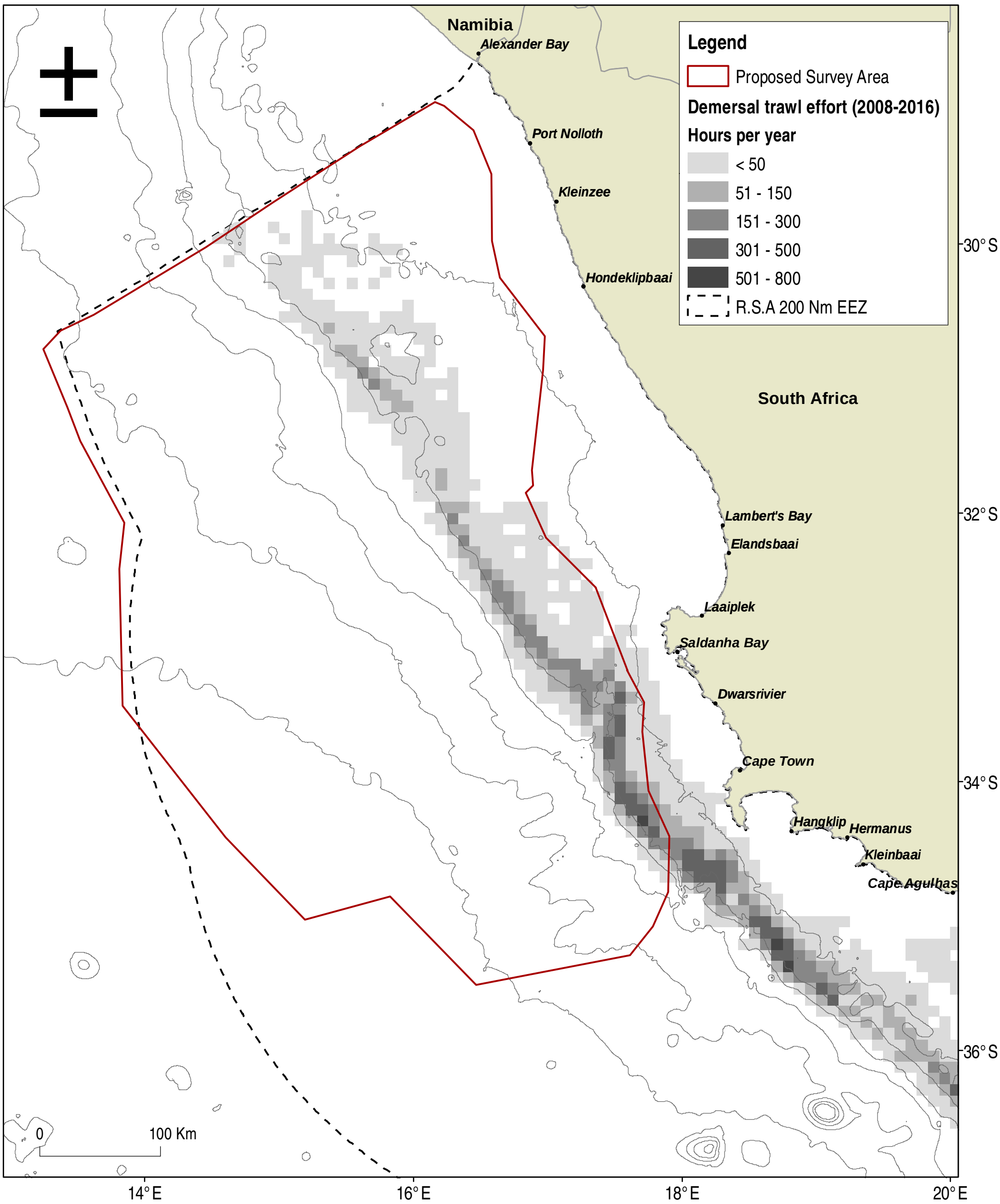

Figure 7-35: Distribution of fishing effort of the offshore demersal trawl sectors (2008-2016).

Note: effort is shown as the number of fishing hours at a gridded resolution of 2x2 minutes (each grid block covers an area of approximately 14 km^2).

7.7.2 Mid-Water Trawl

The mid-water trawl fishery targets adult horse mackerel (*Trachurus capensis*), which aggregate in highest concentration on the Agulhas Bank. Shoals of commercial abundance are found in limited areas and the spatial extent of mid-water trawl activity is relatively limited when compared to that of demersal trawling.

Fishing grounds are located in three main areas on the shelf edge of the South and East coasts:

1. Between 22°E and 23°E at a distance of approximately 70 nm offshore from Mossel Bay;

2. Between 24°E to 27°E at a distance of approximately 30 nm offshore; and
3. South of the Agulhas Bank between 21°E and 22°E.

These grounds range in depth from 100 m to 400 m. However, isolated trawls are occasionally made further offshore in deeper water (up to 650 m). From 2017, DFFE has permitted experimental fishing to take place westward of 20°E.

Mid-water trawling gear configuration is similar to that of demersal trawlers, except that the net is manoeuvred vertically through the water column. Currently the FMV *Desert Diamond* is the only dedicated mid-water trawler. The towed gear may extend up to 1 km astern of the vessel and comprises trawl warps, net and codend (see Figure 7-36).

Once the gear is deployed, the net is towed for several hours at a speed of 4.8 to 6.8 knots predominantly parallel with the shelf break. Mid-water trawling can occur at any depth between the seabed and the surface of the sea without continuously touching the bottom. However, in practice, mid-water trawl gear does occasionally come into contact with the seafloor.

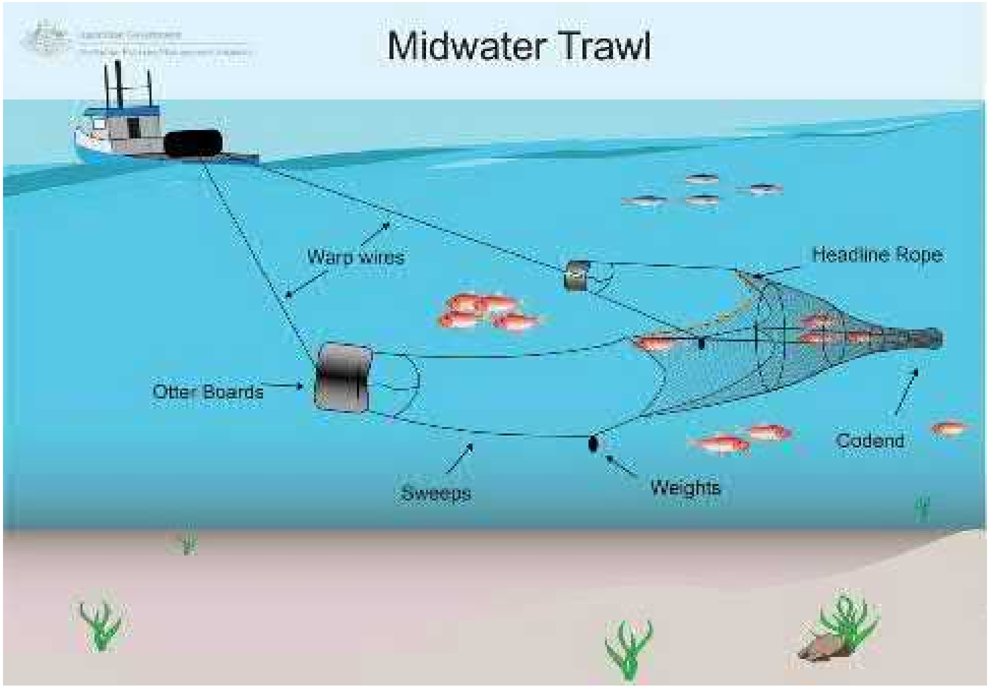

Figure 7-36: Typical configuration of mid-water trawl gear
Source: www.afma.gov.au/fisheries-management/methods-and-gear/trawling

Figure 7-37 shows the spatial extent of grounds fished by mid-water trawlers off the West and South Coasts in relation to the proposed survey area. **There is minimal overlap with the southeastern corner of the proposed survey area between the 200 m and 500 m bathymetric contours**.

Between 2000 and 2016, an average of 229 trawling hours was expended within the proposed survey area, yielding 790 tons of horse mackerel. This is equivalent to 11.9% and 4.1% of the overall effort and catch recorded annually by the sector, respectively. The proposed survey area coincides with 3 570 km^2 of fishing ground, which amounts to 11.1% of the total extent of the grounds fished by the mid-water trawl sector.

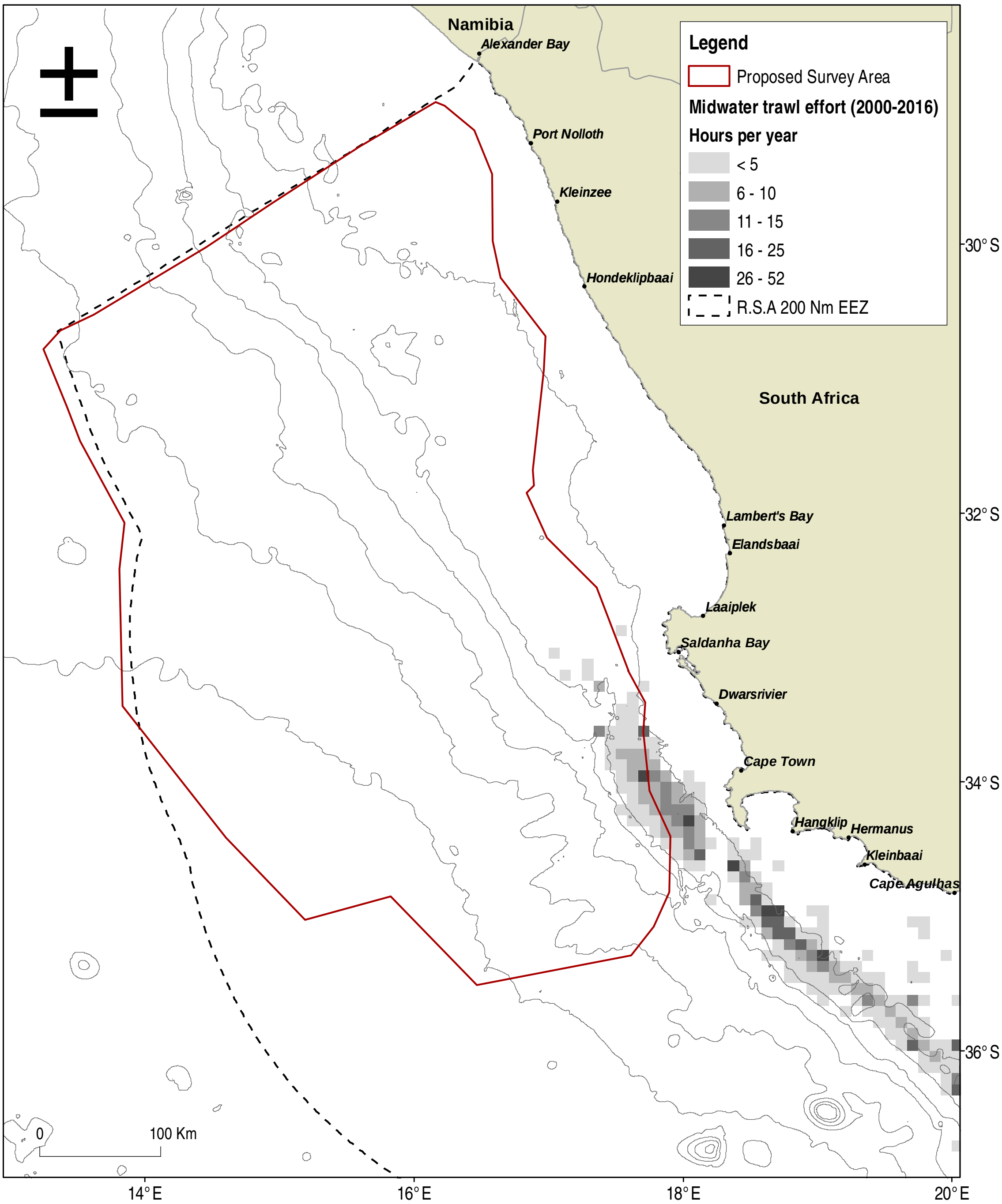

Figure 7-37: Distribution of fishing effort of the mid-water trawl sector (2000-2016).

Note: Data are presented as the number of trawl start positions on a 10' by 10' grid.

7.7.3 Small Pelagic Purse-Seine

The pelagic-directed purse-seine fishery targeting pilchard (*Sardinops sagax*), anchovy (*Engraulis encrasicolus*) and red-eye round herring (*Etrumeus whitheadii*) is the largest South African fishery by volume (tons landed) and the second most important in terms of economic value. The wholesale value of catch landed by the sector during 2017 was R2.164 Billion, or 22% of the total value of all fisheries combined. The total combined catch of anchovy, sardine and round herring landed by the pelagic fishery has decreased by 45% from 395 000 tons in 2016 to just

219 000 tons in 2019, due mainly to a substantial decrease in the catch of anchovy from 262 000 tons in 2016 to only 166 000 tons in 2019. Despite this decline, the average combined catch over the last five years of 322 000 t is only slightly lower than the long-term (1949–2019) average annual catch of 334 000 tons.

The fleet consists of approximately 100 wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 11m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel will steam around it and encircle it with a large net, extending to a depth of 60 m to 90 m (see Figure 7-38). Netting walls surround aggregated fish, preventing them from diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped on board into the hold of the vessel. It is important to note that after the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered on board and this may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

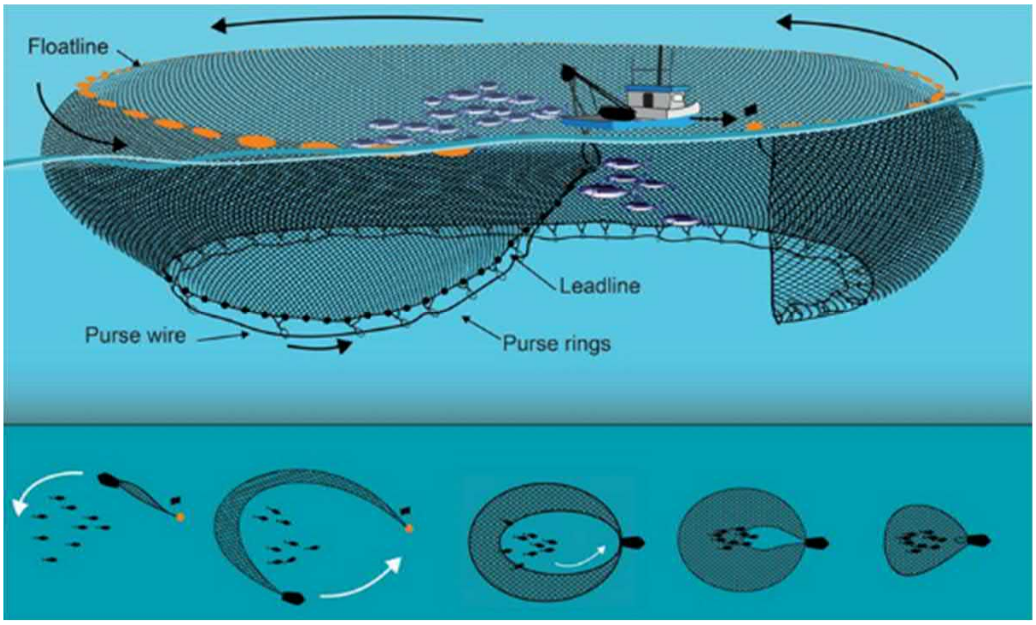

Figure 7-38: Typical configuration and deployment of small pelagic purse-seine for targeting anchovy and sardine as used in South African waters

Source: http://www.afma.gov.au/portfolio-item/purse-seine

Fish are targeted in inshore waters, primarily along the West and South Coasts of the Western Cape and the Eastern Cape Coast, up to a maximum offshore distance of about 100 km. Along the West Coast, the majority of the fleet operate from St Helena Bay, Laaiplek, Saldanha Bay and Hout Bay. The sardine-directed fleet concentrates effort in a broad area extending from Lambert's Bay, southwards past Saldanha and Cape Town towards Cape Point and then eastwards along the coast to Mossel Bay and Port Elizabeth. Figure 7-39 shows the spatial extent of fishing grounds in relation to the proposed survey area. Over the period 2000 to 2016, an average of 365 hours per year (196 sets) were fished within the proposed survey area yielding 8 107 tonnes of catch. This is equivalent to 1.8% of the overall effort and 1.9% of the overall catch reported nationally by the sector. Favoured catch grounds lie predominantly inshore of the proposed survey area, but coincide between St Helena Bay and Cape Point where the survey area extends into shallower areas that approach the 200 m depth contour. The fishery operates throughout the year with a short seasonal break from mid-December to mid-January.

The fishing grounds of the purse-seine fishery overlap with the southern inshore areas of the proposed survey area (see Figure 7-39).

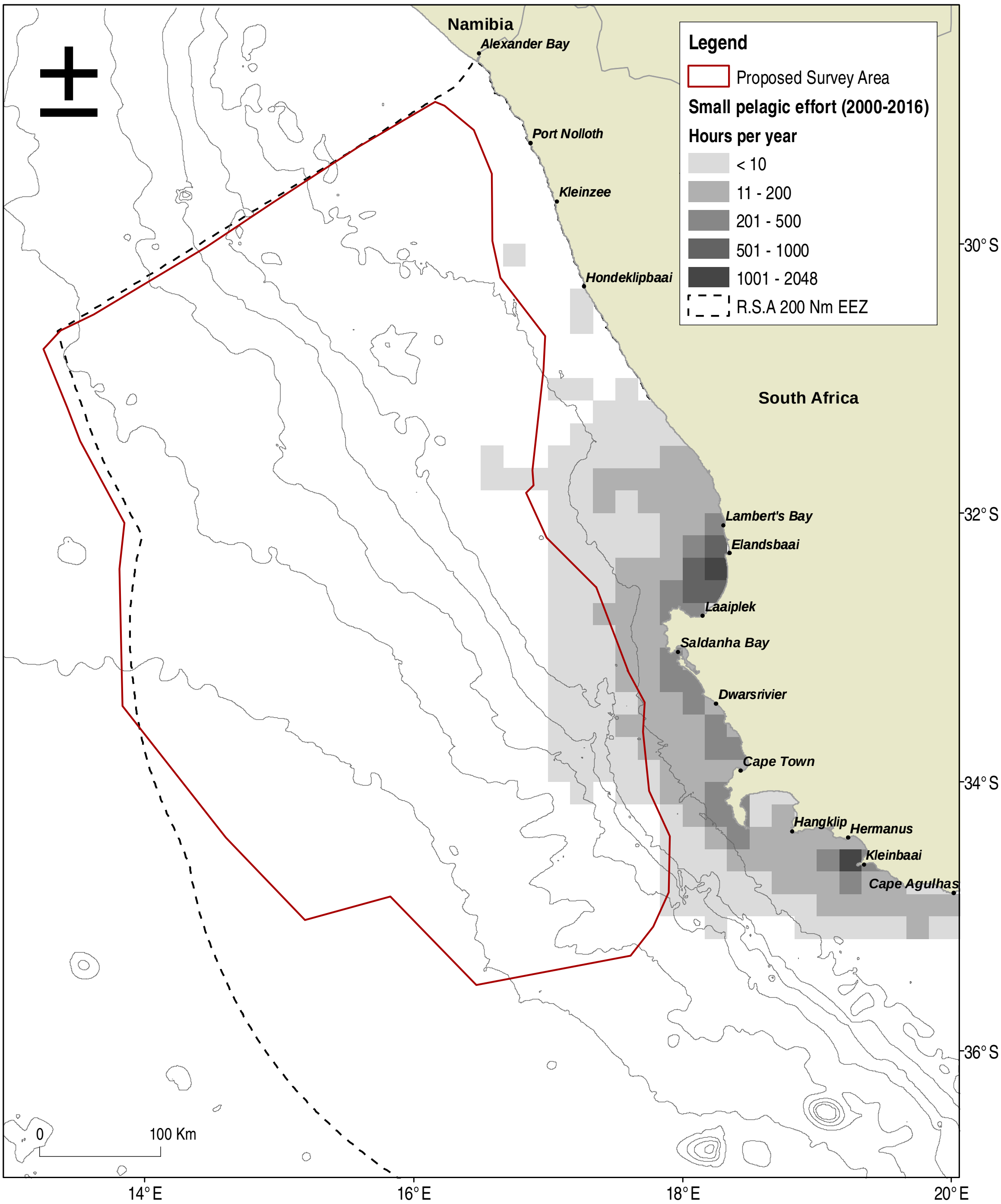

Figure 7-39: Distribution of fishing effort of the purse-seine sector in relation to the proposed survey area (2000-2016)

7.7.4 Demersal Longline

The demersal longline fishing technique is used to target bottom-dwelling species of fish. Like the demersal trawl fishery the target species of this fishery are the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. In 2017, 8 113 tons of catch was landed with a wholesale value of R319.2 Million, or 3.2% of the total value of all fisheries combined. Landings of 8 230 tons were reported in 2018. Fishing takes place along the West and Southeast coasts in areas similar to those targeted by the demersal trawl fleet.

Currently 64 hake-directed vessels active within the fishery, most of which operate from Cape Town and Hout Bay. Secondary points of deployment include St Helena Bay, Saldanha Bay, Hermanus, Gansbaai, Plettenberg Bay and Cape St Francis. Vessels based in Cape Town and Hout Bay operate almost exclusively on the West Coast (west of 20° E). The hake longline footprint extends down the west coast from approximately 150 km offshore of Port Nolloth (15°E, 29°S). It lies inshore to the south of St Helena Bay moving offshore once again as it skirts the Agulhas Bank to the south of the country (21°E, 37°S). Along the South Coast the footprint moves inshore again towards Mossel Bay. The eastern extent of the footprint lies at approximately (26°E, 34.5°S). Lines are set parallel to bathymetric contours, along the shelf edge up to the 1 000 m depth contour in places.

The fishery is directed in both inshore and offshore areas. Inshore long-line operations are restricted by the number of hooks that may be set per line while offshore operations may only take place in waters deeper than 110 m and is restricted to the use of no more than 20 000 hooks per line. Lines are typically between 10 km and 20 km in length, carrying between 6 900 and 15 600 hooks each. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) (see Figure 7-40). Gear is usually set at night at a speed of between five and nine knots. Once deployed the line is left to soak for up to eight hours before it is retrieved. A line hauler is used to retrieve gear (at a speed of approximately one knot) and can take six to ten hours to complete.

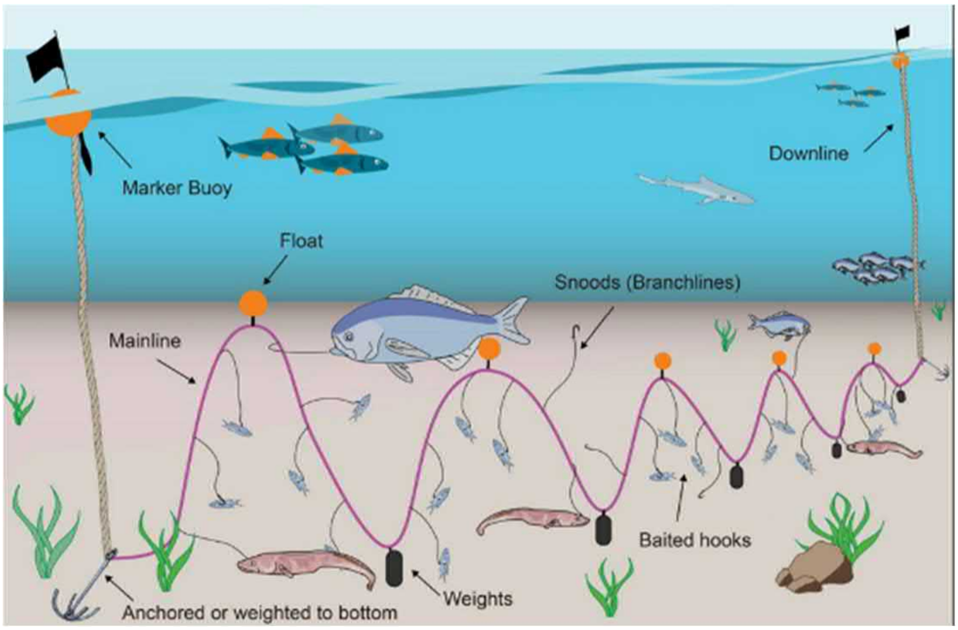

Figure 7-40: Typical configuration of demersal (bottom-set) hake long-line gear
Source: http://www.afma.gov.au/portfolio-item/longlining

The spatial distribution of demersal longline fishing areas in relation to the proposed survey area is shown in Figure 7-41. Over the period 2000 to 2017, an average of 9.4 million hooks per year were set within the proposed survey area, yielding 2 184 tons of hake which is equivalent to 27.6% and 27.3% of the overall effort and catch recorded annually by the sector, respectively. **Most activity occurs across the inshore portion of the proposed survey area and is concentrated shoreward of the 500 m bathymetric contour.** A Namibian-registered fleet of demersal longline vessels operate on the Namibian side of the border at a depth range from 200 m to 500 m. Fishing activity can thus also be expected along the northern boundary of the proposed survey area.

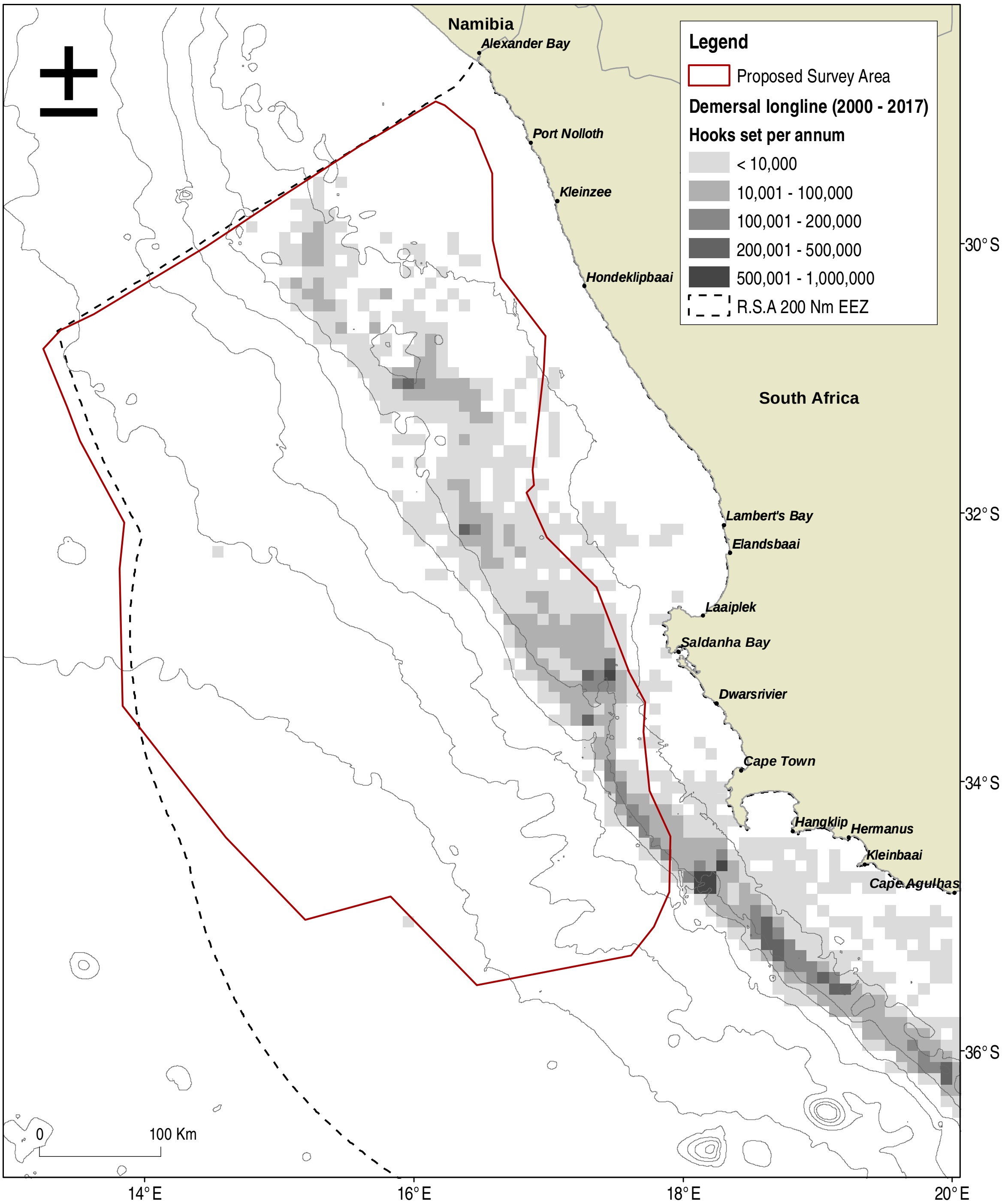

Figure 7-41: Spatial distribution of fishing effort expended by the demersal longline sector (2000-2017)

Note: Effort is shown as the number of hooks set at a gridded resolution of 5x 5 minutes (each grid block covers an area of approximately 85 km^2).

7.7.5 Pelagic Longline

The target species within the South African pelagic long-line sector are yellowfin tuna, bigeye tuna, swordfish and shark species (primarily mako shark). Due to the highly migratory nature of these species, stocks straddle the EEZ of a number of countries and international waters. As such they are managed as a "shared resource" amongst various countries under the jurisdiction of the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Indian Ocean Tuna Commission (IOTC). Since the 1990s foreign vessels were banned from South African waters and fishing rights were allocated to South Africans sometimes working in joint ventures with Japanese. In 2017, 60 fishing rights were allocated for a period of 15 years, and there were 22 active long-line vessels within South African waters (DAFF, 2018). Eighteen vessels operated in the Atlantic (west of 20°E) during 2017. These were exclusively domestic vessels, with three Japanese vessels fishing exclusively in the Indian Ocean (east of 20°E) during 2017 (DAFF, 2018). The wholesale value of catch landed by the sector during 2017 was R154.2 Million, or 1.6% of the total value of all fisheries combined, with landings of 2 541 tons in 2017 and 2 815 tons in 2018.

The fishery operates year-round with a relative increase in effort during winter and spring (see Figure 7-42). Variations in catch per unit effort (CPUE) are driven both by the spatial and temporal distribution of the target species and by fishing gear specifications. Variability in environmental factors such as oceanic thermal structure and dissolved oxygen can lead to behavioural changes in the target species, which may in turn influence CPUE (Punsly and Nakano, 1992).

During the period 2000 to 2016, the sector landed an average catch of 4 527 tons and set 3.55 million hooks per year. Catch by species and number of active vessels for each year from 2005 to 2018 are given in Table 7-8. Total catch and effort figures reported by the fishery for the years 2000 to 2018 are shown in Figure 7-43.

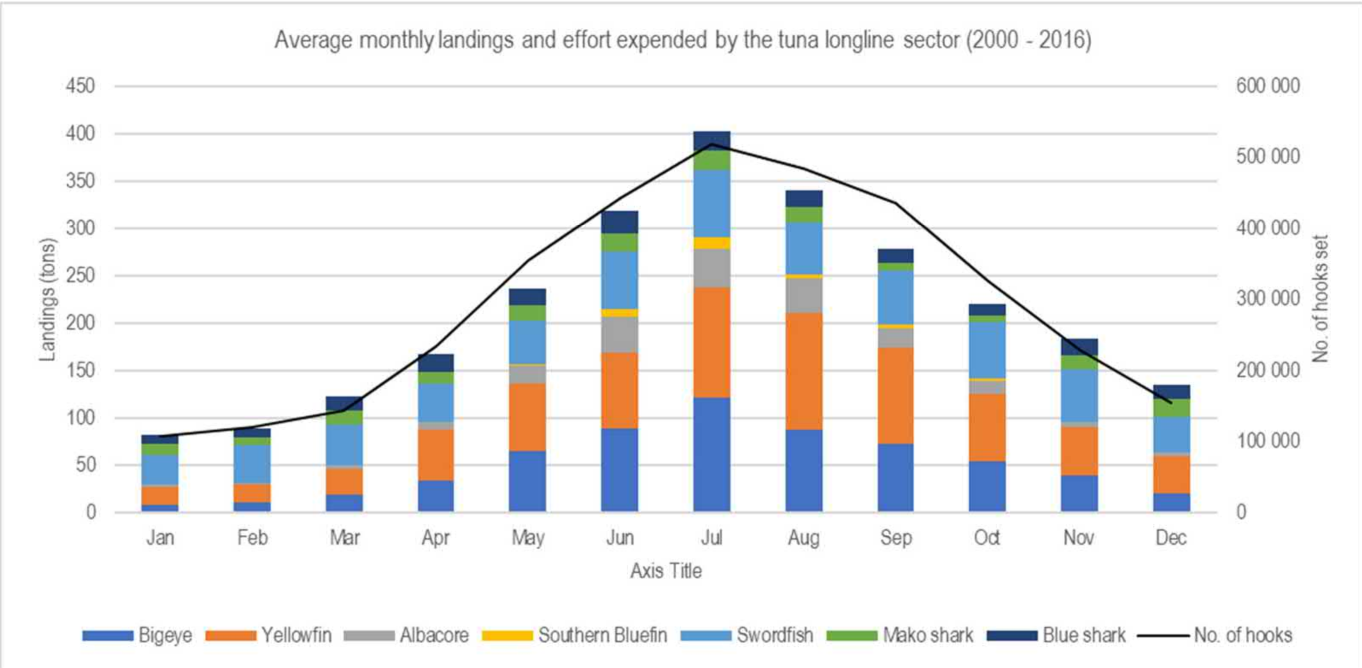

Figure 7-42: Monthly variation of catch and effort recorded by the large pelagic longline sector (average figures for the period 2000 – 2016). In recent years this pattern remains largely unchanged.

Table 7-8: Total catch (t) and number of active domestic and foreign-flagged vessels targeting large pelagic species for the period 2008 to 2018 (Source: DEFF, 2019).

Year	Bigeye tuna	Yellowfin tuna	Albacore	Southern bluefin tuna	Swordfish	Shortfin mako shark	Blue shark	Number of active vessels	
								Domestic	Foreign-flagged
2008	640	630	340	43	398	471	283	15	13
2009	765	1096	309	30	378	511	286	19	9
2010	940	1262	165	34	528	591	312	19	9
2011	907	1182	339	49	584	645	542	16	15
2012	822	607	245	79	445	314	333	16	11
2013	882	1091	291	51	471	482	349	15	9
2014	544	486	114	31	223	610	573	16	4
2015	399	564	151	11	341	778	531	Fleets merged under SA flag with only a few foreign boats: up to 30 boats operating	
2016	315	439	85	18	275	883	528		
2017	497	400	172	47	246	726	523		
2018	478	478	238	208	313	613	592		

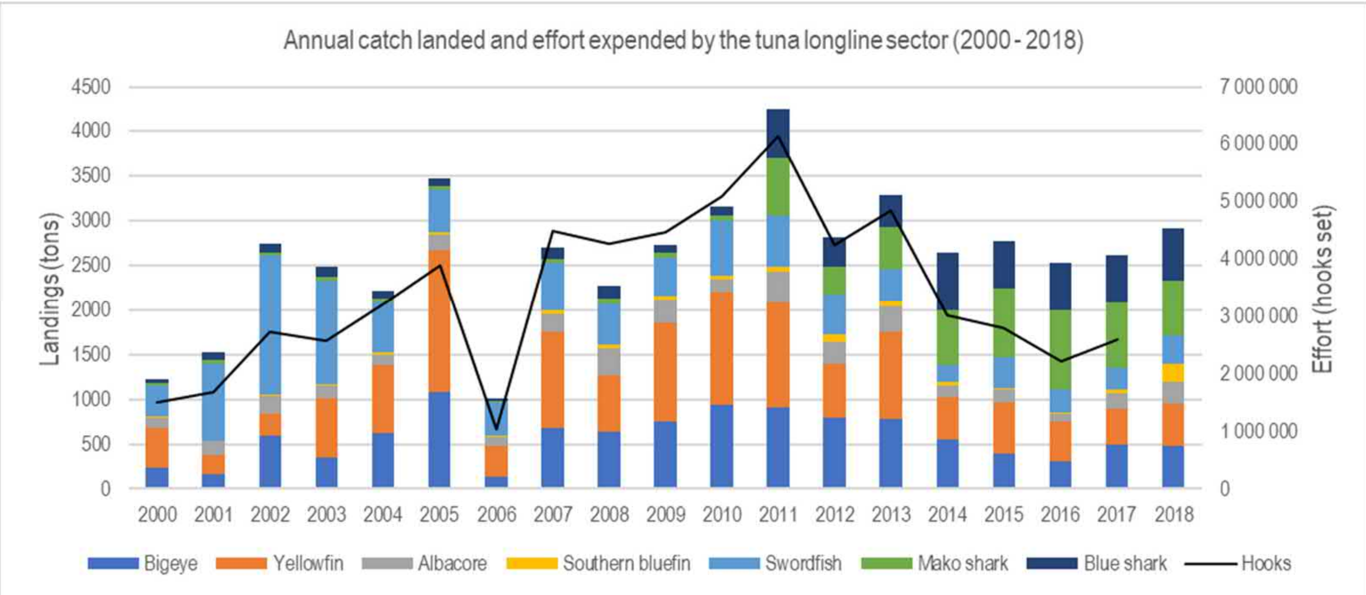

Figure 7-43: Inter-annual variation of catch landed and effort expended by the large pelagic longline sector in South African waters as reported to the two regional management organisations, ICCAT and IOTC (2000 - 2018).

Although most vessels operate from the Cape Town harbour, the areas of operation are extensive in the South African EEZ, along the continental shelf break and further offshore, with **substantial overlap of fishing operations with the proposed survey area.** Pelagic longline effort for tuna extends along and offshore of the 500 m isobath, whilst pelagic shark species are targeted primarily along the 200 m isobath. Fishing effort for the period 2017 to 2019 in relation to the proposed survey area is shown in Figure 7-44. Over the period 2017 to 2019, an average of 765 lines per year were set within the proposed survey area, yielding 1 073 tons of catch. This is equivalent to 18.6 % of the total national effort and 15 % of the total catch reported annually. Fishing activity can be expected offshore of the 500 m bathymetric contour.

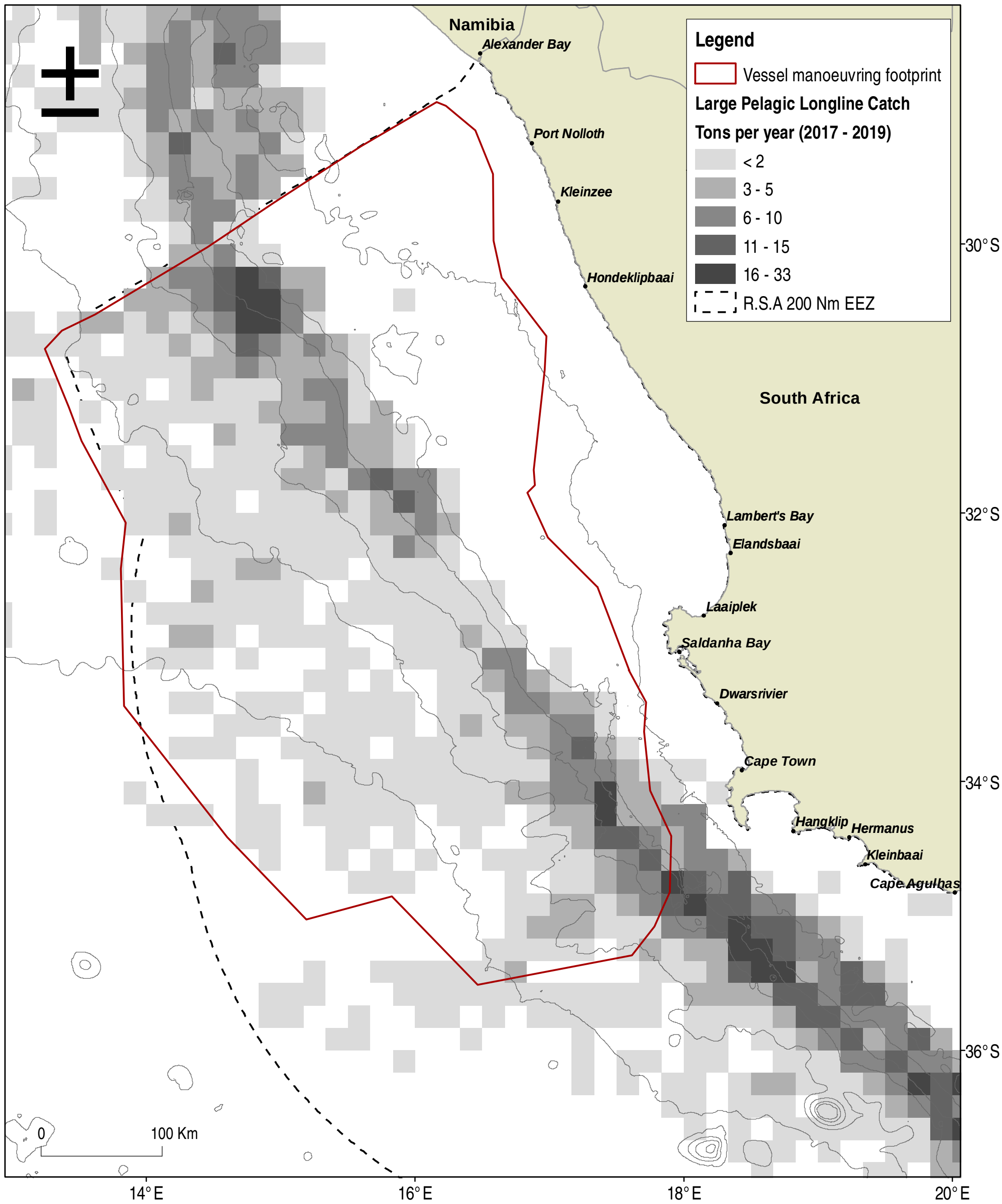

Figure 7-44: Distribution of longline fishing effort targeting large pelagic species in relation to the proposed survey area (2017-2019)

Pelagic long-line vessels set a drifting mainline, which are up to 100 km in length. The mainline is kept near the surface or at a certain depth (20 m below) by means of buoys connected via "buoy-lines", which are spaced approximately 500 m apart along the length of the mainline (see Figure 7-45). Hooks are attached to the mainline via 20 m long trace lines, which are clipped to the mainline at intervals of approximately 50 m. There can be up to 3 500 hooks per line. A single main line consists of twisted rope (6 to 8 mm diameter) or a thick nylon monofilament (5 to 7.5 mm diameter). Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Each end of the line is marked by a Dahn Buoy and Radar reflector, which marks its position for later retrieval by the fishing vessel. A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. During hauling a vessel's manoeuvrability is severely restricted and, in the event of an emergency, the line may be dropped to be hauled in at a later stage.

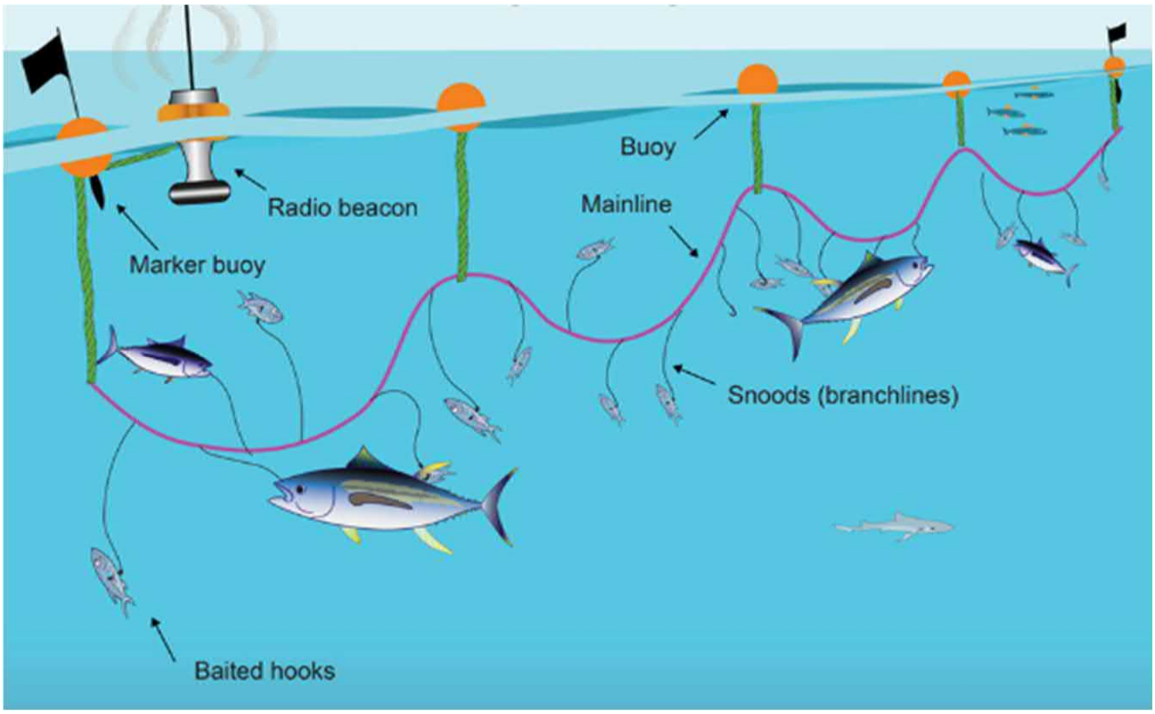

Figure 7-45: Typical pelagic long-line gear source
Source: http://www.afma.gov.au/portfolio-item/longlining)

7.7.6 Tuna Pole

Poling for tuna is predominantly based on the southern Atlantic longfin tuna stock also referred to as albacore. Other catch species include yellowfin tuna, bigeye tuna and skipjack tuna. The fishery is seasonal with vessels active predominantly between November and May and peak catches recorded during November to January. Due to the seasonality of tuna in South African waters, the tuna pole fishery is also allowed access to snoek and yellowtail, resulting in conflict with the traditional line fish sector.

Landings of albacore for 2018 amounted to 2 471 tons, with a wholesale value of R124 million, or 1.2% of the total value of all fisheries in South Africa combined. A total effort of 3 751 catch days were recorded within the ICCAT convention area in 2018, representing an increase in effort of 23% compared to 2017.

The active fleet consists of approximately 92 pole and line vessels based at the ports of Cape Town, Hout Bay and Saldanha Bay. Vessels normally operate within a 100 nm radius of these ports with effort concentrated in the Cape Canyon area (south-west of Cape Point) and up the West Coast to the Namibian border.

Vessels are typically small (an average length of 16 m but ranging up to 25 m). Catch is stored on ice, refrigerated sea water or frozen at sea and the storage method often determines the range of the vessel. Trip durations average between four and five days, depending on catch rates and the distance of the fishing grounds from port. Vessels drift whilst attracting and catching shoals of pelagic tunas. Sonars and echo sounders are used to locate schools of tuna. Once a school is located, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface. Live bait is then used to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the poles are fitted with a short length of fishing line leading to a hook. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (see Figure 7-46).

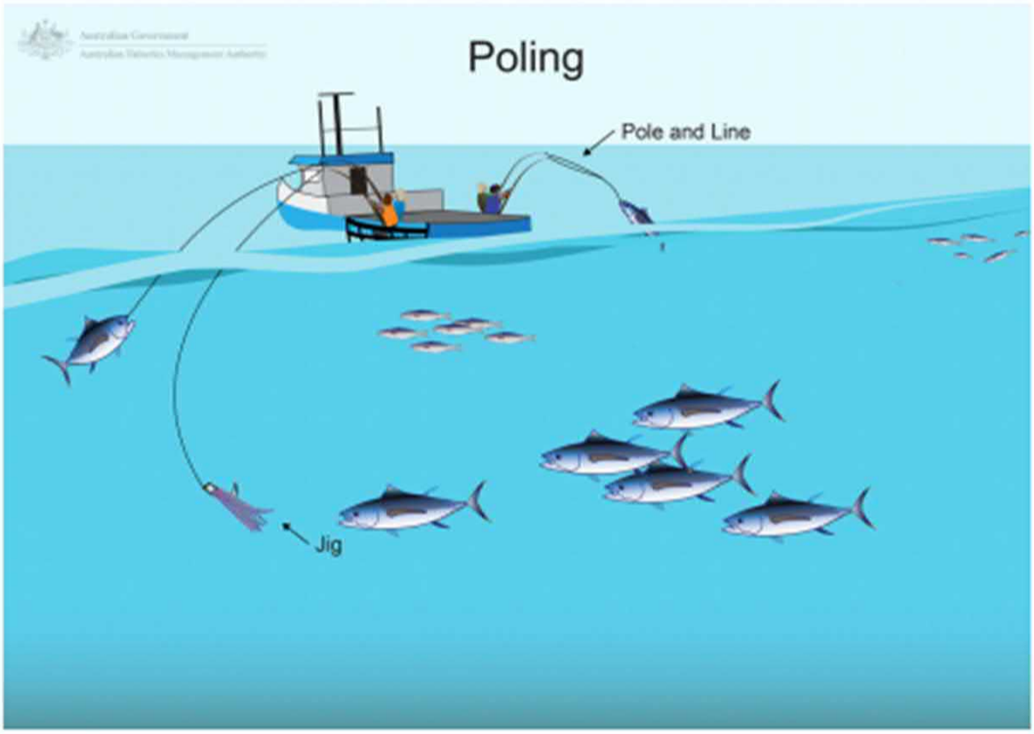

Figure 7-46: Schematic diagram of pole and line operation
Source: http://www.afma.gov.au/portfolio-item/minor-lines

The nature of the fishery and communication between vessels often results in a large number of vessels operating in close proximity to each other at a time. The vessels fish predominantly during daylight hours and are highly manoeuvrable. However, at night in fair weather conditions the fleet of vessels may drift or deploy drogues to remain within an area and would be less responsive during these periods.

Fishing activity occurs along the entire West Coast beyond the 200 m bathymetric contour. Activity would be expected to occur along the shelf break with favoured fishing grounds including areas north of Cape Columbine and between 60 km and 120 km offshore from Saldanha Bay. Snoek-directed fishing activity is coastal and seasonal in nature, taking place inshore of the 100 m depth contour and the proposed survey area from March to July. The seasonality of the catch within the proposed survey area is shown in Figure 7-47 with highest catches in the proposed survey area landed in November and December. Figure 7-48 shows the tuna and snoek pole effort between 2007 and 2019 in the vicinity of the proposed survey area, with tuna-directed fishing taking place particularly over the Cape Canyon. Over the period 2017 to 2019 an average of 1 131 fishing events per year were reported within the proposed survey area, yielding 1 469 tons of albacore. This is equivalent to 44.1% and 51.6 %, respectively, of the total effort and albacore catch for the sector on a national scale. **Tuna pole fishing activity would thus be expected within the proposed survey area.**

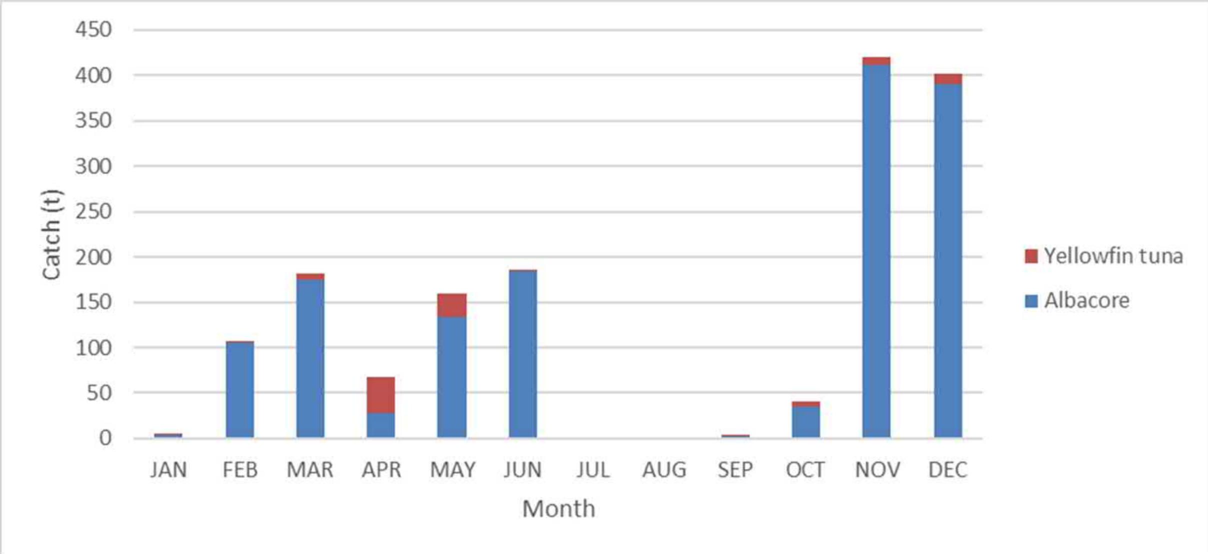

Figure 7-47: Catch per month taken by the tuna pole sector within the proposed survey area (average for period 2017-2019)

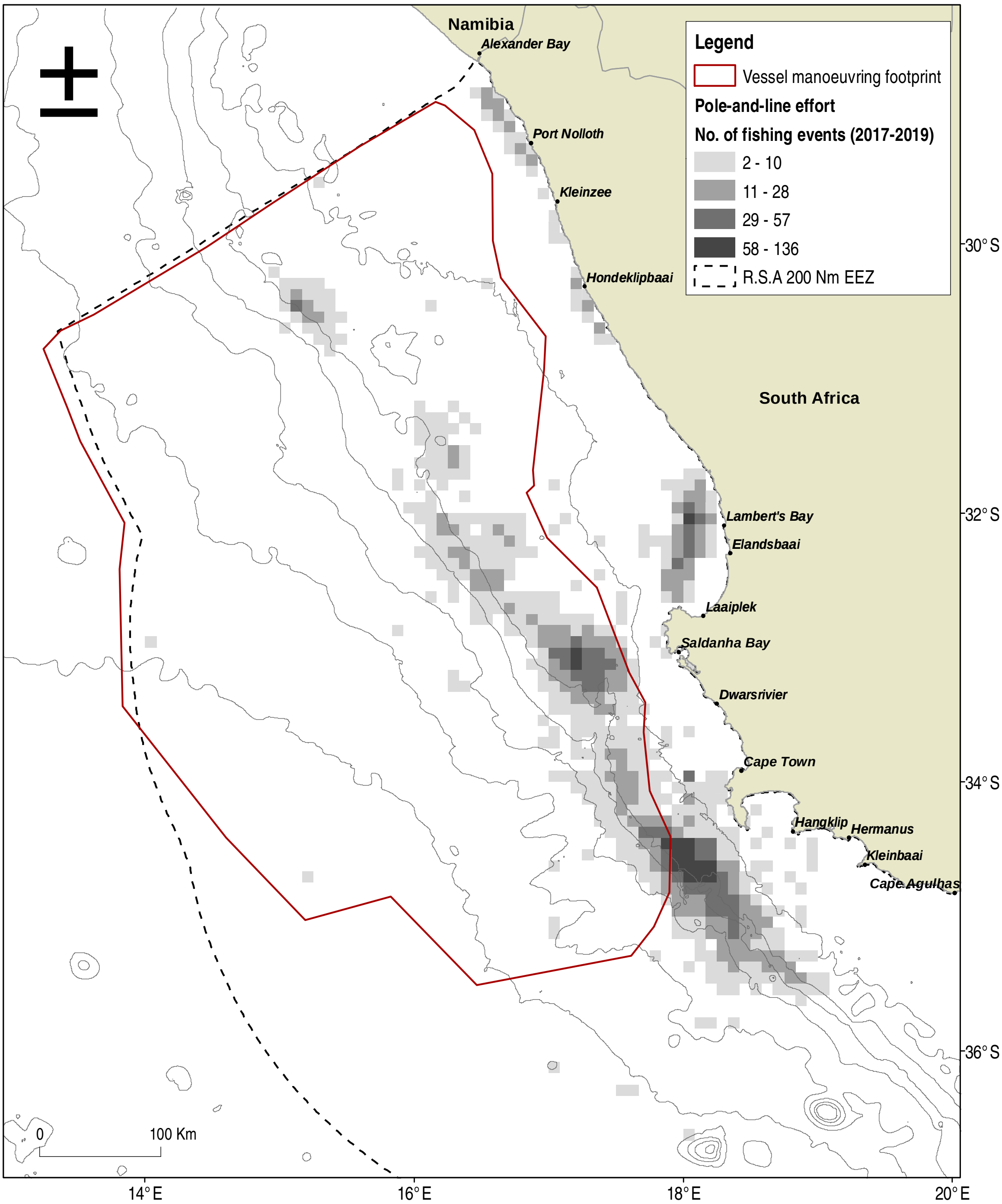

Figure 7-48: Distribution of fishing effort of the pole-line sector targeting pelagic tuna (offshore areas) and snoek (inshore areas) in relation to the proposed survey area (2017-2019)

7.7.7 Traditional Line Fish

The traditional line fishery includes commercial, subsistence and recreational sectors and is South Africa's third most important fishery in terms of total tons landed and economic value. It is a long-standing, **nearshore fishery** based on a large assemblage of different marine species of which 50 species are economically important (with species caught dependent on region). Within the Western Cape the predominant catch species is snoek while other species such as Cape bream (hottentot), geelbek, kob and yellowtail are also important. Towards the East

Coast the number of catch species increases and includes resident reef fish (Sparidae and Serranidae), pelagic migrants (Carangidae and Scombridae) and demersal migrants (Sciaenidae and Sparidae). In 2017, the wholesale value of catch was reported as R122.1 million.

The commercial line fishery operates between Port Nolloth on the West Coast to Cape Vidal on the East Coast from the coast out to approximately the 100 m depth contour. Fishing gear consists of hand line or rod-and-reel. Recreational permit-holders fish via ski boat or from the shore (anglers) whereas the commercial sector is purely boat-based. Subsistence permit-holders are shore-based and estuarine (purely based on the East Coast). Line fishers are restricted to a maximum of ten hooks per line but a single fisherman may operate several lines at a time. Due to the large number of users, launch sites, species targeted, and the wide operational range, the line fishery is managed on an effort basis, rather than on a catch basis.

Since December 2000, the fishery has consisted of 3450 crew operating from 455 commercial vessels. The number of rights holders is 425 (rights are valid until 31 December 2020). For the 2019/2020 fishing season, 395 vessels and 3007 crew are apportioned to commercial fishing, whilst 60 vessels and 443 crew is apportioned to small-scale fishing (refer to Section 7.7.9). DFFE has proposed an increase in the apportionment of TAE to small-scale fishing from 13% to 50% commencing in 2021 in order to boost economic possibilities for coastal communities.

In addition to the vessels that operate within the commercial sector, many more ski boats are used in the recreational sector which may be launched from a number of slipways and harbours. Vessels range in length between 4.5 m and 11 m and the offshore operational range is restricted by vessel category, but is generally within 15 km of launch site and in waters shallower than 100 m (see Figure 7-49). There are, however, records of fishing in the vicinity of Cape Canyon reported at a distance of 55 km offshore of Saldanha Bay. This coincides with the inshore area of the proposed survey area within which over the period 2017 to 2019, an average of 924 kg of albacore tuna was caught. The fishing activity within this area is seasonal with the highest activity recorded from November to December. Effort and catch within the area amounted to 0.01% and 0.02% of the total effort and catch. **There would thus be minimal overlap with the traditional line fish sector in the inshore area of the proposed survey area.**

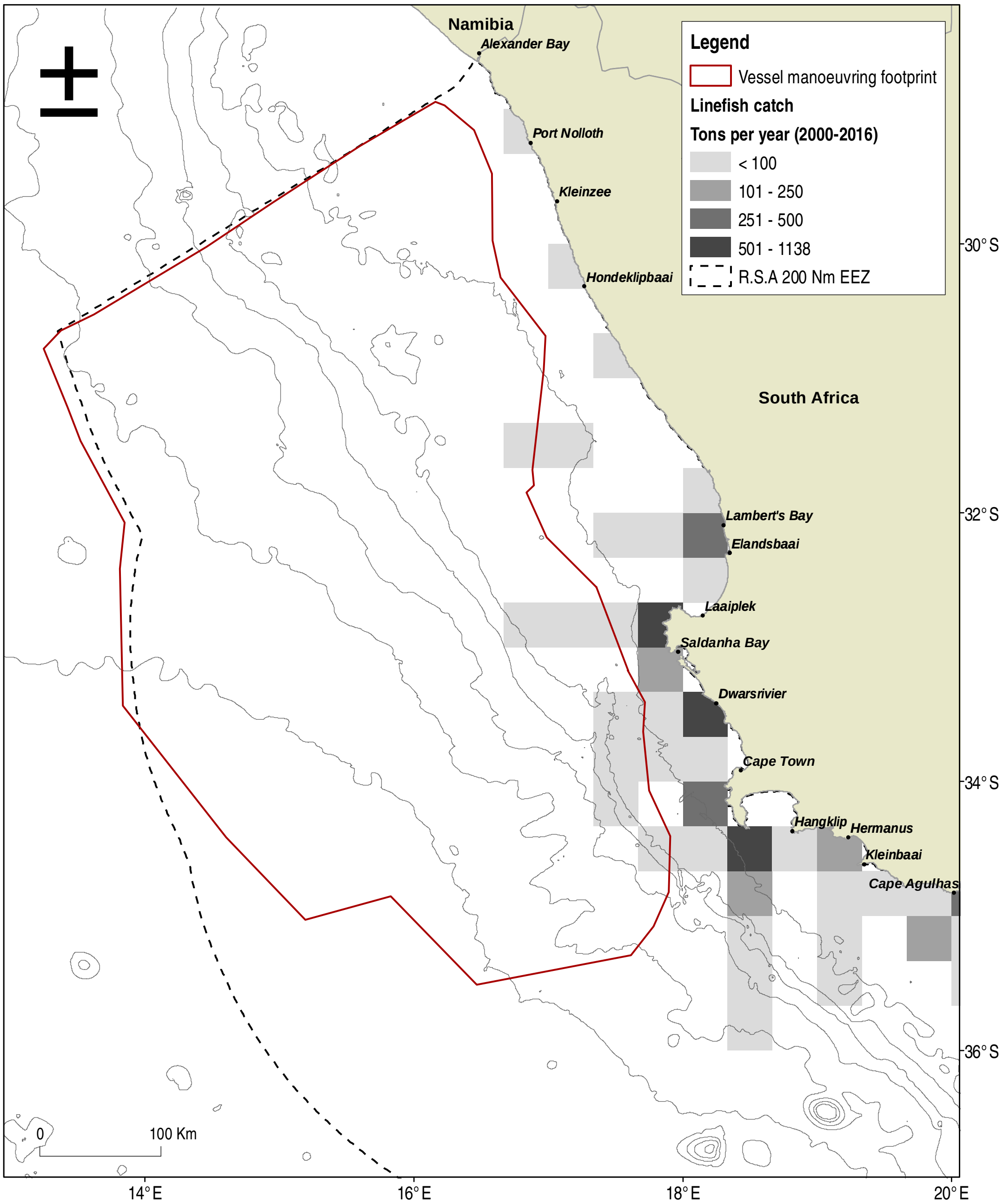

Figure 7-49: The spatial distribution of the traditional line fishery sector in relation to the proposed survey area (2000-2016)

7.7.8 West Coast Rock Lobster

The West Coast rock lobster occurs inside the 200 m depth contour along the West Coast from Namibia to East London on the East Coast of South Africa. The fishery is composed of four sub-sectors: (1) commercial nearshore, (2) commercial offshore, (3) small-scale and (4) recreational fishing. All the sub-sectors share from the same global TAC. The 2020 global TAC was set at 837 tons[8]. The offshore sector is comprised of trap boats that operate at a depth range of approximately 30 m to 100 m whilst the nearshore sector makes use of hoopnets to a

[8] In 2017, the poached rock lobster was estimated at 2 747 tons.

maximum fishing depth of about 30 m. The offshore sector makes use of traps consisting of rectangular metal frames covered by netting, which are deployed from trap boats, whilst the inshore fishery makes use of hoop nets deployed from small dinghy's. Traps are set at dusk and retrieved during the early morning. Vessels using traps will leave up to 30 traps per vessel in the fishing grounds overnight during the week.

Fishing grounds are divided into Zones stretching from the Orange River mouth to east of Cape Hangklip in the South-Eastern Cape. Effort is seasonal with boats operating from the shore and coastal harbours. Figure 7-50 shows the west coast rock lobster catch by management zone for the commercial sector between 2006 and 2016. The proposed survey area is situated offshore of the depth range at which rock lobster is targeted. Over the period 2005 to 2020 there was no fishing activity reported by the offshore or inshore sectors within the proposed survey area. **Fishing grounds thus do not overlap with the proposed survey area, with the closest lobster fishing activity expected approximately 40 km inshore of the proposed survey area.**

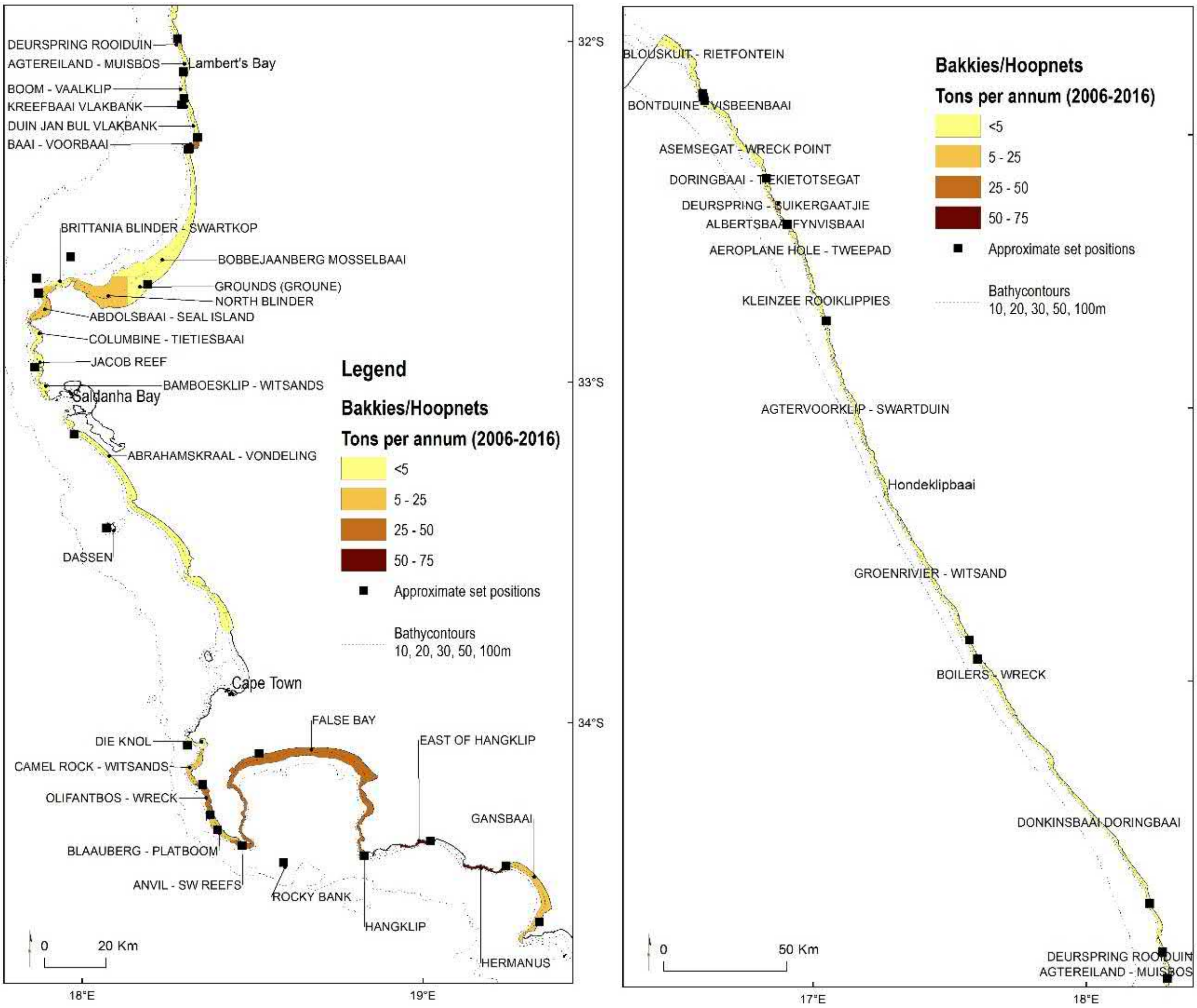

Figure 7-50: An overview of the spatial distribution of inshore west coast rock lobster fishing effort within demarcated lobster management zones (2006-2016)

7.7.9 Small-Scale Fishing

South Africa is implementing a small-scale fisheries policy (SSF) to manage fish stocks sustainably by regulating access to baskets of species through the allocation of rights co-operative groups. This is in process and was gazetted in May 2019 under the Marine Living Resources Act, 1998 (Act No. 18 of 1998).

Small-scale fishers fish to meet food and basic livelihood needs, and may be directly involved in harvesting, processing and distribution of fish for commercial purposes. These fishers traditionally operate on nearshore fishing grounds, using traditional low technology or passive fishing gear to harvest marine living resources on a full-time, part-time or seasonal basis. Fishing trips are usually a single day in duration and fishing/harvesting techniques are labour intensive. The equipment used by small-scale fishers includes rowing boats in some areas, motorized boats on the South and West Coast and simple fishing gear including hands, feet, screw drivers, hand lines, prawn pumps, rods with reels, gaffs, hoop nets, gill nets, seine/trek nets and semi-permanently fixed kraal traps. Distances fished from the shore are constrained by boat size and maritime safety requirements and as a general rule are not expected to be more than 3 nm from the coastline. Small-scale fishers are an integral part of the rural and coastal communities in which they reside and this is reflected in the socio-economic profile of such communities.

A small-scale fishing right is the right to catch different species of fish in the near shore. These rights are allocated to communities and not to individuals in terms of the SSF. Applicants for small-scale fishing rights must have a historical involvement in traditional fishing operations, including the catching, processing or marketing of fish for a cumulative period of at least 10 years. They also need to show a historical dependence on deriving the major part of their livelihood from traditional fishing operations. More than 270 communities have registered an Expressions of Interest (EOI) with the Department.

The policy also requires a multi-species approach to allocating rights, which will entail allocation of rights for a basket of species that may be harvested or caught within particular designated areas. DEFF recommends five basket areas:. DEFF recommends five basket areas:

- Basket Area A – The Namibian border to Cape of Good Hope – 57 different resources
- Basket Area B – Cape of Good Hope to Cape Infanta – 109 different resources
- Basket Area C – Cape Infanta to Tsitsikamma – 107 different resources
- Basket Area D – Tsitsikamma to the Pondoland MPA – 138 different resources
- Basket Area E – Pondoland MPA to the Mozambican border – 127 different resources.

While most of the basket species are nearshore (within 3 nm of the coast), the fisheries that operate further offshore may include hake handline and squid which, will be subjected to the ongoing Fishery Rights Allocation Process (referred to as “FRAP”). While, the small-scale fisheries are defined as a fishery, specific operations and dynamics are not yet fully defined as they are subject to an ongoing process by DFFE.

Those SSF communities that are in process of, or have formed, cooperatives along the West Coast are indicated in Figure 7-51. Approximately 10 000 small-scale fishers have been identified around the whole coast, 103 of which are registered at the Port Nolloth fishing community. The small scale fishery rights cover the nearshore area (defined in section 19 of the MLRA as being within close proximity of shoreline). Small-scale fishermen along the Northern Cape and Western Cape coastline are typically involved in the traditional line and west coast rock lobster fisheries. Since fishing areas are unlikely to extend beyond 3 Nm from the coast, there is **no overlap**

expected with the proposed survey area. Fishing grounds are situated at least 30 km inshore of the proposed survey area.

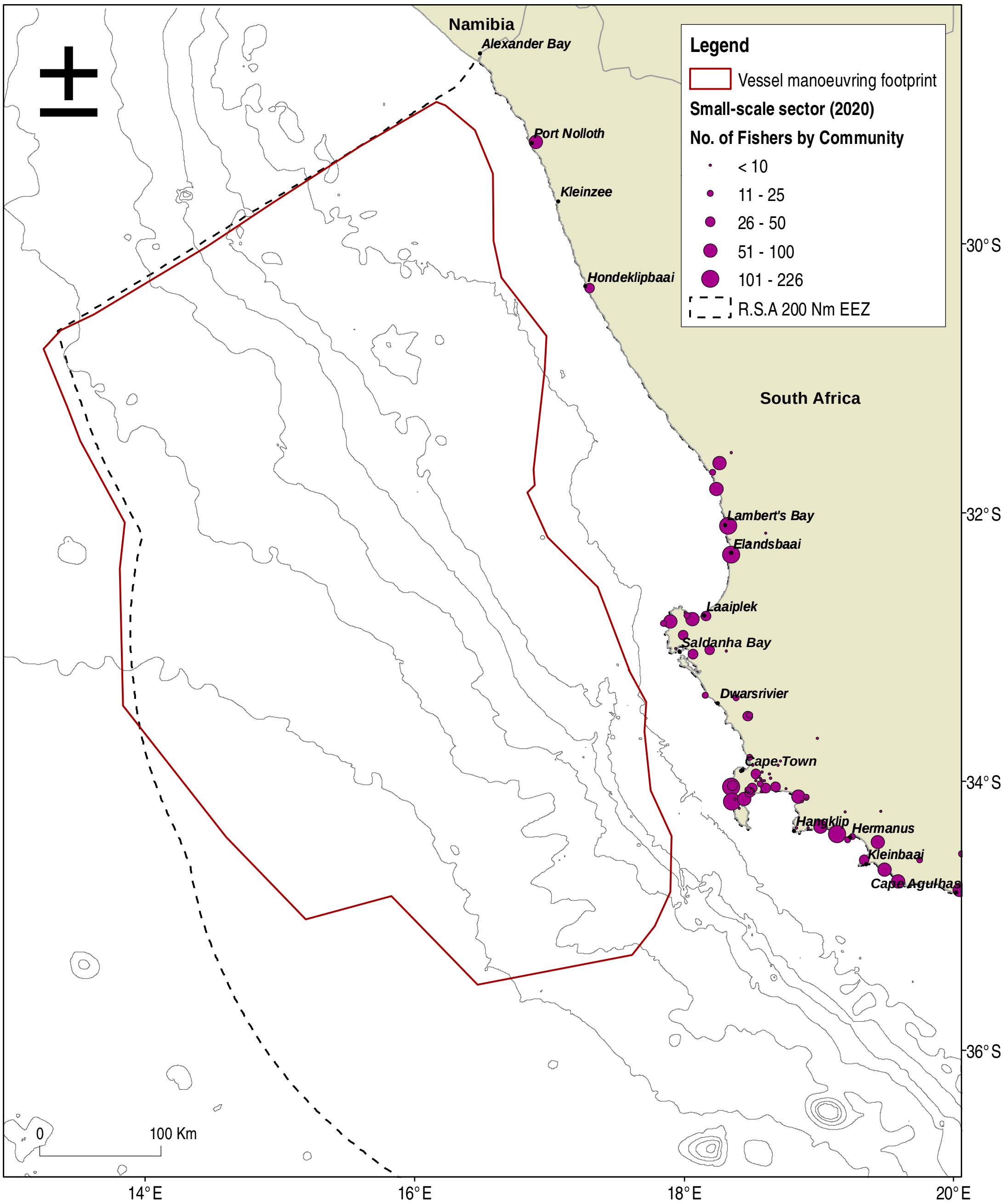

Figure 7-51: Location of small-scale fishing communities along the South African coastline and in relation to the proposed survey area.

7.7.10 Beach-Seine and Gillnet Fisheries (Netfish)

There are a number of active beach-seine and gillnet operators throughout South Africa (collectively referred to as the “netfish” sector). Initial estimates indicate that there are at least 7 000 fishermen active in fisheries using beach-seine and gillnets, mostly (86%) along the West and South coasts. These fishermen utilize 1 373 registered and 458 illegal nets and report an average catch of about 1 600 tons annually, constituting 60% harders (also known as mullet), 10% St Joseph shark and 30% "bycatch" species such as galjoen, yellowtail and white steenbras.

The fishery is managed on a TAE basis with a fixed number of operators in each of 15 defined areas (see Figure 7-52). The number of Rights Holders operating on the West Coast from Port Nolloth to False bay is listed as 28 for beach-seine and 162 for gillnet (DFFE, 2021). Permits are issued solely for the capture of harders, St Joseph and species that appear on the 'bait list'. The exception is False Bay, where Right Holders are allowed to target linefish species that they traditionally exploited.

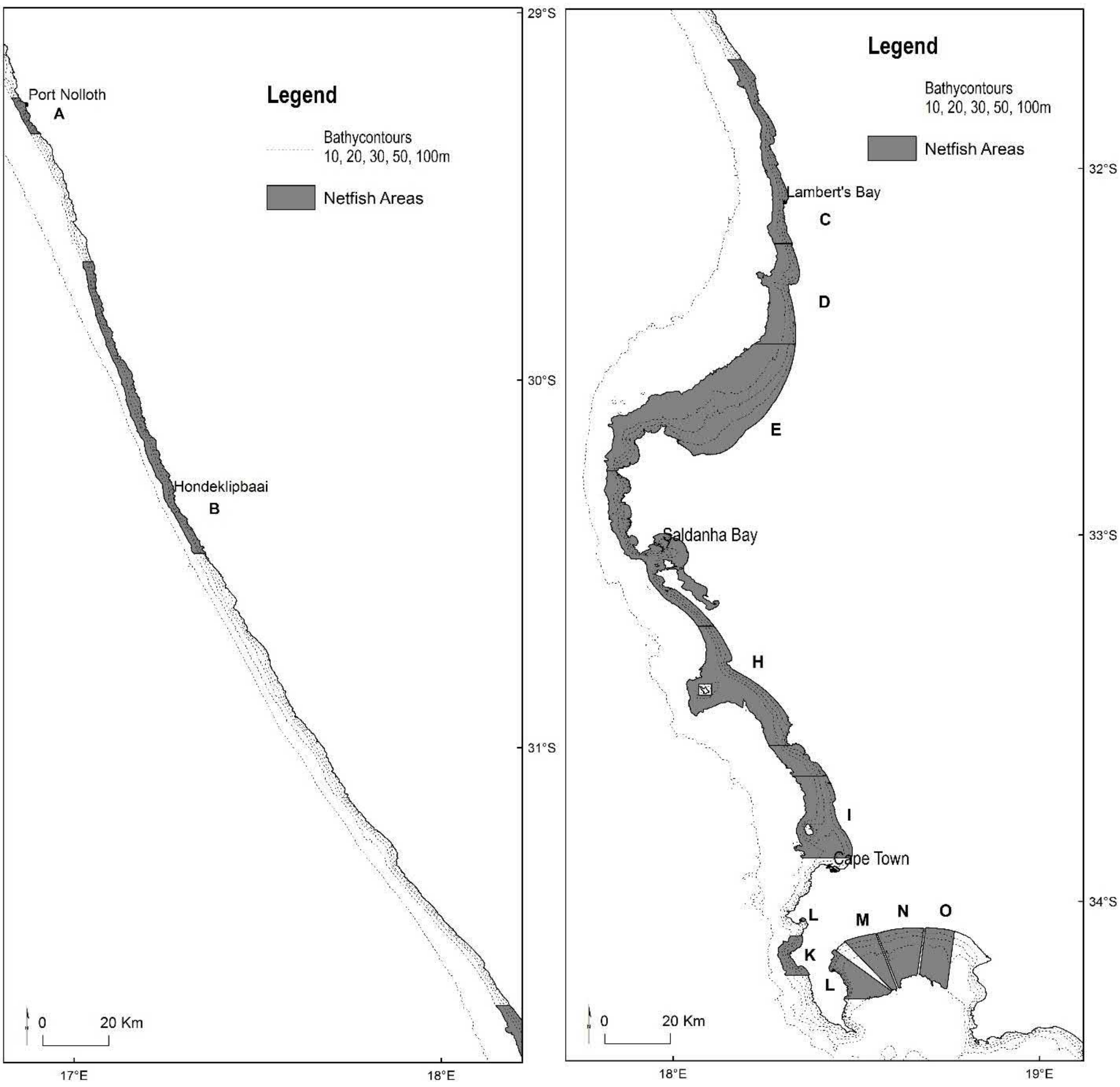

Figure 7-52: Beach-seine and gillnet fishing areas off the West Coast (DAFF 2016/17)

On the West Coast, the beach-seine fishery operates primarily between False Bay and Port Nolloth (Lamberth 2006). Beach-seining is an active form of fishing in which woven nylon nets are rowed out into the surf zone to encircle a shoal of fish. They are then hauled shorewards by a crew of 6–30 persons, depending on the size of the net and length of the haul. Nets range in length from 120 m to 275 m. Fishing effort is coastal and net depth may not exceed 10 m (DAFF 2014b).

The gillnet fishery operates from Yzerfontein to Port Nolloth on the West Coast. Surface-set gillnets (targeting mullet) are restricted in size to 75 m x 5 m and bottom-set gillnets (targeting St Joseph shark) are restricted to 75 m x 2.5 m (da Silva *et al*. 2015) and are set in waters shallower than 50 m. The spatial distribution of effort is represented as the annual number of nets per kilometre of coastline. **The range of gillnets (50 m) and that of beach-seine activity (20 m) will not overlap with the proposed survey area or the area of vessel manoeuvrability.**

7.7.11 Fisheries Research

Swept-area trawl surveys of demersal fish resources are carried out twice a year by DFFE in order to assess stock abundance. Results from these surveys are used to set the annual TACs for demersal fisheries. Surveys of demersal fish resources are carried out in January/February (West Coast survey) and April/May (South Coast survey) each year by DFFE. Stratified, bottom trawls are conducted to assess the biomass, abundance and distribution of hake, horse mackerel, squid and other demersal trawl species on the shelf and upper slope of the South African coast. The gear configuration is similar to that of commercial demersal trawlers, however, nets are towed for a shorter duration of generally 30 minutes per tow. Trawl positions are randomly selected to cover specific depth strata that range from the coast to the 1 000 m bathymetric contour. Approximately 120 trawls are conducted during each survey over a period of approximately one month. Figure 7-53 shows the distribution of research trawls undertaken off the West Coast in relation to the proposed survey area. Approximately 29.2% of the total number of research trawls over the period 1985 to 2012 have been reported within the proposed survey area. **It is possible that demersal research trawls could coincide with the proposed survey inshore of the 1 000 m isobath during January and February**.

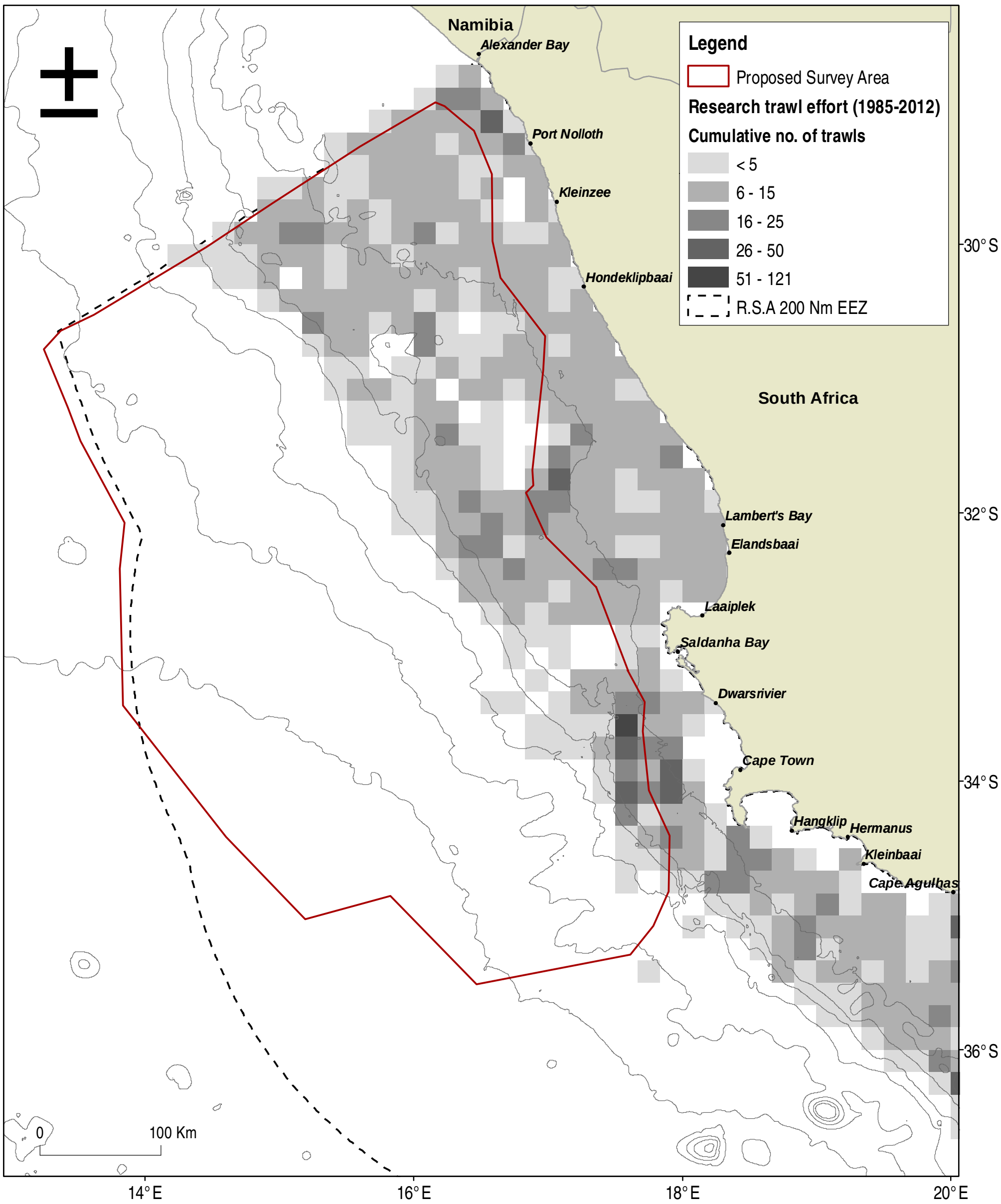

Figure 7-53: Spatial distribution of research survey trawling effort by DFFE off the West Coast.

The biomass of small pelagic species is also assessed bi-annually by an acoustic survey. The first of these surveys is timed to commence mid-May and runs until mid-June while the second starts in mid-October and runs until mid-December. The timing of the demersal and acoustic surveys is not flexible, due to restrictions with availability of the research vessel as well as scientific requirements. During these surveys the survey vessel travels pre-determined transects (perpendicular to bathymetric contours) running offshore from the coastline to approximately the 200 m bathymetric contour (see Figure 7-54). The survey is designed to cover an extensive area from the Orange River on the West Coast to Port Alfred on the East Coast. **It is possible that acoustic research surveys could coincide with the proposed survey inshore of the 200m bathymetric contour during May.**

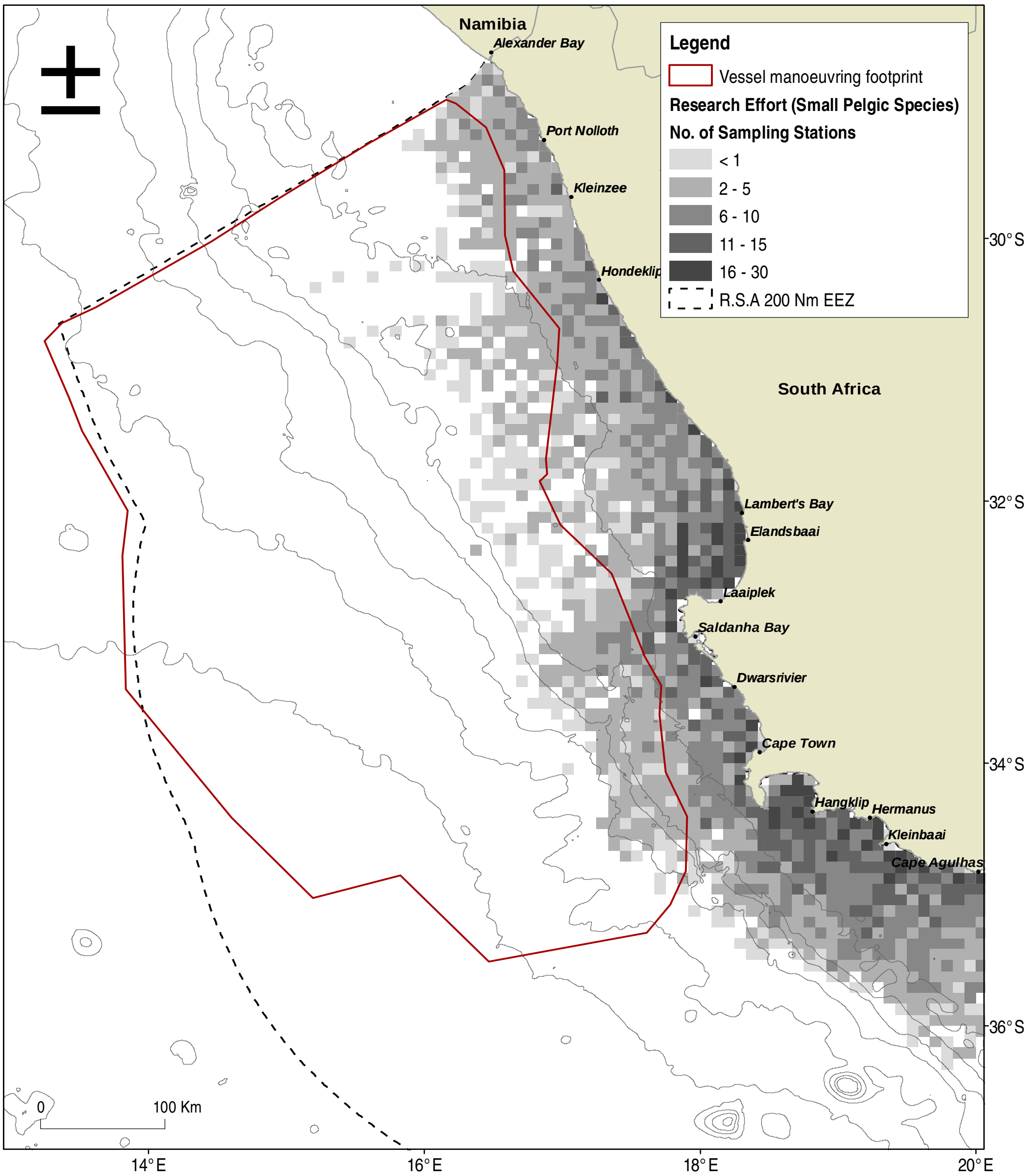

Figure 7-54: Spatial distribution of sampling stations for acoustic surveys off the West Coast (1988-2013).

7.7.12 Summary of Fishing Activities in Project Area

Table 7-9 provides a list of fisheries sectors that operate off the West Coast, the seasonality of fishing effort within the proposed survey area and the likelihood of their presence within the proposed survey area.

Table 7-9: Summary table of seasonal variation in fisheries active in the proposed survey area

Sector	Fishing Intensity by Month (H = high; M = Low to Moderate; N = None)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Demersal Trawl	H	H	H	H	H	H	H	H	H	H	H	H
Mid-water Trawl	M	M	M	H	H	H	H	H	H	H	H	M
Demersal Longline	M	H	H	H	H	M	M	M	M	H	H	H

Sector	Fishing Intensity by Month (H = high; M = Low to Moderate; N = None)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Small Pelagic Purse-Seine	M	H	H	H	H	H	H	H	H	M	M	M
Large Pelagic Longline	M	M	M	M	H	H	H	H	H	H	H	M
Tuna Pole-Line	M	M	M	M	M	M	M	M	M	M	H	H
Traditional Linefish	M	M	M	M	M	M	M	M	M	H	H	H
West Coast Rock Lobster	N	N	N	N	N	N	N	N	N	N	N	N
Small-scale (linefish & rock lobster nearshore sectors)	N	N	N	N	N	N	N	N	N	N	N	N
Research survey (trawl)	M	M	M	N	N	N	N	N	N	N	N	N
Research survey (acoustic)	N	N	N	N	M	M	N	N	N	M	M	M

7.8 OFFSHORE MARINE AND COASTAL INFRASTRUCTURE AND ACTIVITIES

7.8.1 Marine Traffic and Transport

There are various international shipping routes along the West Coast. The majority of the international shipping traffic is located on the outer edge of the continental shelf. Traffic inshore of the continental shelf along the West Coast largely comprises fishing and mining vessels, especially off the coast of Oranjemund. International shipping traffic en route to Cape Town would pass though the proposed survey area (see Figure 7-55).

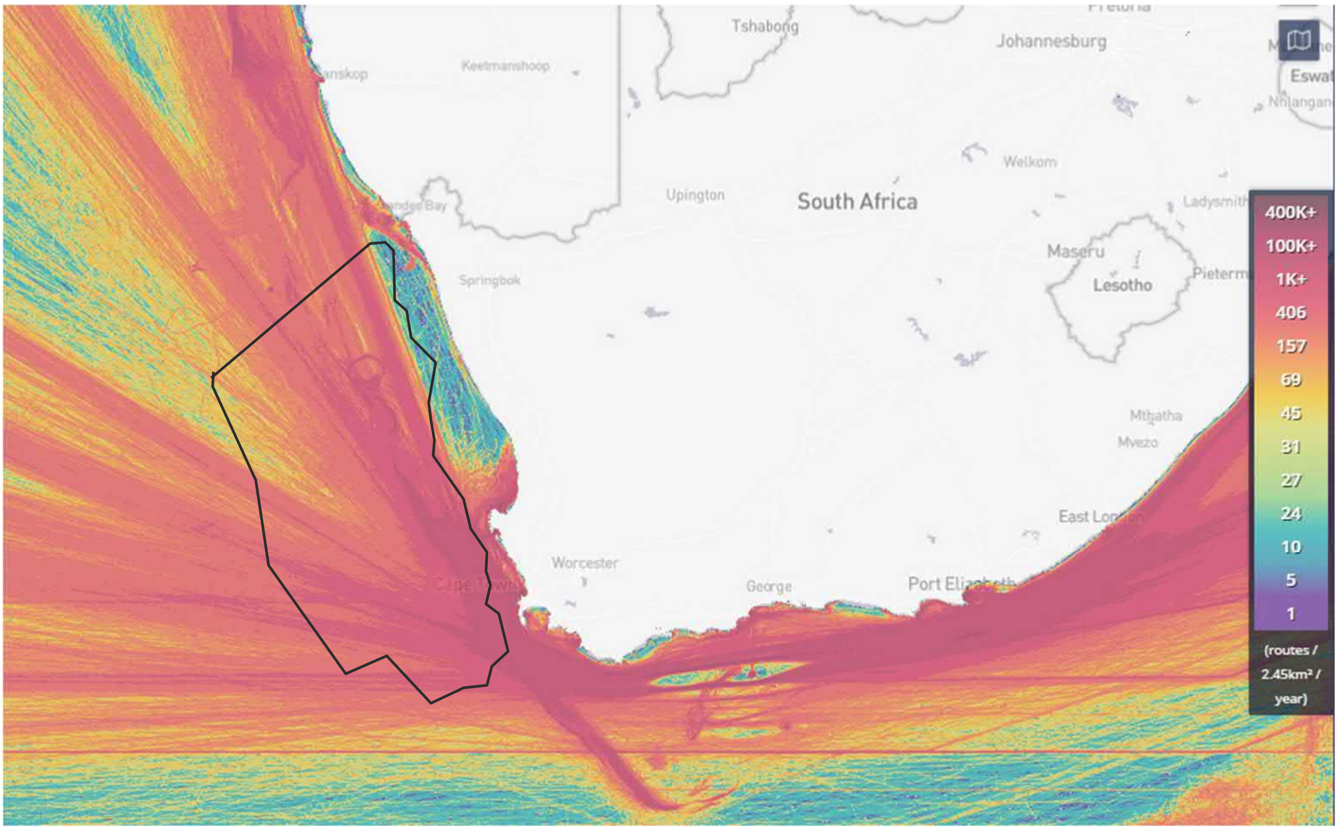

Figure 7-55: The major shipping routes off the coast of South Africa showing the proposed survey area
Source: Marinetraffic.com (2019 data)

7.8.2 Exploration, Production and Mining

7.8.2.1 Oil and gas exploration and production

Exploration for oil and gas is currently undertaken in a number of licence blocks off the West, South and East coasts of South Africa (see Figure 7-56). There is no current development or production from the South African West Coast offshore. The Ibhubesi Gas Field (Block 2A) and Kudu Gas Field (off southern Namibia) have been identified for development.

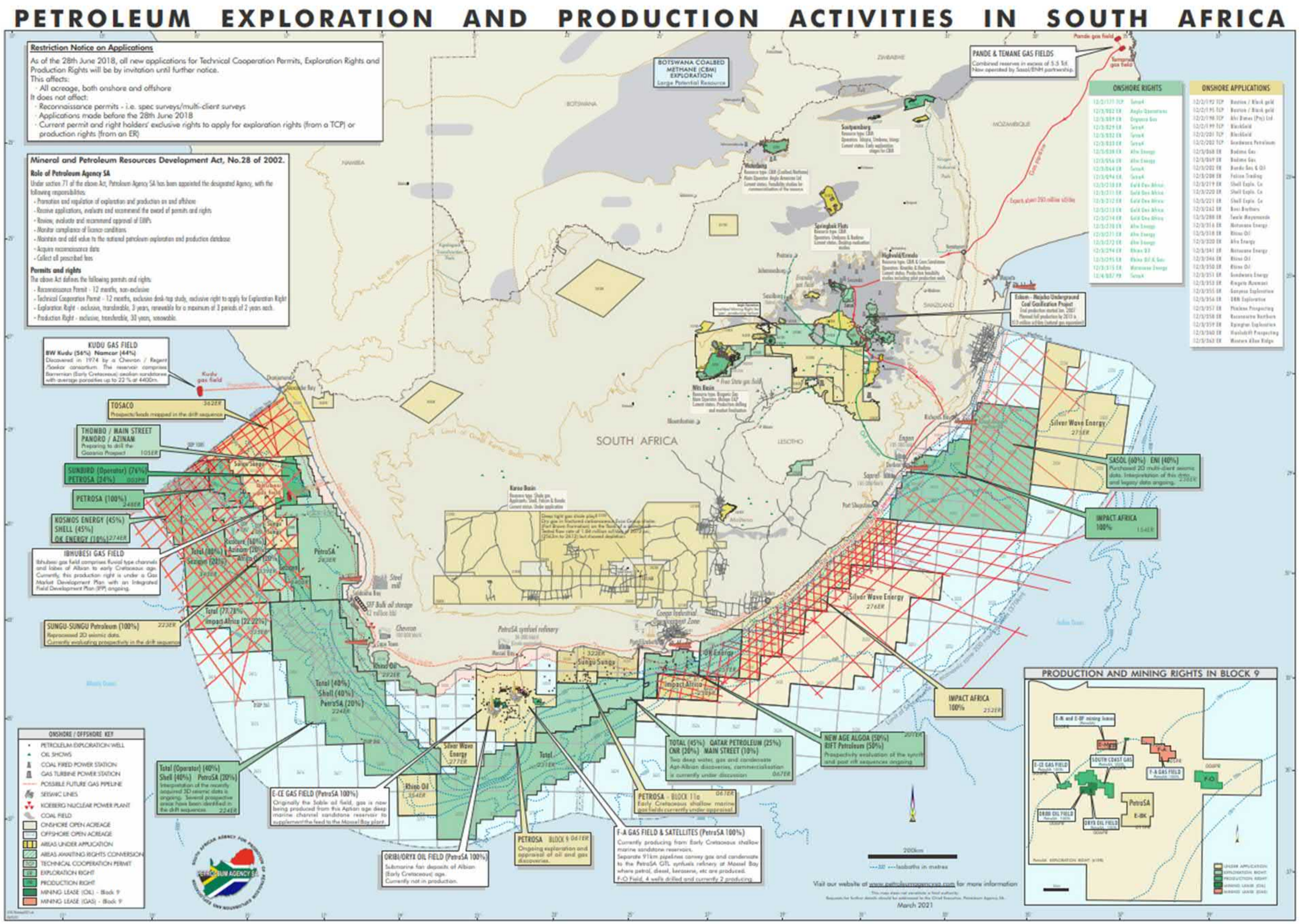

Figure 7-56: Petroleum licence blocks off the West, South and East Coasts of South Africa (PASA 2021)

7.8.2.2 Prospecting and mining of other minerals

Marine diamonds are mined along the West Coast from just south of Lamberts Bay to the Orange River mouth. Twenty diamond mining concessions have been established along the West Coast with each concession divided into four zones from the coast seaward (a, b, c & d). The proposed survey area overlaps with a number of diamond mining concessions along the inshore areas of the survey area (see Figure 7-57).

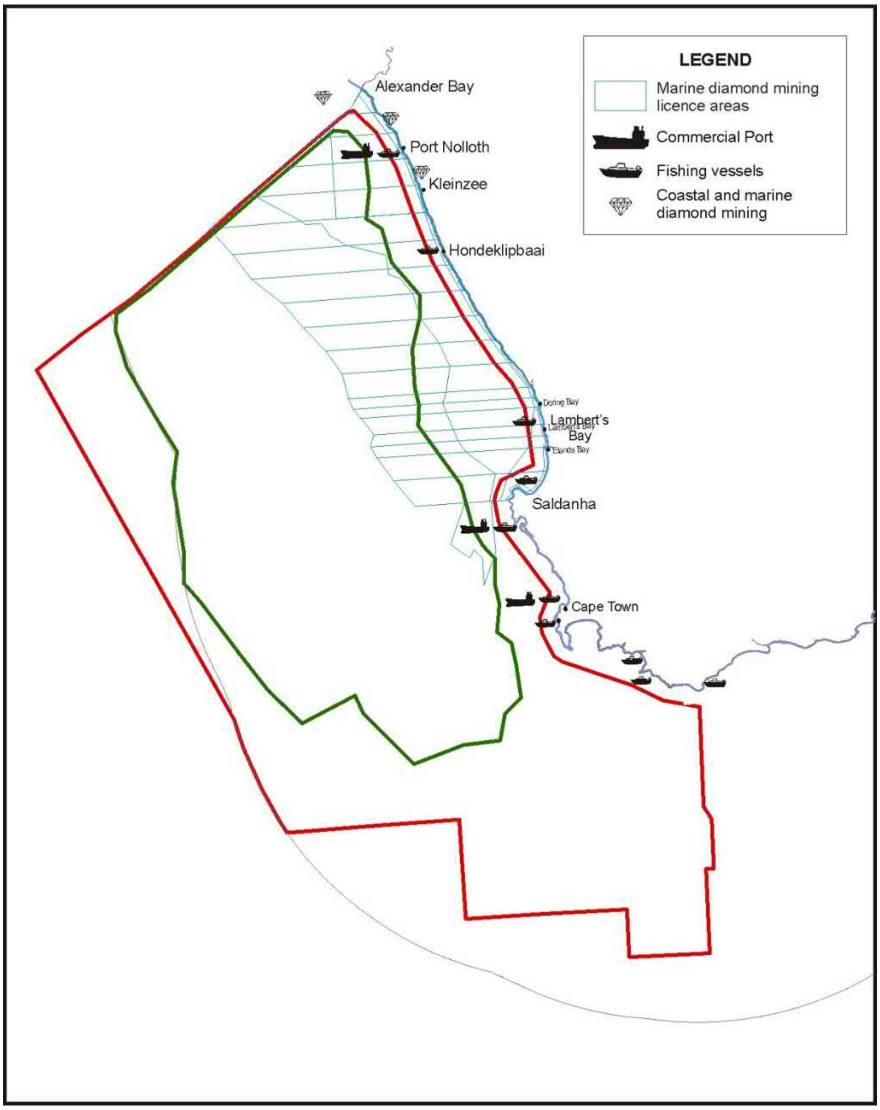

Figure 7-57: South African marine diamond mining areas off the West Coast

The majority of concessions worked at present are those closer inshore (water depths are mostly less than 150 m). Belton Park Trading 127 (Pty) Ltd are presently undertaking deep-water diamond mining in the South African offshore concession areas 2C and 3C. In Namibian waters, diamond mining by De Beers Marine Namibia is currently operational in the Atlantic 1 Mining Licence Area, approximately 40 km to the north of the proposed survey area.

These mining operations are typically conducted from fully self-contained mining vessels with on board processing facilities, using either large-diameter drill or seabed crawler technology. The vessels operate as semi-mobile mining platforms, anchored by a dynamic positioning system, commonly on a three to four anchor spread. Computer-controlled positioning winches enable the vessels to locate themselves precisely over a mining block. These mining vessels thus have limited manoeuvrability.

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

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

Two prospecting areas for marine phosphate are located off the West Coast. Green Flash Trading received their prospecting rights for Areas 251 and 257 in 2012/2013. The proposed survey area overlaps with both these prospecting right areas (see Figure 7-58).

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

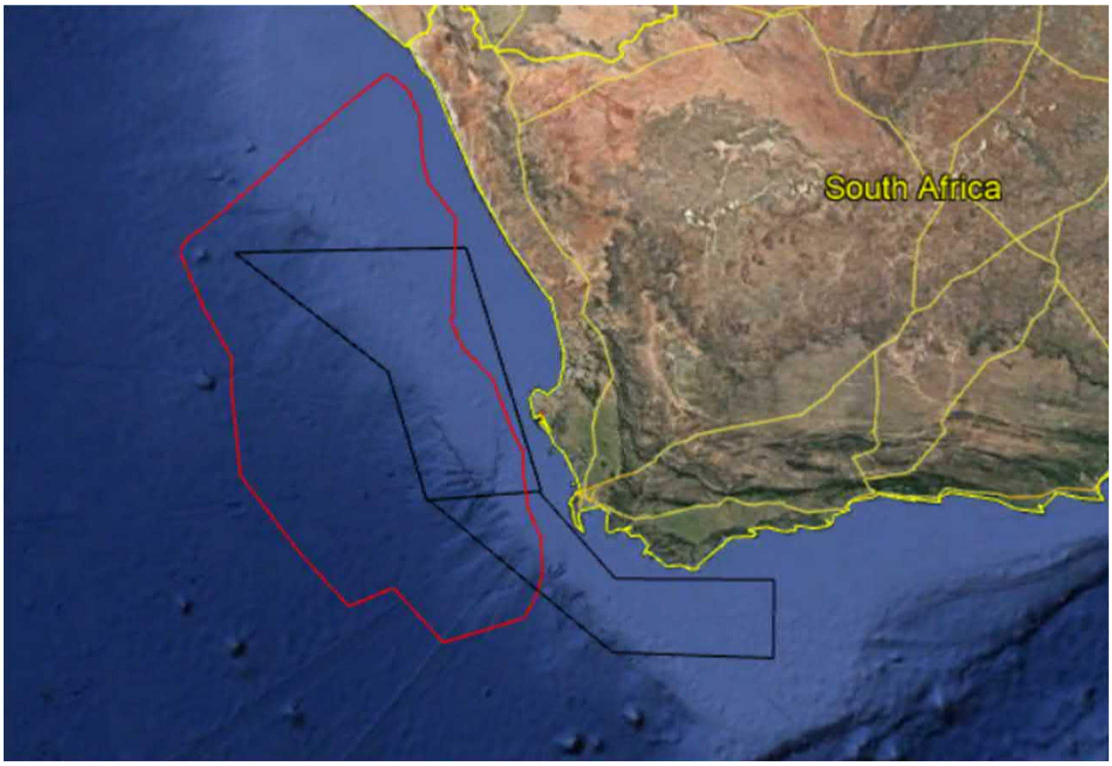

Figure 7-58: The proposed survey area in relation to marine phosphate prospecting rights (black outline)

7.8.3 Anthropogenic Marine Hazards

Hazards on the seafloor are identified in the Annual Summary of South African Notices to Mariners No. 5 or are marked on charts from the South African Navy or Hydrographic. These include ammunition dump sites, undersea cables and recorded wellhead locations. (see Figure 7-59)

7.8.3.1 Ammunition dump sites

From the 1970s to 1995, expired or unusable munitions such as naval shells and other explosive and non-explosive ammunition were dumped in designated marine ammunition dumps. Apart from the potential hazard associated with disturbing unexploded munitions, corrosion may have led to leaching of lead, copper and other pollutants to the marine environment and inadvertent detonation may be physically destructive and may lead to smothering of benthic sea life (Harris *et al.* 2019).

The lack of information on the type, tonnage and condition of the dumped ammunition requires that future exploration be cognisant of these sites and avoid unnecessary disturbance. **An ammunition dump site is located approximately 300 km offshore of Saldanha Bay within the proposed survey area.** Locations of dump sites are marked on all relevant SAN navigational charts (see Figure 7-59).

7.8.3.2 Undersea cables

There are a number of submarine telecommunications cable systems across the Atlantic and the Indian Ocean (see Figure 7-59), including:

- South Atlantic Telecommunications cable No.3 / West African Submarine Cable / South Africa Far East (SAT3/WASC/SAFE): This cable system is divided into two sub-systems, SAT3/WASC in the Atlantic Ocean and SAFE in the Indian Ocean. The SAT3/WASC sub-system connects Portugal (Sesimbra) with South Africa (Melkbosstrand). From Melkbosstrand the SAT-3/WASC sub-system is extended via the SAFE sub-system to Malaysia (Penang) and has intermediate landing points at Mtunzini South Africa, Saint Paul Reunion, Bale Jacot Mauritius and Cochin India (www.safe-sat3.co.za).
- West Africa Cable System (WACS): WACS is 14 530 km in length, linking South Africa (Yzerfontein) and the United Kingdom (London). It has 14 landing points, 12 along the western coast of Africa (including Cape Verde and Canary Islands) and 2 in Europe (Portugal and England) completed on land by a cable termination station in London.
- African Coast to Europe (ACE): The ACE submarine communications cable is a 17 000 km cable system along the West Coast of Africa between France and South Africa (Yzerfontein).
- Equiano: A private subsea cable funded by Google that will start in western Europe and run along the West Coast of Africa, between Portugal and South Africa, with branching units along the way. The first phase of the project, connecting South Africa (at Melkbosstrand) with Portugal, is expected to be completed in 2021.
- 2Africa: The 2Africa subsea cable aims to interconnect Europe (eastward via Egypt), the Middle East (via Saudi Arabia), and 21 landings in 16 countries in Africa (including South Africa). The system is expected to go live in 2023/4.

There is an exclusion zone applicable to the telecommunication cables 1 nm (approximately 1.9 km) each side of the cable in which no anchoring is permitted. The above-mentioned submarine cables pass through the proposed survey area (see Figure 7-59).

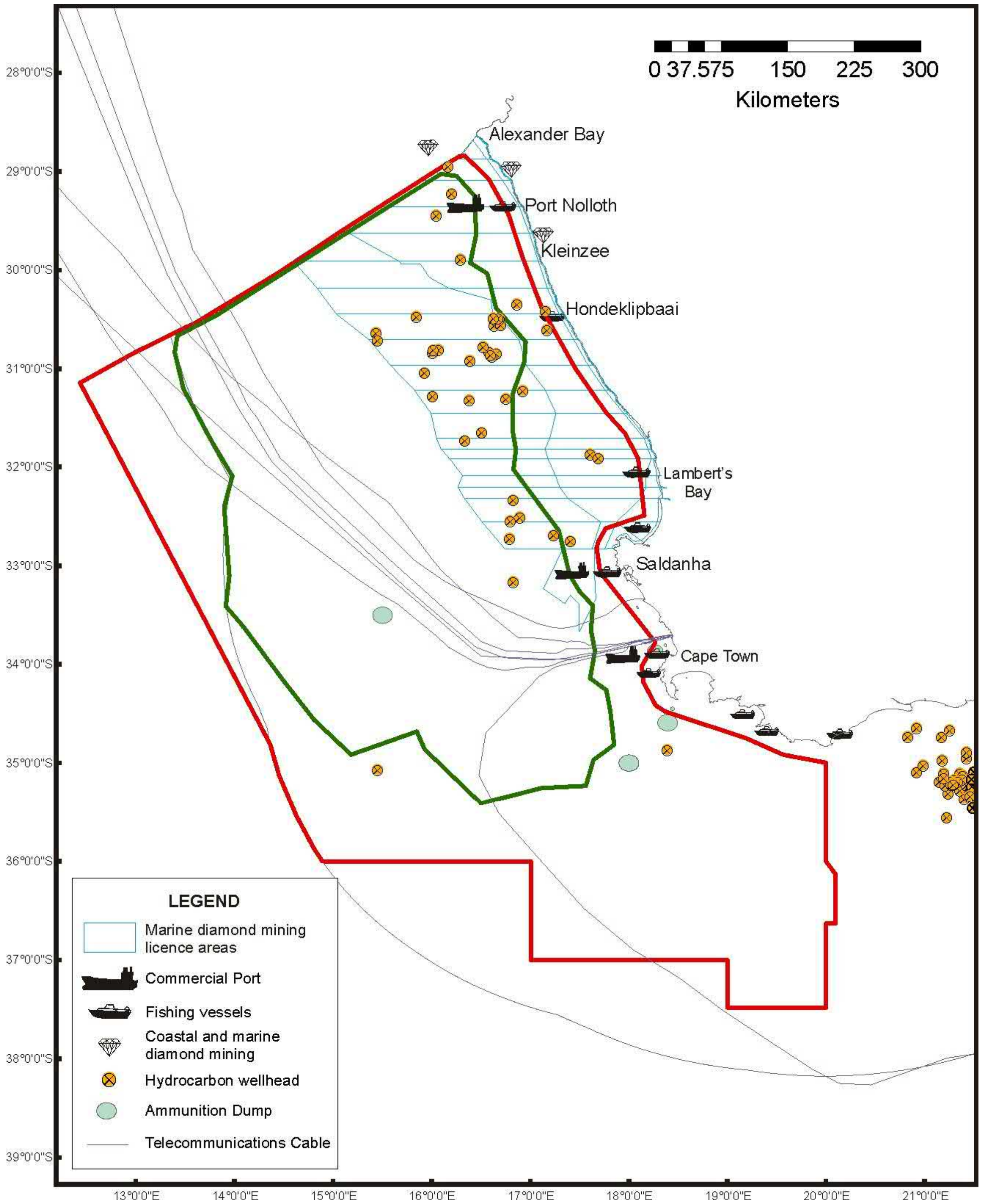

Figure 7-59: Existing undersea hazards off the West Coast in in relation to the proposed survey area
Source: adapted from Hydrographic office data

7.8.3.3 Offshore renewable projects

No offshore renewable energy projects are active in South Africa currently. However, a study on offshore wind energy potential for the entire African continent indicated very good technical offshore wind energy potential for South Africa with **most of the offshore wind resources concentrated in coastal zones** (Elsner, 2019).

7.9 ARCHAEOLOGICAL AND CULTURAL SITES

At least 2 400 vessels are known to have sunk, grounded, or been wrecked, abandoned or scuttled in South African waters since the early 1500s (Gribble 2018). More than 1 900 of these wrecks are more than 60 years old and are thus protected by the National Heritage Resources Agency (NHRA) as archaeological resources. All known shipwrecks off the coast of South Africa occur in waters shallower than 100 m within 50 km of the coast. **Shipwrecks are thus likely to only be located within the extreme inshore areas of the proposed survey area**. It is possible that surveys for oil and gas exploration could detect wrecks or shipping remains, thereby contributing to archaeological knowledge.