4. THE AFFECTED ENVIRONMENT

This chapter provides a description of the South Coast region and the environment likely to be affected by the proposed exploration activities.

4.1 INTRODUCTION

Licence Block 11B/12B is located within the offshore area of the South Coast region of South Africa, which stretches between Cape Agulhas (34° 30'S, 20° 00'E) and Cape Padrone (33° 38´S, 27° 00'E). The licence area is 18 734 km^2 in extent. The northern boundary of the licence block is located between approximately 130 km and 70 km offshore roughly between Mossel Bay and Cape St Francis, with water depths ranging from 500 m to 2 000 m (see Figure 1-1).

The South Coast region is dominated by the Agulhas Bank, a roughly 116 000 km^2 triangular extension of the continental shelf. The Agulhas Bank represents a transition zone between the warm Agulhas Current waters to the east and the cool waters of the Benguela system to the west.

4.2 METEOROLOGY

The main features affecting the weather patterns along the South Coast are the mid-latitude cyclones generated to the south-west of the country and the South Atlantic and Indian Ocean high pressure cells (Shannon, 1985; Preston-Whyte and Tyson, 1988) (see Figure 4-2). The northward movement and weakening of the high-pressure cells during winter and the corresponding northward shift of easterly-moving mid-latitude cyclones (which occur to the south of the region in summer) cause the frontal systems and their associated westerly winds to move overland, affecting coastal weather patterns (Heydorn & Tinley, 1980; Schumann, 1998). Associated with the passage of mid-latitude cyclones are the shallow low-pressure systems that move around the coast from west to east ahead of frontal systems (Heydorn & Tinley, 1980). These may produce warm offshore winds followed by colder westerly to south-westerly winds (Schumann, 1998). Westerly winds predominate in winter, with a marked increase in easterly wind direction in summer. Gale force winds are most frequent in winter. During summer, easterly wind directions increase markedly resulting in roughly similar strength/frequency of east and west winds during that season (Jury, 1994). The strongest winds are observed at capes, including Agulhas, Infanta, Cape Seal, Robberg and Cape Recife (Jury & Diab, 1989). Calm periods are most common in autumn (CSIR & CCA, 1998).

4.3 PHYSICAL OCEANOGRAPHY

4.3.1 BATHYMETRY AND SEDIMENTS

The bathymetry of the South Coast is dominated by the Agulhas Bank. From its narrowest point (40 km) on the West Coast between Cape Columbine and Cape Point, the continental shelf widens to the south reaching its apex 250 km offshore on the Agulhas Bank. Between 22° and 26° E, the shelf break indents towards the coast forming the Agulhas 'bight' (Schumann, 1998) narrowing eastwards to approximately 115 km offshore in the region of Algoa Bay. The bathymetry drops steeply at the coast to approximately 50 m, with depth increasing gradually to the shelf break at a depth of 140 m off Port Elizabeth, 130 m off Cape St Francis, and 300 m south of Cape Agulhas (Birch & Rogers, 1973). Major bathymetric features on the Agulhas Bank include several banks namely, Alphard, 6-Mile, 12-Mile, 45-Mile, 72-Mile, Blues and Browns (which are situated south of Cape Infanta) as well as the Agulhas Arch and Alphard Rise (Birch &

Rogers, 1973, CCA & CSIR, 1998). Dalgleish Bank and Grue Bank lie due south of Knysna, with Grue Bank situated within Licence Block11B/12B. Outside the shelf break, depth increases rapidly to more than 1 000 m (Hutchings, 1994). Submarine canyons can be found in the shelf break off Knysna, Plettenberg Bay and Port Elizabeth while the Southwest Indian Seamounts occur to the east of the Agulhas Bank at a depth greater than 3 000 m. Figure 4-1 depicts the bathymetry and seabed features situated in the vicinity of the study area.

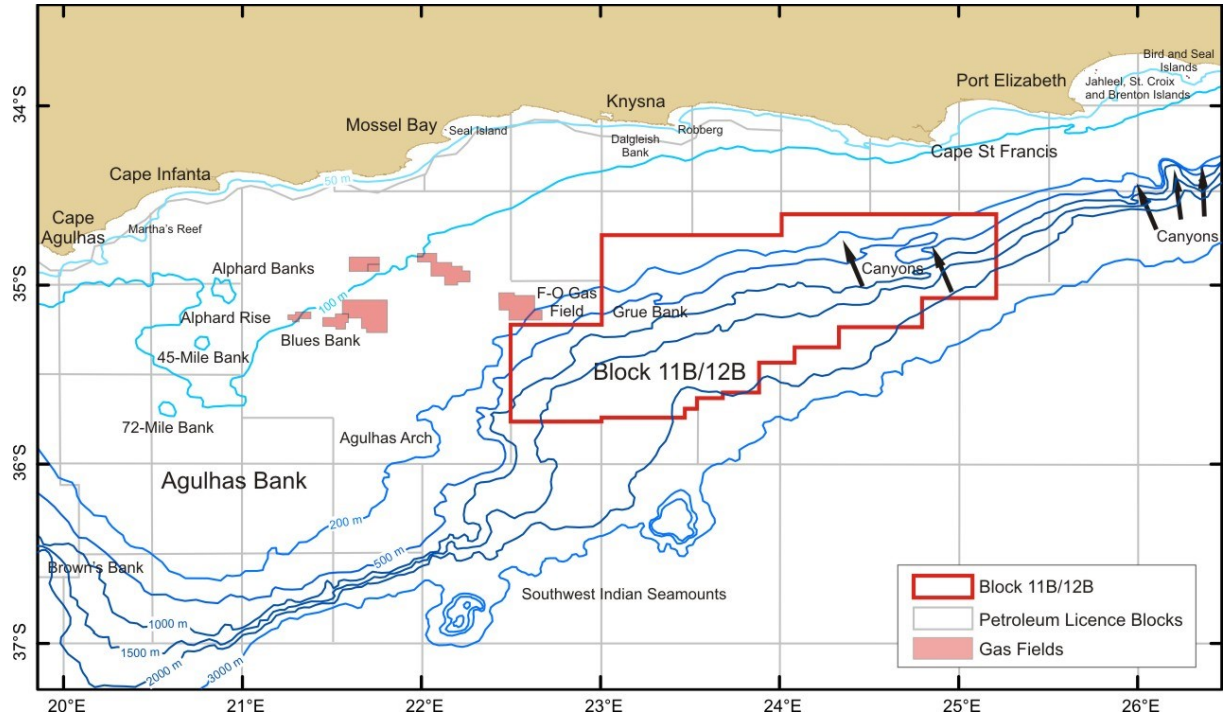

Figure 4-1: Bathymetry (after Sink et al. 2012b) and seabed features of the South Coast in relation to Block 11B/12B (red outline).

The coastline of the South Coast is characterised by a number of capes separated by sheltered sandy embayments. A large expanse of the mid-shelf region of the Agulhas Bank comprises either rock or areas with sparse sediment cover, with an inner shelf sediment-wedge extending up to 30 km offshore (Birch & Rogers, 1973; Schumann, 1998) (see Figure 4-3). Although mud patches occur inshore east of Cape Infanta and south of Cape Agulhas, the majority of unconsolidated sediment is sand to muddy sand (Birch & Rogers, 1973).

The seabed in both the inshore region and eastern half of the South Coast is dominated by rocky reefs (Birch & Rogers, 1973). However, much of the Agulhas Bank mid-shelf seafloor comprises a combination of rock and areas with sparse sediment cover (Dingel *et al*, 1987).

The distribution of benthic habitat types across the Agulhas Bank as mapped in the 2011 National Biodiversity Assessment indicates that the north of Licence Block 11B/12B is characterised by Agulhas Hard Outer Shelf sediments followed by Agulhas Sandy Outer Shelf and Agulhas Hard Shelf Edge sediments which extend to its western boundary. As the seabed drops below 1 000 m in depth, benthic habitat in the licence block becomes representative of Southwest Indian Upper Bathyal unconsolidated sediments. Benthic habitat types along the South Coast are illustrated in Figure 4-4.

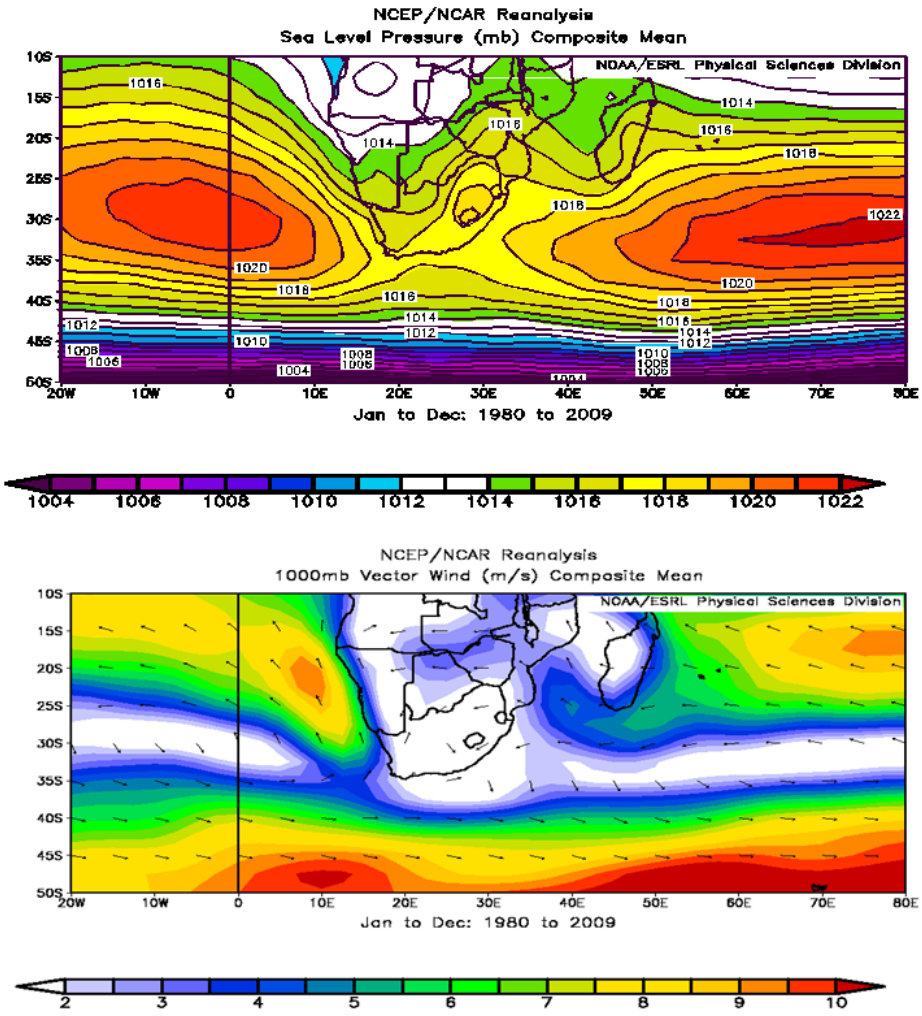

Figure 4-2: **Average sea level pressure (top; hPa) and wind speed and direction (bottom; m.s-1) for the period 1979 – 2009 for both the Atlantic and Indian Oceans from NCEP reanalysis data. Images provided from the NCEP reanalysis site (http://www.esrl.noaa.gov/psd/data/reanalysis/reanalysis.shtml).**

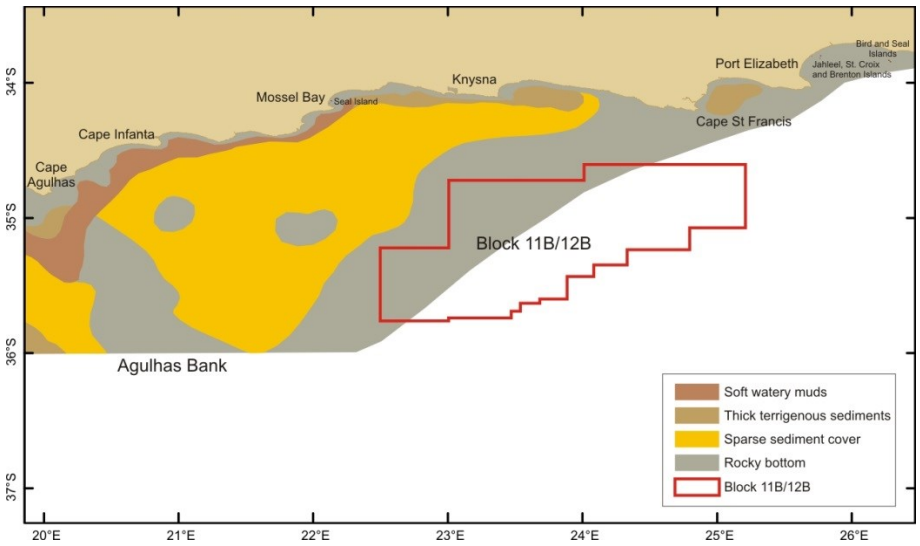

Figure 4-3: **Sediment distribution on the continental shelf of the South Coast (adapted from Birch & Rogers, 1973), in relation to Licence Block 11B/12B (red polygon).**

4.3.2 WATER MASSES AND CIRCULATION

The oceanography off the South Coast is almost totally dominated by the warm Agulhas Current. The current forms between 25° and 30° S, flowing southwards along the shelf edge of the East Coast of southern Africa as part of the anticyclonic Indian Ocean gyre, before retroflecting between 16° and 20° E (Schumann, 1998). It is a well-defined and intense jet some 100 km wide and 1 000 m deep (Schumann, 1998), flowing in a south-west direction at a rapid rate, with current speeds of 2.5 m/sec or more and water transport rates of over 60 × 10^6 m^3/sec having been recorded (Pearce *et al.,* 1978; Gründlingh, 1980). On the eastern half of the offshore South Coast, the Agulhas Current flows along the shelf break at speeds of up to 3 m/sec, diverging inshore of the shelf break south of Still Bay (34° 28' S, 21° 26' E) before realigning to the shelf break off Cape Agulhas (Heydorn & Tinley, 1980). The Agulhas Current may produce large meanders with cross shelf dimensions of approximately 130 km, which move downstream at approximately 20 km per day. It may also shed eddies, which travel at around 20 cm/sec and advect onto the Agulhas Bank (Swart & Largier, 1987; Penven *et al*, 2001). After detaching from the shelf edge at 15° E, the Agulhas Current retroflects and flows eastwards (Schumann, 1998) (see Figure 4-5 and Figure 4-6).

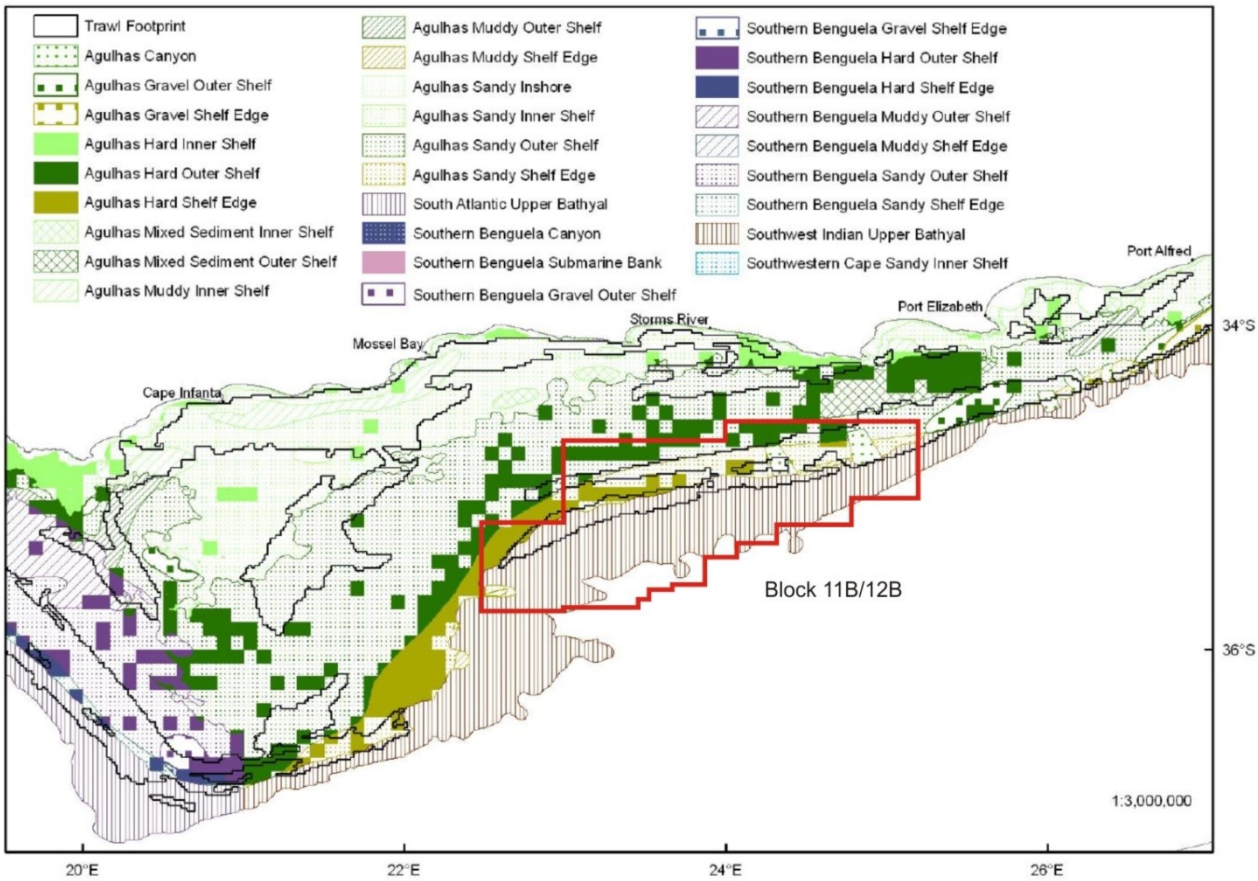

Figure 4-4: The distribution of benthic habitat types in the vicinity of the study area (adapted from Sink *et al.,* 2012).

Currents over the inner and mid-shelf (to depths of 160 m) are weak and variable, with velocities along the eastern half of the South Coast ranging from 25 to 75 cm/sec midshelf and 10 to 40 cm/sec nearshore. Eastward flow may occur close inshore (Boyd *et al*., 1992; Boyd & Shillington, 1994), being particularly strong off Port Elizabeth. Bottom water shows a persistent westward movement, although short-term current reversals may occur (Swart & Largier, 1987; Boyd & Shillington, 1994; CCA & CSIR, 1998). Substantial bottom currents have been recorded from readings undertaken in Licence Block 11B/12B by CNRI and in previous drilling operations undertaken by PetroSA in Licence Block 9. Video evidence (from remote operated vehicles) from the Black Adder (E-DR1) drilling operation, which

occurred approximately 80 km west of Licence Block 11B/12B, shows mud and cuttings having been completely removed by currents. An eastwards to north-east flow direction of bottom currents has been recorded at three offshore locations (Cape Seal, Cape St Francis and Port Alfred) along the South Coast with current velocities at bottom depths between 200 m and 1 200 m being considerably less (0.3 to 0.7m/s) than that of the surface Agulhas current (Atkinson, 2010). The occurrence of a slow, persistent reverse undercurrent is also clearly evident from previous data provided by CNRI within Block 11B/12B that was recorded for a period of 15 months.

As the Agulhas Current originates in the equatorial region of the western Indian Ocean its waters are typically blue and clear, with low nutrient levels. The surface waters are a mix of Tropical Surface Water (originating in the South Equatorial Current) and Subtropical Surface Water (originating from the mid-latitude Indian Ocean). The surface waters of the Agulhas Current may be over 25º C in summer and 21º C in winter and have lower salinities than the Equatorial Indian Ocean and South Indian Ocean Central water masses found below. Surface water characteristics, however, vary due to insolation and mixing (Schumann, 1998). South Indian Ocean Central Water of 14º C and a salinity of 35.3 ppt occur below the surface water layers at between 150 to 800 m depth. The deeper waters comprise, from shallowest to deepest, Antarctic Intermediate Water, North Indian Deep Water, North Atlantic Deep Water and Antarctic Bottom Water. Sub-tropical Surface Water of between 15 and 20º C often intrudes into the Agulhas Current at depths of 150 to 200 m from the east (Schumann, 1998).

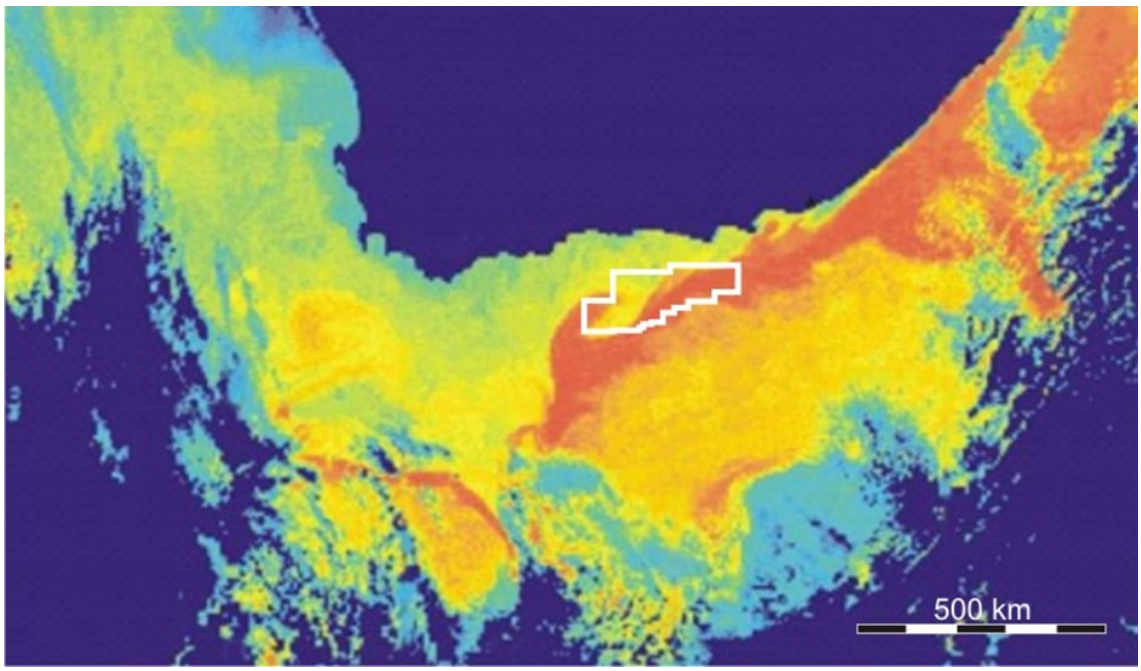

Figure 4-5: The predominance of the Agulhas Current in the oceanography of the Licence Block 11B/12B area (white outline).

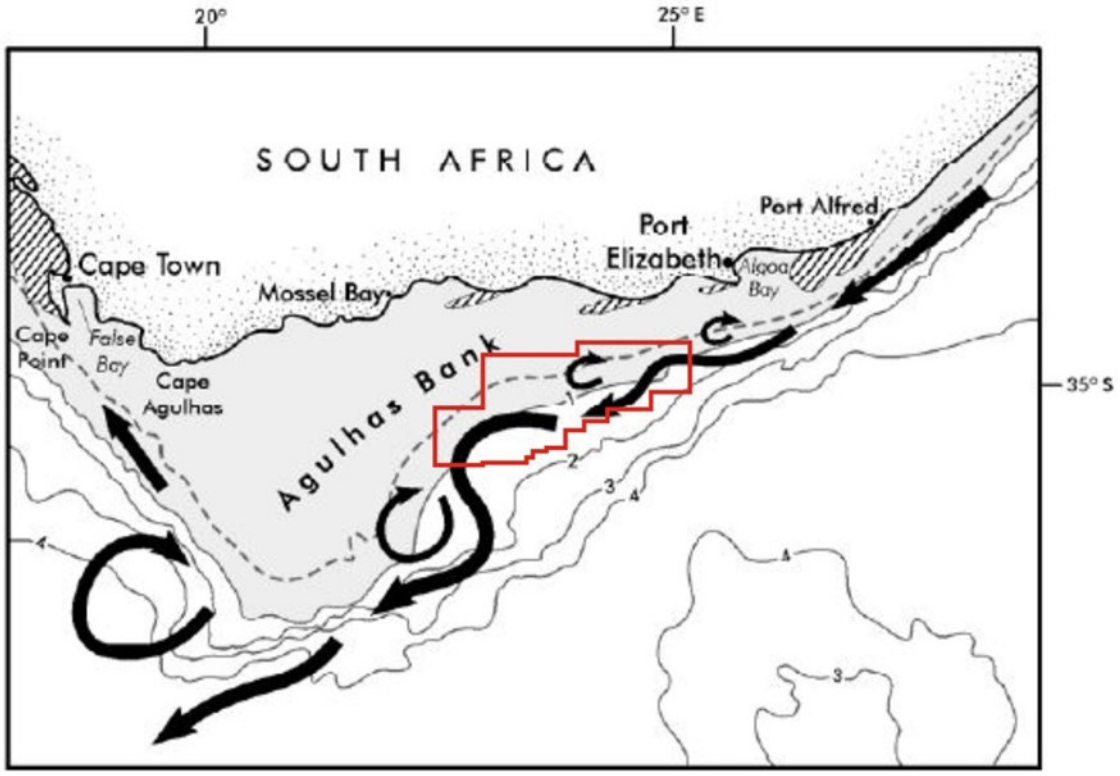

Figure 4-6: The major circulatory elements along the South Coast in relation to the Licence Block 11B/12B area (red polygon). The broken line denotes the edge of the continental shelf (200 m isobath) and upwelling is shown by hatching (adapted from Lutjeharms, 2006).

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

4.3.3 THERMAL STRUCTURE, VARIABILITY AND UPWELLING

According to Morant (2013), the thermal structure of Agulhas Bank waters is mediated by the intrusions of Agulhas Current water at surface and subsurface depths, upwelling and surface heating by insolation. At the inner boundary of the Agulhas current, cold bottom water is advected onto the Agulhas Bank via shelf-edge upwelling (Schumann, 1998). This process is primarily due to frictional interactions between the Agulhas Current and bottom topography (Hutchings, 1994) and is most intense at the eastern boundary of the South Coast, where the cold bottom layer breaks the surface. Such shelf-edge upwelling largely defines the strong thermocline and halocline topography that typically develops between the cold bottom water and the sun warmed surface layer during spring, summer and autumn and is broken down through turbulence in winter.

On the central bank, a prominent feature of the midshelf is the ridge of cool water that extends in a north-east (NE) – south-west (SW) direction between the shelf-edge upwelling and inshore waters close to the coast (Swart & Largier, 1987; Boyd & Shillington, 1994; Schumann, 1998). The ridge has its 'base' at the coast between Cape Seal and Cape St Francis and appears to be most prominent under south-east wind conditions, which cause coastal upwelling in the Knysna region (Walker, 1986; Boyd & Shillington, 1994;

Jury, 1994). As easterly winds dominate in the spring-autumn period the cool water ridge is a semi-permanent feature during much of the year. Inshore of the cool water ridge, the thermoclines may be disrupted by coastal upwelling on the lee side of capes under easterly wind conditions (Schumann *et al*., 1982; Walker, 1986; Schumann, 1998). Such upwelling usually begins at the prominent capes and progresses westwards (Schumann *et al*., 1982; Schumann, 1988), and can result in temperature changes of up to 8° C within a few hours (Hutchings 1994).

The thermoclines on the central and eastern Agulhas Bank are resistant to breakdown under strong wind conditions due to their strong gradients and because they are maintained by advection. Temperature gradients are usually around 5-6°C/10 m close inshore east of Cape Agulhas but reaching extremes of 10°C/10 m around the Alphard Banks and eastwards inshore towards Cape St. Francis. The thermoclines at the eastern edge of the South Coast are located at 20-40 m depth (Largier & Swart, 1987). During strong winds, the isothermal upper mixed layer erodes down into the top of the thermocline, thereby increasing the temperature gradient and thus thermocline stability (Carter *et al*., 1987). In contrast, on the outer Agulhas Bank, offshore of the cold water ridge, thermocline development is weak. In winter, when westerly winds dominate, the cold bottom water recedes to the shelf break and the nearer shore water column tends to become isothermal (Schumann & Beekman, 1984; Boyd & Shillington, 1994).

4.3.4 SWELLS AND WAVES

On the South Coast, the majority of waves arrive from the south-west quadrant (Whitefield et al., 1983), dominating wave patterns during winter and spring (Carter & Brownlie, 1990). Waves from this direction frequently exceed 6 m (Swart & Serdyn 1981, 1982) and can reach up to 10 m (Heydorn, 1989). During summer, easterly wind-generated 'seas' occur (Heydorn & Tinley, 1980; Heydorn, 1989; Carter & Brownlie, 1990). Giant waves (>20 m high) are at times encountered within the Agulhas Current (Heydorn & Tinley, 1980). These arise from the meeting of the south-westerly swells and the southerly flowing Agulhas Current, and may be a navigation hazard at times.

4.3.5 TIDES

Tides are typically semi-diurnal along the South Coast with an average tidal range of between 0.5 m during neap tides and 1.5 to 2.0 m during springs (Schumann, 1988) (see Table 4-1). The tidal range increases slightly from west to east. Tides propagate from west to east along the South African coast eastwards of Cape Point, so that high water is earlier in the west than east along the South Coast (Schumann, 1998).

Table 4-1: Tide data (m) for different sites along the South Coast (from SA Tide Tables, 1995 & 2009).

Site	MLWS	MLWN	ML	MHWN	MHWS	HAT
Mossel Bay	0.25	0.84	1.13	1.41	2.00	2.42
Knysna	0.36	0.90	1.16	1.43	1.96	2.31
Port Elizabeth	0.29	0.84	1.09	1.35	1.90	2.35

MLWS - Mean low water spring
MLWN - Mean low water neap
ML - Mean level
MHWN - Mean high water neap
MHWS - Mean high water spring
HAT - Highest astronomical tide

4.3.6 TURBIDITY

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

4.3.7 NUTRIENT DISTRIBUTION

Nitrate-nitrogen concentrations in Agulhas Current source water range from 7-10 µM/l, while those of sub-thermocline water may be up to 20 µM/l (Carter *et al*., 1987). During winter, when the water column is well mixed, bottom nutrients mix upwards and nutrient concentrations in the surface waters are higher than in summer (CSIR & CCA, 1998).

Primary production is nitrogen-limited in the upper layers of the euphotic zone, but light-limited in the sub-surface chlorophyll maximum layer (Probyn & Lucas, 1987). It is unlikely that phosphorous would ever become limiting, except perhaps at the primary production maximum. Much of the ammonia and phosphorous needed for phytoplankton growth in the surface layers is supplied by heterotrophic microflagellates (1 - 5 µm) and nanoplankton (1 - 15 µm). However, size-related differences in the relative importance of the microplanktonic groups to the immobilisation and recycling of different nutrients occur (Probyn & Lucas, 1987). On the Agulhas Bank, the 1 – 5 µm size class were found to be a proportionally greater sink for phosphorous than for ammonium, immobilising on average 36% of the total phosphorous assimilated (Probyn & Lucas, 1987). However, microplankton uptake and regeneration of both ammonium and phosphorus were approximately in balance, indicating that variations in assimilation ratios were the result of heterotrophic excretory activity. Here, picoplankton in the 15 – 200 µm size range were more important in the regeneration of phosphorous than of ammonium, the latter primarily being regenerated by the nanoplankton (1 – 15 µm).

4.3.8 OXYGEN CONCENTRATION

Bottom waters on the Agulhas Bank have higher oxygen concentrations than those found along the West Coast. Only localised areas of the South Coast have slightly reduced oxygen levels (Hutchings, 1994). Potential for phytoplankton blooms is discussed in Section 4.4.1.1 (a).

4.3.9 SEDIMENTARY PHOSPHATES

Phosphorite is a phosphate-rich sedimentary rock usually containing between 5% and 20% phosphate. In the context of the marine environment, it appears as a nodular hard ground capping of several metres thick or as a series of unconsolidated sediments (Morant, 2013). The largest of the sedimentary phosphates in South Africa is the diagenetic replacement resource found on the Agulhas Bank which occurs as near continuous ‘pavements’ or cappings of limestones. These resources are situated at depths of between 200 m and 500 m on the continental shelf between Cape Agulhas and Cape Recife and cover an area of approximately 21 500 km^2. The distribution of phosphorite in relation to the Licence Block is depicted in Figure 4-7.

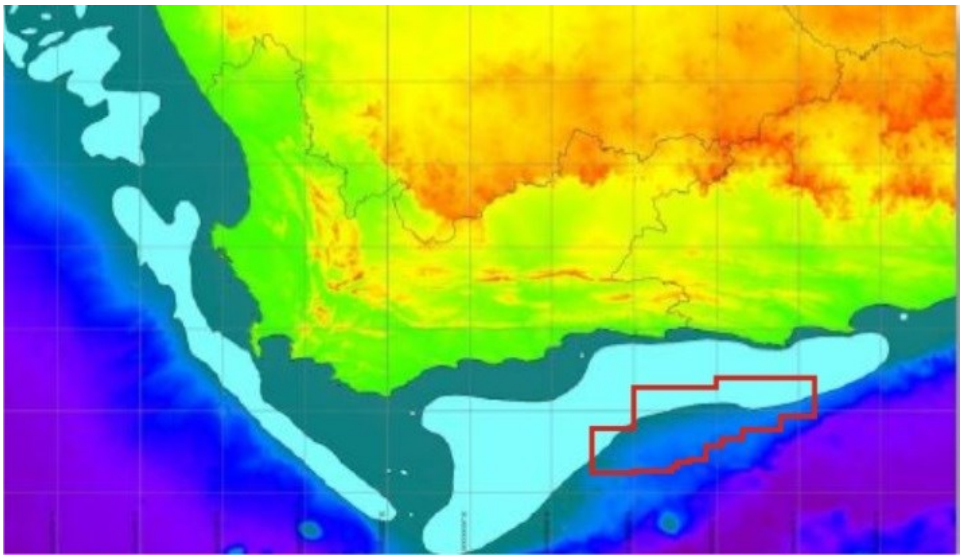

Figure 4-7: Distribution of phosphorite (light blue) on the South African continental shelf in relation to Licence Block 11B/12B (red polygon) (adapted from Morant, 2013).

The "open shelf" phosphorite deposits originated from the precipitation of phosphate in the form of calcium phosphate within an environment of intense upwelling and high biological activity along the continental margin of South Africa. The upwelling was associated with a change in temperature and pressure which resulted in a decrease in solubility of the phosphate salts in the oceanic water and consequently, the precipitation of phosphates (in the form of apatite) over the continental shelf to form phosphatic packstones and colitic pellets. The precipitation was facilitated by the decay of siliceous phytoplankton. Following precipitation the phosphates combined with calcium (derived from the disaggregation of calcareous foraminiferal and coccolithophorid debris on the outer continental shelf) to form phosphatised lime-rich muds. The muds were further lithified or consolidated by means of replacement with secondary calcium phosphate (francolite) to form a near continuous hard capping of phosphate rock over the seafloor sediments (Birch, 1990; Morant, 2013).

During periods of sea level change, the phosphate-rich rocks were extensively re-worked, eroding the hard capping pavements thereby liberating the heavy phosphate-bearing minerals (mainly glauconite and apatite) and concentrating them in the overlying unconsolidated sediments. Migrating zones of deposition and erosion occurred during repeated transgressive/regressive cycles. Renewed carbonate deposition and a further period of phosphatisation occurred when the deposition zones migrated back across the shelf in response to a rising sea level, thereby incorporating boulders and cobbles of phosphatized limestone and glauconite left behind after the previous regressive cycle into the second-generation phosphatic deposits, forming conglomeratic rock types. Two main periods of phosphatization have been identified, namely the Middle Miocene (ca 15 Ma), and possibly the Upper Eocene (ca 37 Ma) (Birch, 1990; Morant, 2013).

The ore bearing lithologies comprise three non-conglomeratic and two conglomeratic rock types. The non-conglomeratic types are phosphatized foraminiferal lime packstones (a type of limestone), which are either poor in glauconite and quartz, rich in goethite, or highly glauconitic. The first conglomeratic type is also rich in glauconite, but contains pebble inclusions of phosphatized foraminiferal limestone. The second conglomeratic type is distinguished by its low glauconite content and high macrofossil and goethite abundance. The depth of mineralization within the conglomeratic ores is typically restricted to the upper few metres of sediment. The phosphate-rich rocks on the Agulhas Bank are estimated to have an average P_2O_5 content of 16.2%. With an area of 35 000 million m^2, an average thickness of 0.5 m, the Agulhas Bank offshore phosphate deposits are estimated to contain in the order of 5 000 million tons of

P_2O_5 (Birch, 1990). Potential for phosphate mining is being investigated in areas off the South Coast and is discussed in further detail in Section 4.5.3.

4.4 BIOLOGICAL OCEANOGRAPHY

South Africa is divided into nine bioregions, two of which occur in the study area (namely Agulhas Inshore and West Indian Offshore) (see Figure 4-8) (Lombard *et al*., 2004).

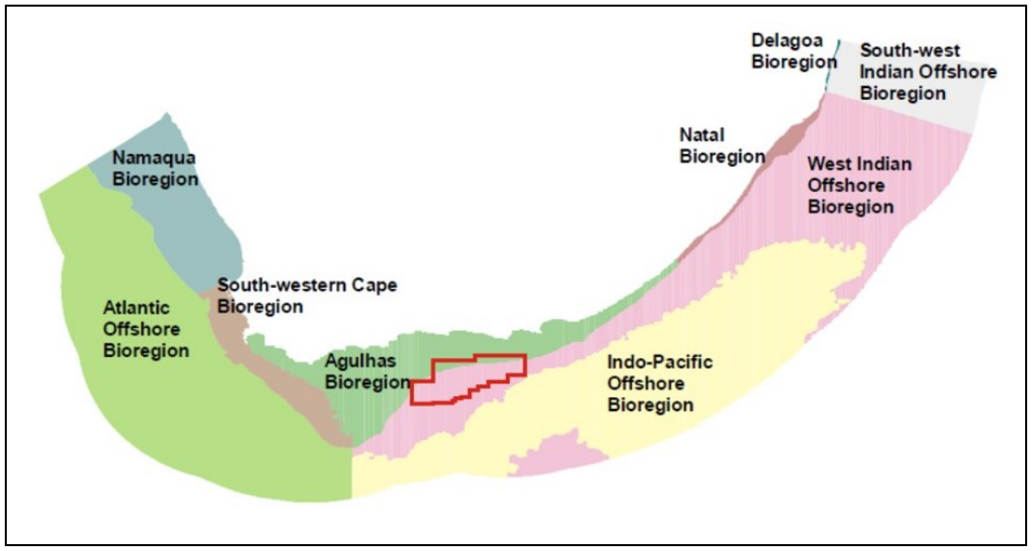

Figure 4-8: **The inshore and offshore bioregions occurring in the licence area (red outline) (adapted from Lombard *et al*., 2004).**

The National Biodiversity Assessment 2011 (Sink et. al., 2012) included an investigation into the state of biodiversity and ecosystems in South Africa's marine and coastal environment and mapped the ecosystem threat status of offshore benthic and pelagic habitats. The licence area coincides with benthic habitats of 'Least Threatened', 'Vulnerable' and 'Critically Endangered' status while the pelagic habitats occurring in the licence block are classified as 'Vulnerable' and 'Least Threatened' (see Figure 4-9).

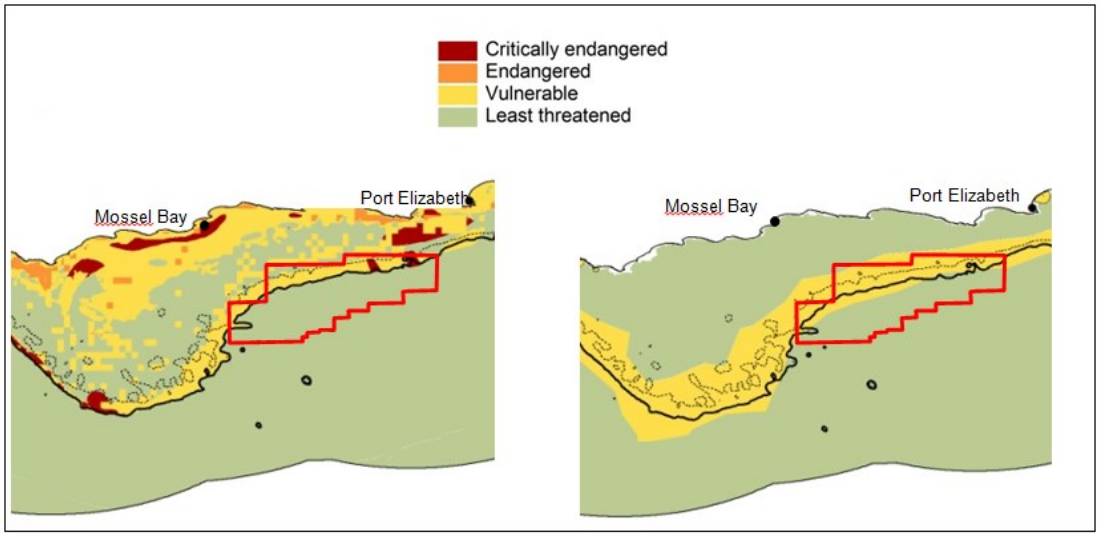

Figure 4-9: Ecosystem threat status for coastal and offshore benthic habitat types (left), and offshore pelagic habitat types (right) on the offshore South Coast in relation to Licence Block 11B/12B (red outline) (adapted from Sink *et al*., 2012).

Communities within the South Coast region are largely ubiquitous, being particular only to substrate type and depth zone. The biological communities present in Licence Block 11B/12B comprise many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The deep-water marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments, deep-water reefs and the water column. The biological communities 'typical' of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened species.

4.4.1 OFFSHORE REGION

4.4.1.1. Plankton

(a) Phytoplankton

Primary productivity in the Agulhas Bank surface waters is generally low with mean *chlorophyll a* concentrations of 1.46 mg/m^3 in the top 30 m of the water column in inshore areas (<200 m depth) dropping to 1.00 mg/m^3 further offshore (200 m to 500 m depth) (Brown *et al*., 1991; Brown, 1992). *Chlorophyll a* concentrations vary seasonally, being minimal in winter and summer (<1 to 2 mg/m^3) and maximal (2 to 4 mg/m^3) in spring and autumn (Brown, 1992). Lower concentrations are partly due to nutrient limitation due to the strong summer thermoclines or light limitations due to deep mixing in winter (Probyn *et al*., 1994), but if the thermocline falls within the 1% light depth, phytoplankton biomass can increase dramatically, with sub-surface chlorophyll concentration maxima often being in excess of 10 mg/m^3 (Carter *et al*., 1987; Hutchings, 1994). Chlorophyll concentrations can also be high where upwelling occurs at the coast (Probyn *et al*., 1994). Along the eastern half of the South Coast (Knysna to Cape Padrone), phytoplankton concentrations are usually higher than further west and the phytoplankton comprises predominantly large cells (Hutchings, 1994).

Although seasonal diatom blooms do occur along the South Coast and on the Agulhas Bank, the red tides (harmful algal blooms (HAMs)) characteristic of the Benguela upwelling system are seldom reported east of Cape Agulhas (Pitcher & Calder, 2000).

(b) Zooplankton

On the South Coast zooplankton communities have comparatively high species diversity (De Decker, 1984), with standing stocks along the eastern half of the South Coast ranging from 3 – 6 gC/m^2. The South Coast mesozooplankton (>200 µm) is dominated by the calanoid copepod *Calanus aghulensis*, which associates with shallow thermoclines and the mid-shelf cool water ridge (Verheye *et al*., 1994). This species may contribute up to 85% of copepod biomass in the region and is an important food source for pelagic fishes (Peterson *et al*., 1992). Biomass of mesozooplankton increases from west (~0.5 to ~1.0 gC/m^2) to east (~1.0 to ~2.0 gC/m^2), mirroring the eastward increase in *chlorophyll a* concentrations, peaking on the central and eastern Agulhas Bank during summer in association with the subsurface ridge of cool upwelled water. Macrozooplankton (>1600 µm) standing stocks are estimated to be 0.079 gC/m^2 between Cape Agulhas and Cape Recife (Verheye, unpublished data). Dense swarms of euphausiids dominate this zooplankton component and form an important food source for pelagic fishes (Cornew *et al*., 1992; Verheye *et al*., 1994). Salps and doliolids sometimes reach very high biomass levels on the Agulhas Bank and form large swarms (De Decker, 1973).

(c) Ichthyoplankton

The Agulhas Bank (particularly the western portion) is an important spawning area for a variety of pelagic species, including anchovy, pilchard and horse mackerel. East of Cape Agulhas anchovy, pilchard and horse mackerel have been reported to spawn between the shelf-edge upwelling and the cold-water ridge, where copepod availability is highest (Crawford, 1980; Hutchings, 1994; Roel & Armstrong, 1991; Hutchings *et al*., 2002) (Figure 4-10). The eggs and larvae spawned in this area are thought to largely remain on the Agulhas Bank, although some may be carried to the West Coast or be lost to the Agulhas Current retroflection (Hutchings, 1994; Duncombe Rae *et al*., 1992; Hutchings *et al*., 2002). Pilchards also spawn on the Agulhas Bank (Crawford, 1980), with adults moving eastwards and northwards after spawning. Round herring are also reported to spawn along the South Coast (Roel & Armstrong, 1991). Demersal species that spawn off the South Coast include the Cape hake and kingklip. Spawning of the shallow-water hake occurs primarily over the shelf (<200 m) whereas that by the deep-water hake occurs off the shelf. Similarly, kingklip spawn off the shelf edge to the south of St Francis and Algoa Bays, and thus on the eastern edge of Licence Block 11B/12B (Shelton, 1986; Hutchings, 1994) (Figure 4-10). Squid (*Loligo* spp.) spawn principally in the inshore waters (<50 m) between Knysna and Port Elizabeth, with larvae and juveniles spreading westwards. Their distribution and abundance is highly erratic and linked to temperature, turbidity, and currents (Augustyn *et al*., 1994).

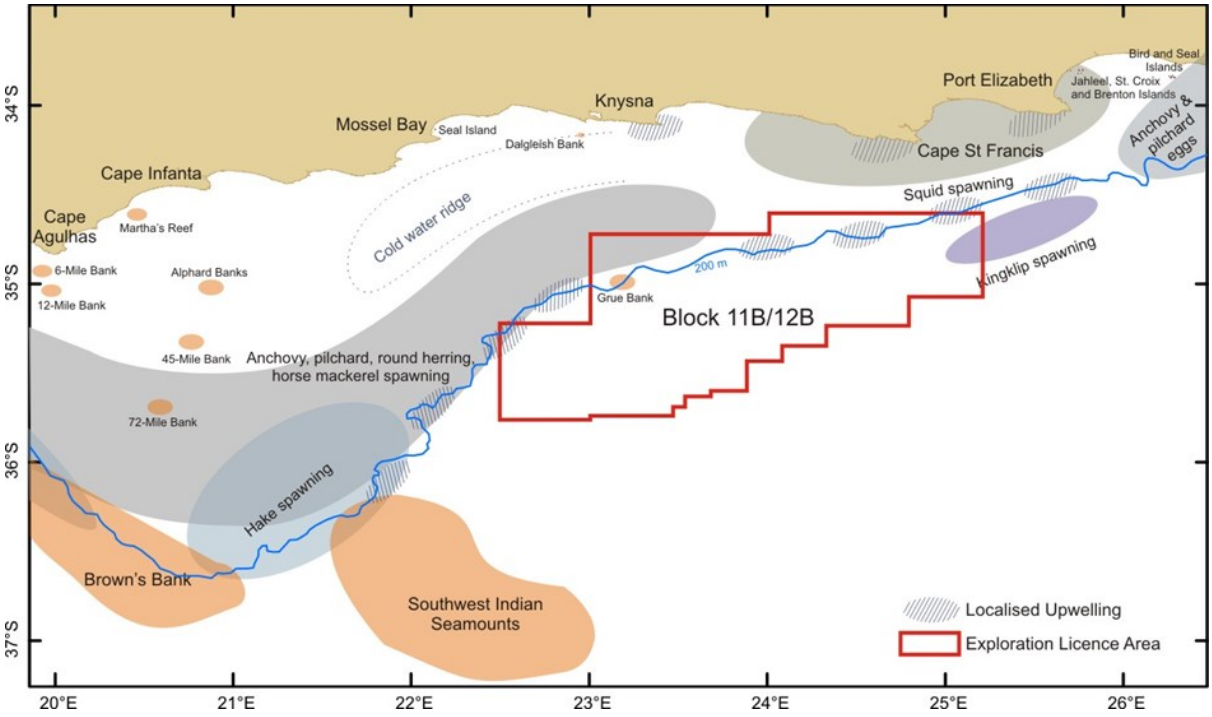

Figure 4-10: Important fishing banks, seamounts, pelagic and demersal fish and squid spawning areas in relation to Licence Block 11B/12B (red outline) (after Anders, 1975, Crawford et al., 1987, Hutchings, 1994). The 200 m depth contour is also shown.

The inshore area of the Agulhas Bank, especially between the cold water ridge and the shore, serve as an important nursery area for numerous linefish species (e.g. elf *Pomatomus saltatrix*, leervis *Lichia amia*, geelbek *Atractoscion aequidens,* carpenter *Argyrozona argyrozona*) (Wallace *et al*., 1984; Smale *et al*., 1994). Adults undertake spawning migrations along the South Coast into KwaZulu-Natal (KZN) waters (Van der Elst, 1976, 1981; Griffiths, 1987; Garret, 1988; Beckley & van Ballegooyen, 1992). The eggs and larvae are subsequently dispersed southwards by the Agulhas Current, with juveniles occurring on the inshore Agulhas Bank (Van der Elst, 1976, 1981; Garret, 1988). In the case of the carpenter fish, a

high proportion of the reproductive output comes from the central Agulhas Bank and the Tsitsikama Marine Protected Area (MPA), and two separate nursery grounds appear to exist, one near Port Elizabeth and a second off the deep reefs of Cape Agulhas, with older fish spreading eastwards and westwards (van der Lingen *et al*., 2006).

4.4.1.2. Benthic Invertebrate Communities

The seabed communities in the licence area lie within the Agulhas sub-photic and continental slope biozones, which extend from a 30 m depth to the shelf edge, and beyond to the lower slope, respectively. These biozones lie within the 'minimal protected category' (1 - 5%) and portions of the shelf area are defined as 'Vulnerable', 'Endangered' or 'Critically Endangered' because existing MPAs are deemed insufficient for conserving marine habitats and their associated biodiversity (Lombard *et al*., 2004; Sink *et al*., 2012a) (Figure 4-9). Based on the high endemism known to occur there, the coastal area in the vicinity of Mossel Bay has been recognised as one of seven areas in the biozone in need of additional protection. Extractive utilisation of marine resources has been identified as the greatest threat to biodiversity in the biozones (Lombard *et al*. 2004; Sink *et al*. 2012a).

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

Information on offshore benthic invertebrate communities occurring in the South Coast offshore is sparse and no formally, peer-reviewed literature is currently available. However, a study funded by PetroSA (through a sponsorship agreement with the World Wildlife Fund (WWF)) to assess the offshore benthic biodiversity on the Agulhas Bank as well as information contained in specialist reports by Quick & Sink (2005) and Shipton & Atkinson (2010) which informed the Environmental Impact Assessments (EIA) for the South Coast Gas project and development of the F-O Gas Field respectively, categorised the benthic communities expected to occur on the Agulhas Bank into four main groups. These groups are based on the distribution of the main seabed types identified by Dingle *et al*. (1987) and are detailed below:

1. **Terrigenous muds**: although no studies have specifically examined the biota of this habitat type in South Africa, a high biodiversity of benthic macrofauna (polychaetes, nematodes, amphipods, isopods, molluscs, echinoderms etc.) is expected.
2. **Relict shelly sands**: sandy habitats of varying grain size typically provide relatively stable environments and are thus able to support highly diverse benthic communities, including seapens, molluscs, echinoderms (brittle stars and heart urchins), cerianthids (tube anemones), sponges and the deep-water rock lobster *Palinurus gilchristi*. A wide diversity of infauna also occurs, including polychaetes, amphipods, isopods, molluscs, etc.

3. **Pre-Mesozoic basement rock:** this low profile habitat typically hosts sponges, black corals, gorgonians and ascidians (Sink *et al.,* 2006). Although often covered in a thin layer of sediment, the scattered, emergent rock fragments or debris support colonisation by colonial benthic invertebrates.
4. **Pre-Mesozoic rock outcrops** – these highly structured reef areas are likely to be characterised by highly diverse benthic and motile biota including sponges, azooxanthellate corals, octocorals, gorgonians, black corals, cerianthids and stylasterine lace corals, bryozoans, ascidians, basket stars and the South Coast rock lobster *Palinurus gilchristi*. Fauna occurring in the deeper reef areas and canyons have community assemblages distinctly different to those found in shallower reefs, where deep reefs and canyons support unique and diverse invertebrate fauna (Sink *et al.,* 2006).

The four stable habitat groups described above have been identified as sensitive, as the fauna typically associated with them are frequently slow-growing, slow to mature and long-lived, making them particularly vulnerable to disturbance.

The Agulhas Bank hosts a diversity of deep-water corals and sponges (Figure 4-11 and Figure 4-12), that have established 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. Reef-building cold water corals have also been documented within the Southwest Indian Upper Bathyal, Agulhas Sandy Shelf Edge and in association with deep reefs and submarine canyons on the Agulhas Inner Shelf and Shelf Edge respectively (Sink & Samaai, 2009; Sink *et al*., 2011). Substantial shelf areas could thus potentially be capable of supporting rich, deep-water benthic, filter-feeding communities. Corals and sponges add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze *et al*., 1997; MacIssac *et al*., 2001). Their frameworks offer refugia for a great variety of invertebrates and fish (including commercially important species) within, or in association with, the living and dead frameworks.

Our understanding of the invertebrate fauna of the sub-photic zone is relatively poor (Gibbons *et al*., 1999) and the conservation status of the majority of invertebrates in this bioregion is not known. Quick & Sink (2005) undertook an exercise to collate records of species from the Agulhas Bank area which included a wide variety of seapens, alcyonacean soft corals, gorgonians and ascidians, many of which are regarded as endemic to the bioregion. This was supplemented by information obtained through analysis of ROV footage taken in reef and unconsolidated habitats and on gas-field infrastructure, SAT diver collections, trap sampling and grab sampling as part of the dedicated PetroSA-WWF study (Sink *et al*., 2010).

The findings of these studies suggested that the deep water reefs (Alphard, 45-Mile and 72-Mile Banks) support exceptionally diverse and dense assemblages with clear depth zonation patterns. Whereas the shallower regions of the Alphard Banks (16 to 90 m) supported a kelp community dominated by *Ecklonia radiate,* the invertebrate fauna in deeper regions included a high diversity of sponge species (*Antho kellyae*, *Biemna anisotoxa*, *Clathria* spp., *Isodictya elastic, I. frondosa* and *Polymastia* sp.), fragile bryozoans, slow-growing hydrocorals (*Allopora nobilis* and *A. subviolacea*), gorgonians (*Eunicella albicans*, *Eunicella tricorona, Leptogorgia palma* and *Homophyton verrucosum*), gorgonian whip corals (resembling *Ctenocella* sp.) and black corals (*Antipathes* sp.).

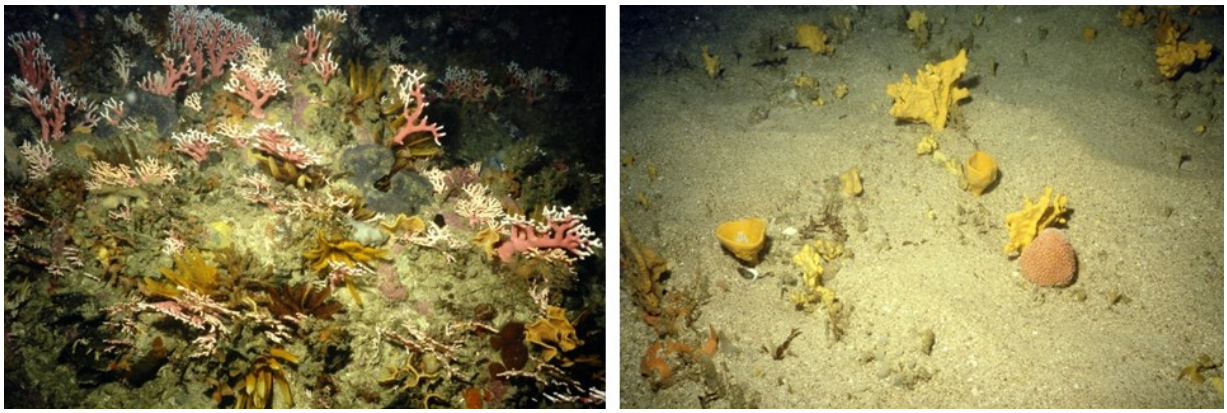

Figure 4-11: Offshore benthic communities occurring on reefs on the central Agulhas Bank include protected cold water porcelain coral Allopora nobilis, sponges, crinoids and bryozoans (left), whereas a variety of habitat-forming sponges, colonial ascidians and hydroids occur on sandy seabed (right) (Photos: Andrew Penney).

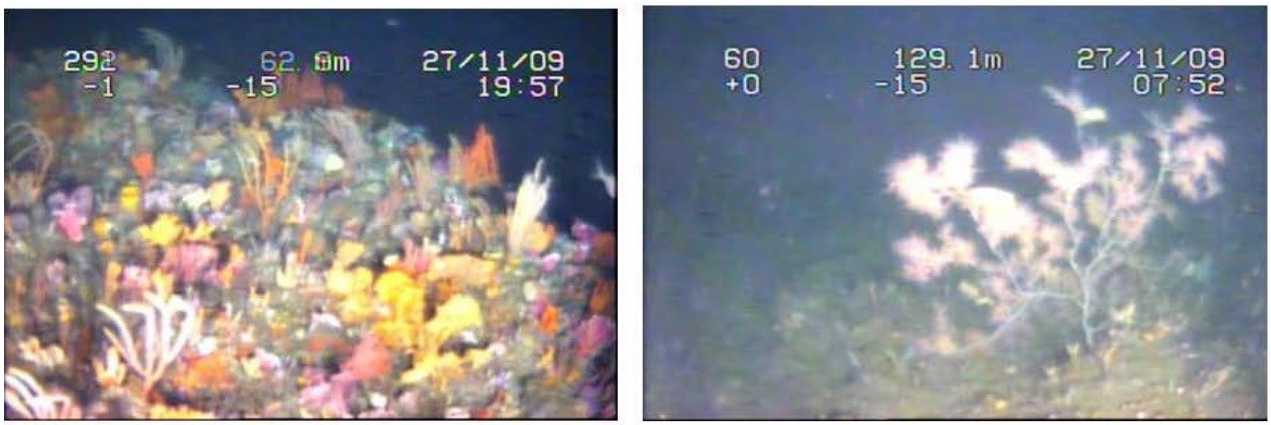

Figure 4-12: Vulnerable sponge- and soft coral–dominated biota at the Alphard Bank (left) and black coral at the 72-Mile Bank (right) (from Sink et al., 2010).

In the 68 – 75 m depth range of the 45-Mile Bank (60 and 100 m), the invertebrate fauna included large cup- and vase-shaped sponges (*Hemiasterella vasiformis*, *Suberites* sp. and *Axinella* spp.), Geodiid and stove-pipe sponges, black corals, gorgonians, alcyonarian soft corals and slow growing hydrocorals, as well as a diverse fish assemblage. The 110 to 140 m depth range of the 72-Mile Bank revealed a "mass occurrence" of the tubular sponge *Biemna anisotoxa*, as well as *Geodia* sp. *Geodia megastar*, *Pachastrella* sp., *Stelleta trisclera* and *Erylus* sp. Hard corals (*Balanophyllia* and *Caryophyllia*), black corals, hydrocorals and gorgonians (*Eunicella papillosa)* are also present, with high variability in terms of invertebrate diversity and abundance within the reef complex again being evident. Echinoderms included the urchin *Echinus gilchristi* and an unidentified conspicuous orange starfish. Broken bryozoans (*Reteporella* spp.) and solitary hard corals (*Caryophyllia* spp.) occurred at deeper depths.

Benthic epifaunal assemblages on unconsolidated sediments near the 45-Mile Bank were dominated by spiral whelk shells and various isolated sponges, bryozoans and/or soft corals, suggesting the area may be low profile reef inundated with a layer of sand. Unconsolidated sediments within Licence Block 9 (to the west of the licence area) and the frequently-trawled "Blues" area were dominated by the urchins (*Spatangus capensis*, *Brissopsis lyrifera capensis* and *Echinus gilchristi*), starfish (*Marthasterias glacialis, Toraster* sp.), sponges, spiral whelk shells, horsemussels, crabs (*Mursia cristiata, Gonoplax angulatus*), seapens, soft corals (possibly *Alcyonarium variable*) and burrowing tube anemones (*Cerianthus* sp.).

The benthic environment within the vicinity of the F-O Gas Field in Licence Block 9 is characterised by sandy unconsolidated sediment with several isolated rocky outcrops. Bioturbation at the sediment surface suggests a rich infaunal community. The rocky outcrops also support a diverse range of gorgonians, bryozoans and sponges. The combination of habitat types (soft sediments and rocky formations) results in a highly diverse benthic fauna.

In addition to the benthic invertebrates inhabiting deep reefs and unconsolidated sediments in the general study area, distinct communities have developed associated with petroleum infrastructure on the Agulhas Bank oil fields. The fouling assemblages are structured with depth; invertebrate communities in shallower water (0 - 30 m) resemble communities typical of rocky intertidal and shallow subtidal ecosystems in the region. In deeper water, however, there is only partial overlap with species recorded on deep reefs in the area, with sponges, soft corals, anemones and bryozoans associated with petroleum infrastructure being distinct from those of deep reef ecosystems. Furthermore, several areas of infrastructure were dominated by introduced taxa that are not representative of the indigenous biodiversity of the region.

Inshore of Licence Block 11B/12B, the Agulhas Inshore Reef and Agulhas Inshore Hard Ground benthic habitats lie at depths of between 5 m and 30 m, and have been identified by Sink *et al*. (2012a) as 'Critically endangered - Moderately protected', and 'Vulnerable - Moderately protected', respectively. These reefs and hard grounds extend from the Mbashe River (east of East London) to Cape Point (Figure 4-13). The reefs are considered to be warm temperate reefs, which have a more heterogeneous community structure when compared with those in the South-western Cape and Natal inshore regions.

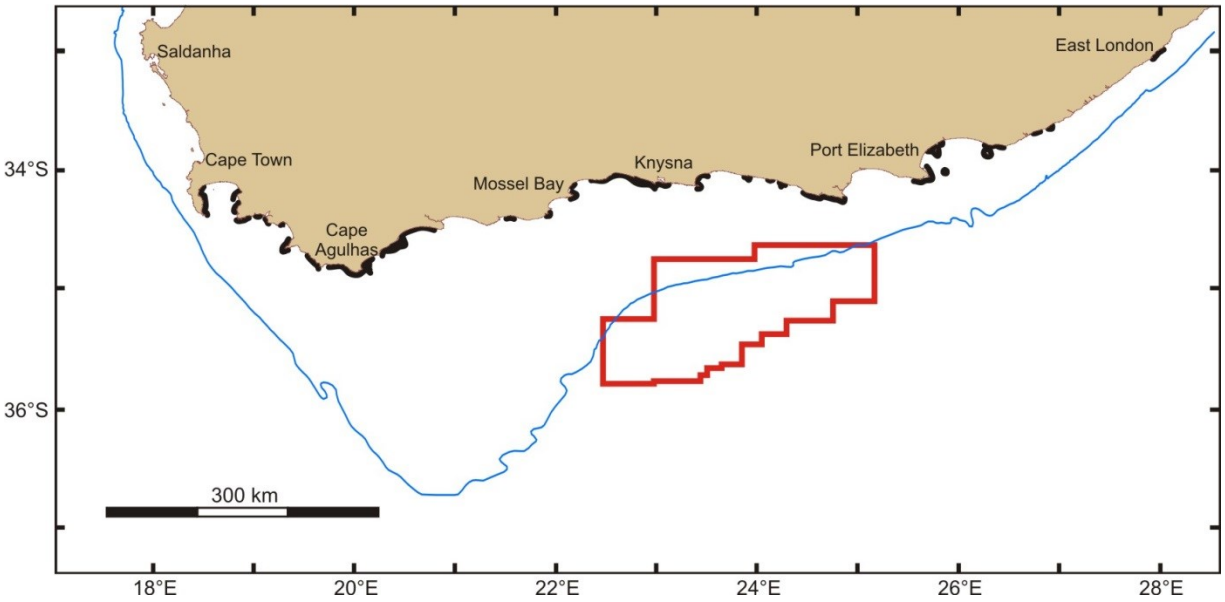

Figure 4-13: The extent of the Agulhas Inshore Reef and Hard Ground habitat types in relation to Licence Block11B/12B (adapted from Sink *et al*. 2012a).

Agulhas reefs are dominated by sponges (e.g. golf ball sponge *Tethya aurantium*, the black stink sponge *Ircinia arbuscula*, the orange teat sponge *Polymastia mamillaris* and *Clathria spp*.), ascidians (e.g. *Gynandrocarpa placenta*, *Sycozoa arborescens*, *Didemnum* sp., *Pycnoclavella narcissus*, and the endemic *Clavellina lepadiformis)*, bryozoans (e.g. *Schizoretepora tessellata*, *Laminopora jellyae* and *Gigantopora polymorpha*) and a variety of octocorals (noble coral *Stylaster nobilis,* the sunburst soft coral *Malacacanthus capensis*, cauliflower soft coral *Drifa thyrsoidea*, purple soft coral *Alcyonium fauri,* Valdivian soft coral *A. valdiviae*, and the Variable soft coral *A. variabile*). Large gorgonians are conspicuous on these reefs with key species including *Leptogorgia palma*, *Eunicella tricoronata, E.*

papillosa, E. albicans, and *Acabaria rubra.* Other important invertebrates include the red-chested sea cucumber *Pseudocnella insolens,* basketstars *Astroclades euryale*, featherstars *Comanthus wahlbergi* and *Tropiometra carinata*. Algal species include *Plocamium* spp., articulated corallines *Corallina* spp. and *Arthrocardia* spp., with the articulated coralline algae *Amphiroa ephedrae* being a dominant species in the shallow subtidal. Although abalone *Haliotis midae* were dominant space occupiers in shallow waters, poaching and overexploitation have severely depleted the population in their core habitat (Sink *et al.,* 2012a).

In the Port Elizabeth and Mossel Bay areas, inshore reefs to approximately 30 m depth show relatively distinct changes in community structure from those described above, being characterised by uniquely diverse reef assemblages dominated by cauliflower soft coral (Sink et al., 2012a). In particular, the islands in Algoa Bay form ecological distinct subtidal habitats, containing many endemic species of invertebrates and seaweeds.

The Agulhas Reefs and Hard Grounds have been identified as being sensitive to overfishing, pollution impacts, anchor damage and impacts associated with mariculture, mining and petroleum activities, with specific reef habitats being identified as 'endangered' and 'critically endangered' (as illustrated in Figure 4-9). Areas within the Robberg MPA, Goukamma MPA and south of Goukamma have been identified as key locations in which to increase reef protection along the South Coast. MPAs and other areas of protection are discussed in further detail in Section 4.5.5.3.

Information on offshore invertebrates occurring within the general study area is sparse. The more motile invertebrate fauna that occurs on the Agulhas Bank includes the squid (*Loligo vulgaris reynaudii*) and the rock lobster (*Palinurus gilchristi*).

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

The deep-water rock lobster occurs on rocky substrate in depths of 90 to 170 m between Cape Agulhas and southern KwaZulu-Natal. Larvae drift southwards in the Agulhas Current, settling in the south of the Agulhas Bank before migrating northwards again against the current to the adult grounds (Branch *et al*., 2010). Both juveniles and adults can thus be expected in the licence area. The species is fished commercially along the southern Cape Coast between the Agulhas Bank and East London, with the main fishing grounds being in the 100 to 200 m depth range south of Cape Agulhas on the Agulhas Bank, and off Cape St Francis, Cape Recife and Bird Island.

Other deep-water crustaceans that may occur inshore of the study area are the shovel-nosed crayfish (*Scyllarides elisabethae*) which occurs primarily on gravelly seabed at depths of around 150 m, although it is sometimes found in shallower water. Its distribution range extends from Cape Point to Maputo. Another rock lobster species occurring on the South Coast is the West Coast rock lobster (*Jasus lalandii*), which is typically associated with shallow-water reefs, although observations at depths of 120 m (Branch *et al*., 2010) have been recorded.

4.4.1.3. Fish

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

Marine fish can generally be divided in three different groups, pelagic (those species associated with water column), demersal (those associated with the substratum) 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.

(a) Pelagic species

Small pelagic shoaling species occurring along the South Coast include anchovy (*Engraulis encrasicolus*), pilchard (*Sardinops sagax*), round herring (*Etrumeus japonicas*), chub mackerel (*Scomber japonicas*) and horse mackerel (*Trachurus trachurus capensis*). Anchovies are usually located between the cool upwelling ridge and the Agulhas Current (Hutchings, 1994) and are larger than those of the West Coast. After spawning intensively in an area around the 200 m depth contour between Mossel Bay and Plettenberg Bay from October to January, most adults move inshore and eastwards ahead of warm Agulhas Current water. The Agulhas Bank area, however, is not considered an important anchovy recruitment ground (Hampton, 1992). Round herring juveniles similarly occur inshore along the South Coast, but move offshore with age (Roel *et al*., 1994; Hutchings, 1994).

Pilchards (or sardines) are typically found in water between 14°C and 20°C. Spawning occurs on the Agulhas Bank during spring and summer (Crawford, 1980), with recruits being found inshore along the South Coast (Hutchings, 1994). There is also recent evidence for winter (June-July) spawning of pilchards on the central Agulhas Bank in patches where high concentrations of phytoplankton occur (van der Lingen *et al*., 2006). It is thought that the Agulhas Bank may be a refuge for pilchard under low population levels and, therefore, vital for the persistence of the species (CCA & CSIR, 1998). During the winter months of June to August, the penetration of northerly-flowing cooler water along the Eastern Cape coast and up to southern KwaZulu-Natal effectively expands the suitable habitat available for this species, resulting in the movement of large shoals northwards along the coast in what has traditionally been known as the ‘sardine run’. The cool band of inshore water is critical to the ‘run’ as the sardines will either remain in the south or only move northwards further offshore if the inshore waters are above 20°C. The shoals can attain lengths of 20 to 30 km and are typically pursued by great white sharks, copper sharks, common dolphins, Cape gannets and various other large pelagic predators (www.sardinerun.co.za). Catch rates of several important species in the recreational shoreline fishery of KwaZulu-Natal have been shown to be associated with the timing of the sardine run (Fennessey *et al.,* 2010). Other pelagic species that migrate along the coast include elf (*Pomatomus saltatrix*), geelbek (*Atractoscion aequidens*), yellowtail (*Seriola lalandi*), kob (*Argyrosomus* sp) seventy-four (*Cymatoceps nasutus*), strepie (*Sarpa salpa*), Cape stumpnose (*Rhabdosargus holubi*) and mackerel (*Scomber japonicas*) (Van der Elst, 1988).

The fish most likely to be encountered on the shelf, beyond the shelf break and in the offshore waters of Licence Block 11B/12B 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 (see Table 4-2). 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.

The great white shark (*Carcharodon carcharias)* is a significant apex predator in the Algoa Bay area, particularly in the vicinity of the seal colony at Black Rocks. Although not necessarily threatened with extinction, great whites are listed in Appendix II (species in which trade must be controlled in order to avoid utilisation incompatible with their survival) of CITES (Convention on International Trade in Endangered Species) and is described as "vulnerable" in the IUCN Red listing. In response to global declines in abundance, great white sharks were legislatively protected in South Africa in 1991. Long-term catch-per-unit-effort data from protective gillnets in KwaZulu-Natal, however, suggest a 1.6% annual increase in capture rate of this species following protection, although high interannual variation in these data lessen the robustness of the trend (Dudley & Simpfendorfer, 2006).

Great white sharks migrate along the entire South African coast, typically being present at seal colonies during the winter months, but moving nearshore during summer (Johnson *et al.,* 2009). Recent research at Mossel Bay into the residency patterns of great white sharks revealed that male sharks display low site fidelity, often rapidly moving in and out of the area. Females in contrast, display high site fidelity and may remain resident in the area for up to two months (Koch & Johnson, 2006). Great white sharks are, however, capable of transoceanic migrations (Pardini *et al.,* 2001; Bonfil *et al*., 2005; Koch & Johnson, 2006), with recent electronic tag data suggesting links between widely separated populations in South Africa and Australia and possible natal homing behaviour in the species. Although during transoceanic migrations they appear to spend most of the time just below the sea surface, frequent deep dives to a much as 980 m are made whilst *en route*. Long-distance return migrations along the South African coast are also frequently undertaken, particularly by immature individuals (Bonfil *et al*., 2005). These coastal migrations are thought to represent feeding-related events.

Table 4-2: Some of the more important large migratory pelagic fish likely to occur in the offshore regions of the South Coast.

Common Name	Species	IUCN Conservation Status
Tunas		
Southern bluefin tuna	*Thunnus maccoyii*	Critically Endangered
Bigeye tuna	*Thunnus obesus*	Vulnerable
Longfin tuna/Albacore	*Thunnus alalunga*	Near Threatened
Yellowfin tuna	*Thunnus albacares*	Near Threatened
Frigate tuna	*Auxis thazard*	Least concern
Eastern Little tuna/Kawakawa	*Euthynnus affinis*	Least concern
Skipjack tuna	*Katsuwonus pelamis*	Least concern
Billfish		
Blue marlin	*Makaira nigricans*	Vulnerable
Striped marlin	*Kajikia audax*	Near Threatened
Sailfish	*Istiophorus platypterus*	Least concern
Swordfish	*Xiphias gladius*	Least concern
Black marlin	*Istiompax indica*	Data deficient
Pelagic Sharks		
Great hammerhead shark	*Sphyrna mokarran*	Endangered
Smooth hammerhead shark	*Sphyrna zygaena*	Vulnerable
Pelagic thresher shark	*Alopias pelagicus*	Vulnerable
Bigeye thresher shark	*Alopias superciliosus*	Vulnerable
Common thresher shark	*Alopias vulpinus*	Vulnerable

Common Name	Species	IUCN Conservation Status
Dusky shark	*Carcharhinus obscurus*	Vulnerable
Great white shark	*Carcharodon carcharias*	Vulnerable
Shortfin mako	*Isurus oxyrinchus*	Vulnerable
Longfin mako	*Isurus paucus*	Vulnerable
Whale shark	*Rhincodon typus*	Vulnerable
Blue shark	*Prionace glauca*	Near Threatened

(b) Demersal species

There is a high diversity of Teleosts (bony fish) and Chondrichthyans (cartilaginous fish) associated with the inshore and shelf waters off the South Coast, many of which are endemic to the Southern African coastline and form an important component of the demersal trawl and long-line fisheries.

The Cape hake (*Merluccius capensis*) is distributed widely on the Agulhas Bank, while the deep-water hake (*Merluccius paradoxus*) is found further offshore in deeper water (Boyd *et al*., 1992; Hutchings, 1994). The nursery grounds for both species are located off the West Coast and fish move southwards onto the Agulhas Bank as they grow. Juveniles of both species occur throughout the water column in shallower water than the adults. Kingklip (*Genypterus capensis*) is also an important demersal species, with adults distributed in deeper waters along the whole of the South Coast, especially on rocky substrate (Japp *et al*., 1994). They are reported to spawn in an isolated area beyond the 200 m isobaths between Cape St Francis and Port Elizabeth, in the north-eastern portion of Licence Block 11B/12B during spring (see Figure 4-10). Juveniles occur further inshore along the entire South Coast. The Agulhas or East Coast sole (*Austroglossus pectoralis*) inhabits inshore muddy seabed (<125 m) on the shelf between Cape Agulhas and Algoa Bay (Boyd *et al*., 1992). Apart from the above-mentioned target species, numerous other by-catch species are landed by the South Coast demersal trawling fishery including panga (*Pterogymnus laniarius)*, kob (*Argyrosomus hololepidotus*), gurnard (*Chelidonichthyes* spp.), monkfish (*Lophius* sp.), john dory (*Zeus capensis*) and angel fish (*Brama brama*).

The shallower inshore areas (<100 m) along the South Coast comprise a varied habitat of rocky reefs and soft-bottom substrates, which support a high diversity of endemic sparid and other teleost species (Smale *et al*., 1994), some of which move into inshore protected bays to spawn (Buxton, 1990) or undertake spawning migrations eastwards up the coast. Those species that undertake migrations along the South Coast include red steenbras, white steenbras (summer), kob, geelbek and elf (winter). Spawning of the majority of species endemic to the area occurs in spring and summer. Many of these species, as well as numerous pelagic species that frequent nearshore waters, are targeted by line-fishermen and form an important component of the commercial and recreational linefishery (see Table 4-3).

Table 4-3: Some of the more important demersal and pelagic linefish species landed by commercial and recreational boat fishers and shore anglers along the South Coast (adapted from CCA & CMS, 2001).

Common name	Scientific name	Common name	Scientific name
Demersal teleosts			
Bank steenbras	Chirodactylus grandis	Red steenbras	*Petrus rupestris*
Belman	*Umbrina canariensis*	Red stumpnose	*Chrysoblephus gibbiceps*
Blacktail	*Diplodus sargus*	River bream	*Acanthopagrus berda*
Blue hottentot	*Pachymetopon aeneum*	Rockcod	*Epinephalus spp.*
Bronze bream	*Pachymetopon grande*	Sand steenbras	*Lithognathus mormyrus*
Cape stumpnose	*Rhabdosargus holubi*	Santer	*Cheimerius nufar*
Carpenter	*Argyrozona argyrozona*	Scotsman	*Polysteganus praeorbitalis*

Common name	Scientific name	Common name	Scientific name
Dageraad	*Chrysoblephus christiceps*	Seventyfour	*Polysteganus undulosus*
Englishman	*Chrysoblephus anglicus*	Slinger	*Chrysoblephus puniceus*
Fransmadam	*Boopsoidea inornata*	Snapper salmon	*Otolithes ruber*
Galjoen	*Dichistius capensis*	Spotted grunter	*Pomadasys commersonnii*
Grey chub	*Kyphosus biggibus*	Squaretail kob	*Argyrosomus thorpei*
Kob	*Argyrosomus hololepidotus*	Steentjie	*Spondyliosoma emarginatum*
Mini kob	*Johnius dussumieri*	Strepie	*Sarpa salpa*
Musselcracker	*Sparodon durbanensis*	White steenbras	*Lithognathus lithognathus*
Natal stumpnose	*Rhabdosargus sarba*	White stumpnose	*Rhabdosargus globiceps*
Poenskop	*Cymatoceps nasutus*	Wreckfish	*Polyprion americanus*
Pompano	*Trachinotus africanus*	Zebra	*Diplodus cervinus*
Red roman	*Chrysoblephus laticeps*		
Pelagic teleosts			
Elf	*Pomatomus saltatrix*	Queenfish	*Scomberoides commersonianus*
Garrick/leerfish	*Lichia amia*	Queen mackerel	*Scomberomorus plurilineatus*
Geelbek	*Atractoscion aequidens*	Tenpounder	*Elops machnata*
Green jobfish	*Aprion virescens*	Wahoo	*Acanthocybium solandri*
King mackerel	*Scomberomorus commerson*	Yellowtail	*Seriola lalandi*
Kingfish species	*Caranx* spp.		

Furthermore, a wide variety of chondrichthyans occur in nearshore waters of the South Coast (see Table 4-4), some of which, such as St Joseph shark (*Callorhincus capensis*), Soupfin shark (*Galeorhinus galeus*) and Biscuit skate (*Raja straeleni*), are also landed by the trawl and line fishery.

Table 4-4: Some of the chondrichthyan species occurring along the South Coast (adapted from CCA & CMS, 2001).

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

4.4.1.4. Turtles

Three species of turtle occur along the South Coast, namely the leatherback (*Dermochelys coriacea*), the loggerhead (*Caretta caretta*) and occasionally the green (*Chelonia mydas*) turtle.

- Leatherback turtles (Critically Endangered) inhabit the deeper waters of the Atlantic Ocean and are considered a pelagic species. They travel the ocean currents in search of their prey (primarily jellyfish) and may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al*., 2004; Lambardi *et al*., 2008). They come into coastal bays and estuaries to mate and lay their eggs on the adjacent beaches.
- Loggerhead turtles (Endangered) tend to keep more inshore, hunting around reefs, bays and rocky estuaries along the East Coast of Africa, where they feed on a variety of benthic fauna including

crabs, shrimp, sponges and fish. In the open sea their diet includes jellyfish, flying fish and squid (www.oceansafrica.com/turtles.htm).

- The green turtle (Endangered) is a non-breeding resident often found feeding on inshore reefs.

Both the leatherback and the loggerhead turtle nest on the beaches of north-east KwaZulu-Natal and southern Mozambique during the summer months. These loggerhead and leatherback nesting populations are the southern-most in the world (Nel *et al*., 2013). Even though these populations are smaller (in nesting numbers) than most other populations, they are genetically unique (Dutton *et al*., 1999; Shamblin *et al*., submitted) and thus globally important populations in terms of conservation of these species.

Loggerhead and leatherback females come ashore to nest from mid-October to mid-January each year. The eggs incubate for two months and hatchlings emerge from their nests from mid-January to mid-March. The mean hatching success for loggerheads (73 %) and leatherbacks (76 %) on the South African nesting beaches (de Wet, 2013) is higher than reported at other nesting sites globally. Those hatchlings that successfully escape predation on their route to the sea, enter the surf and are carried approximately 10 km offshore by coastal rip currents to the Agulhas Current (Hughes, 1974b). As hatchlings are not powerful swimmers they drift southwards in the current. During their first year at sea, the post-hatchlings feed on planktonic prey items (Hughes, 1974a), with their activities largely remaining unknown (Hughes, 1974a). After approximately 10 years, juvenile loggerheads return to coastal areas to feed on crustaceans, fish and molluscs and subsequently remain in these neritic habitats (Hughes, 1974b). In contrast, leatherbacks remain in pelagic waters until they become sexually mature and return to coastal regions to breed. Loggerheads reach sexual maturity at about 36 years of age whereas leatherbacks reach maturity sooner, at approximately 15 years (Tucek *et al*., submitted). It has been estimated that only one to five hatchlings survive to adulthood (Hughes, 1974b; de Wet, 2013).

Female loggerhead and leatherback turtles, however, do not nest every year due to the high energetic costs of reproduction (Wallace & Jones, 2008). During this remigration interval they travel thousands of kilometres (particularly leatherbacks) with ocean currents in search of foraging grounds (Luschi *et al*., 2003a; Luschi *et al*., 2003b). Turtles marked with titanium flipper tags have revealed that South African loggerheads and leatherbacks have a remigration interval of 2 – 3 years, migrating to foraging grounds throughout the South Western Indian Ocean (SWIO), as well as in the eastern Atlantic Ocean. They follow different post-nesting migration routes (Hughes *et al*., 1998; Luschi *et al*., 2006), with loggerheads preferring to stay inshore whilst travelling northwards to foraging grounds along the southern Mozambican coastline or crossing the Mozambique Channel to forage in the waters off Madagascar (see Figure 4-14).

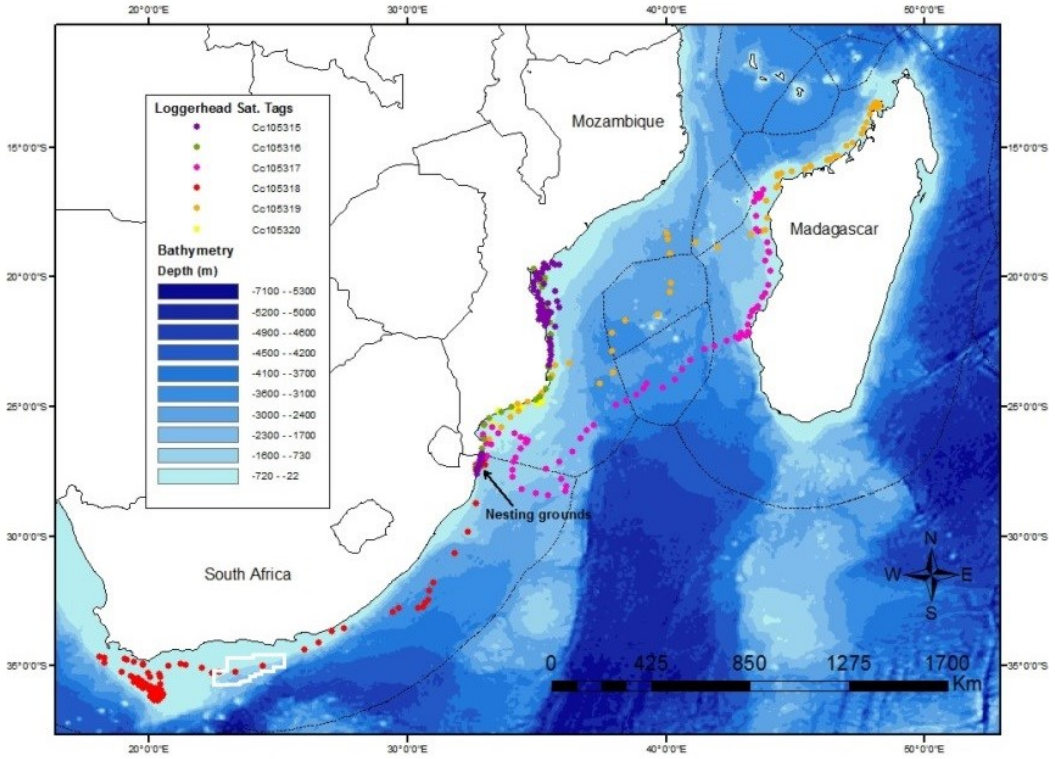

Figure 4-14: Spatial distribution of satellite tagged loggerhead females (2011/2012; Oceans and Coast, unpublished data) in relation to Block 11B/12B (white polygon).

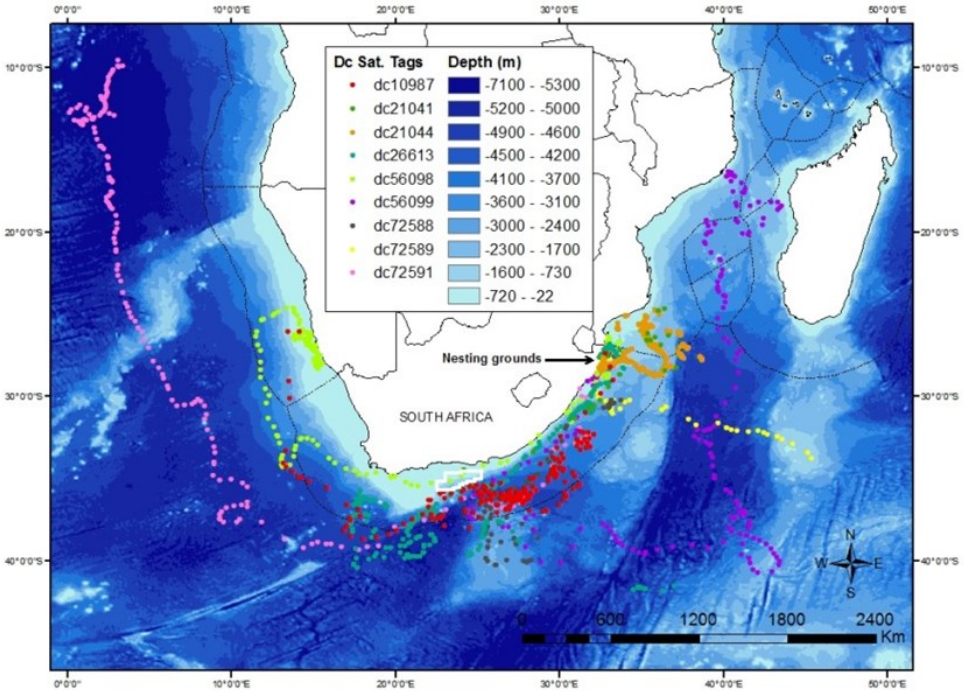

Figure 4-15: The post-nesting distribution of nine satellite tagged leatherback females (1996 – 2006; Oceans and Coast, unpublished data) in relation to Licence Block 11B/12B (white polygon).

In contrast, leatherbacks move south with the Agulhas Current to deeper water in high-sea regions to forage (Hughes et al., 1998; Luschi *et al*., 2003b; Luschi *et al*., 2006), with some individuals following the Benguela Current along the West Coast of South Africa, as far north as central Angola as illustrated in Figure 4-15 (de Wet, 2013). Both species are likely to be encountered in Licence Block 11B/12B. Green

turtles nest primarily on the along the coast of Mozambique as well as on Europa and Tromelin Islands (Lauret-Stepler *et al.*, 2007).

4.4.1.5. Seabirds

South Coast seabirds can be separated into three categories: 'breeding resident species', 'non-breeding migrant species' and 'rare vagrants' (Shaughnessy, 1977; Harrison, 1978; Liversidge & Le Gras, 1981; Ryan & Rose, 1989). Overall, 60 species are known, or thought likely to occur, along the South Coast. Fifteen species breed within the South Coast region (see Table 4-5), including Cape gannets, African penguins, Cape cormorants, white-breasted cormorants, roseate terns, damara terns, swift terns and kelp gulls. Recent changes in bird populations in the South Coast region include eastward extensions of the breeding range of Hartlaub's gull (*Larus hartlaubii*) and crowned cormorant (*Phalacrocorax coronatus*) and the development of a new African penguin (*Spheniscus demersus*) colony in the De Hoop Reserve east of Cape Agulhas (van der Lingen *et al*. 2006).

On the Agulhas Bank seabirds at times intensively target shoals of pelagic fish. Small pelagic species such as anchovy and pilchard form important prey items for Agulhas Bank seabirds, particularly the Cape gannet, the African penguin and the various cormorant species. Most of the breeding resident seabird species feed on fish (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). Feeding strategies include surface plunging (gannets and terns), pursuit diving (cormorants and penguins) and scavenging and surface seizing (gulls). All these species feed relatively close inshore, although gannets and kelp gulls may feed as far as 100 km offshore. Increases in numbers of breeding pairs of kelp gull (*L. dominicanus*), crowned cormorant, swift terns (*Sterna bergii*), and Cape gannet (*Morus capensis*) at eastern colonies have been observed in response to the eastward shift of sardines, however, no increase in breeding pairs of African penguins at eastern colonies has been reported (van der Lingen *et al*., 2006).

African penguin colonies along the South Coast occur at Dyer Island, Cape Recife and on the Algoa Bay islands (St Croix Island, Jaheel Island, Bird Island, Seal Island, Stag Island and Brenton Rocks). The African penguin forages at sea with most birds being found within 20 km of the coast. The majority of Algoa Bay penguins forage to the south of Cape Recife and thus inshore of Licence Block 11B/12B. African penguins mainly consume pelagic shoaling fish species such as anchovy, round herring, horse mackerel and pilchard, and their distribution is consistent with that of the pelagic shoaling fish, which occur within the 200 m isobath.

Table 4-5: Breeding resident seabirds present along the South Coast and their conservation status (adapted from CCA & CMS, 2001).

Common name	Scientific name	Conservation status
African black oystercatcher	*Haematopus moquini*	Near Threatened
African penguin	*Spheniscus demersus*	Endangered
Great cormorant	*Phalacrocorax carbo*	Least Concern
Cape cormorant	*Phalacrocorax capensis*	Near Threatened
Bank cormorant	*Phalacrocorax neglectus*	Endangered
Crowned cormorant	*Phalacrocorax coronatus*	Least Concern
White-breasted cormorant	*Phalacrocorax lucidus*	Not assessed
Cape gannet	*Morus capensis*	Vulnerable
Kelp gull	*Larus dominicanus*	Least Concern
Greyheaded gull	*Larus cirrocephalus*	Least Concern
Hartlaub's gull	*Larus hartlaubii*	Least Concern
Caspian tern	*Sterna caspia*	Vulnerable

Common name	Scientific name	Conservation status
Swift tern	*Sterna bergii*	Least Concern
Roseate tern	*Sterna dougalii*	Least Concern
Damara tern	*Sterna balaenarum*	Near Threatened

4.4.1.6. Marine mammals

The marine mammal fauna occurring off the South Coast of South Africa include cetaceans (whales and dolphins) and seals.

(a) Cetaceans

Thirty-four species of whales and dolphins are known (based on historic sightings or strandings) or likely (based on habitat projections of known species parameters) to occur in the waters of the South Coast (see Table 4-6) (Findlay 1989; Findlay *et al*., 1992; Ross, 1984; Peddemors, 1999). Of the 34 species listed, three are 'Endangered' and one is considered 'Vulnerable' (IUCN Red Data List Categories). Nineteen 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 mostly dating from the 1960s. Information on smaller cetaceans in deeper waters is particularly poor.

The distribution of whales and dolphins on the South Coast can largely be split into those associated with the continental shelf and those that occur in deep, oceanic waters. Species from both environments may, however, be found associated with the shelf (200 - 1 000 m), making this the most species-rich area for cetaceans. Cetacean density on the continental shelf is usually higher than in pelagic waters as species associated with the pelagic environment tend to be wide-ranging across thousands of kilometers.

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

<u>Mysticete (Baleen) whales</u>
Mysticete cetaceans occurring in the study area include the southern right, humpback, blue, fin, sei, minke, dwarf minke, Bryde's and pygmy right. Most of these species occur in pelagic waters, with only occasional visits into shelf waters. Humpbacks and southern rights, however, are likely to be encountered frequently inshore during winter months. All of these species show some degree of migration either to, or through, the study area when *en route* between higher-latitude feeding grounds (Antarctic or Subantarctic) and lower-latitude breeding grounds. Depending on the ultimate location of these feeding and breeding grounds, seasonality off South Africa can be either unimodal (usually in June-August, e.g. minke and blue whales) or bimodal (usually May-July and October-November, e.g. fin whales), reflecting a northward and southward migration through the area. As whales follow geographic or oceanographic features, the northward and southward migrations may take place at difference distances from the coast, thereby influencing the seasonality of occurrence at different locations. Due to the complexities of the migration patterns, each species is discussed in further detail below.

- The most abundant baleen whales off the coast of South Africa are southern right and humpback whales.

Southern right whales (listed as Least Concern) migrate to the southern African subcontinent to breed and calve, where they tend to have an extremely coastal distribution mainly in sheltered bays (90% <2 km from shore; Best, 1990, Elwen & Best, 2004). Winter concentrations have been recorded all along the South and East Coasts of South Africa as far north as Maputo Bay, with the most significant concentration currently on the South Coast between Cape Town and Port Elizabeth. They typically arrive in coastal waters off the South Coast between June and November each year, although animals may be sighted as early as April and as late as January. While in local waters, southern rights are found in groups of 1 to 10 individuals, with cow-calf pairs predominating in inshore nursery areas. From July to October, animals aggregate and become involved in surface-active groups, which can persist for several hours. 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). When the population numbers crashed, the range contracted down to just the South Coast of South Africa, but as the population recovers, it is repopulating its historic grounds including Mozambique (Banks *et al.,* 2011) and Namibia (Roux *et al.,* 2011). The most recent abundance estimate for this population is available for 2008 which estimated the population at approximately 4 600 individuals including all age and sex classes, which is thought to be at least 23% of the original population size (Brandaõ *et al.,* 2011). Given that the population continues to grow at approximately 7% per year (Brandaõ *et al.,* 2011), the 2013 population would number more than 6 000 individuals.

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

- Blue whales (listed as Endangered) were historically caught in high numbers off Durban, showing a single peak in catches in June/July. Sightings of the species in the area between 1968 and 1975 were rare and concentrated in March to May (Branch *et al*., 2007) and only from far offshore (40-60 nautical miles (nm)). However, scientific search effort (and thus information) in pelagic waters is very low. The chance of encountering the species in the licence area is considered low.

- Fin whales (listed as Endangered) were historically caught off the East Coast of South Africa, with a unimodal winter (June-July) peak in catches off Durban. However, as northward moving whales were still observed as late as August/September, it is thought that the return migration may occur further offshore. The location of their winter breeding grounds remains a mystery (Best, 2007).

Some juvenile animals may feed year round in deeper waters off the shelf (Best, 2007). There are no recent data on abundance or distribution of fin whales off Southern Africa.

- Sei whales (listed as Endangered) migrate through South African waters, where they were historically hunted in relatively high numbers, to unknown breeding grounds further north. Their migration pattern shows a bimodal peak with numbers on the East Coast highest in June (on the northward migration) and with a second larger peak in September. All whales were caught in waters deeper than 200 m, with most deeper than 1 000 m (Best & Lockyer, 2002). Almost all information is based on whaling records (1958-1963) and there is no current information on abundance or distribution patterns in the region.

- Antarctic minke whales (listed as Data Deficient) range from the pack ice of Antarctica to tropical waters and are usually seen more than approximately 50 km offshore. Although adults of the species do migrate from the Southern Ocean (summer) to tropical/temperate waters (winter) where they are thought to breed, some animals, especially juveniles, are known to stay in tropical/temperate waters year round. Off Durban, Antarctic minke whales were reported to increase in numbers in April and May, remaining at high levels through June to August and peaking in September (Best, 2007). The dwarf minke whale (listed as Least Concern) has a more temperate distribution than the Antarctic minke and they do not range further south than 60-65°S. Dwarf minke whales have a similar migration pattern to Antarctic minkes with at least some animals migrating to the Southern Ocean in summer months. Dwarf minke whales occur closer to shore than Antarctic minkes and have been seen <2 km from shore on several occasions around South Africa, particularly on the East Coast during the 'sardine run' (O'Donoghue *et al*., 2010a, 2010b, 2010c). Historic whaling records indicate that off Durban they were taken mainly between April and June. Both species are generally solitary and densities in Licence Block 11B/12B are likely to be low.

- Two genetically and morphologically distinct populations of Bryde's whales live off the coast of southern Africa - a larger pelagic form described as *Balaenoptera brydei*, and a smaller neritic form (of which the taxonomic status is uncertain, but is included by Best (2007) with the *B. brydei* of the subregion). The "inshore population" is unique amongst baleen whales in the region by being resident year round on the continental shelf and Agulhas Bank ranging from approximately Durban in the east to at least St Helena Bay off the West Coast. Sightings over the last two decades suggest that its distribution may be shifting eastwards (Best, 2001, 2007; Best et al., 1984). This is a small population, which may be decreasing in size (Penry, 2010) suggesting that it is unlikely to be frequently encountered in the licence area. 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 abundances highest during summer (January – March). The offshore form is unlikely to be encountered off the South Coast.

- The smallest of the baleen whales, the pygmy right whale occurs along the southern African East Coast to as far north as 30°S. There are no data on the abundance or conservation status of this species, although it was not subjected to commercial whaling so the population is expected to be near to original numbers. Sightings of this species at sea are rare (Best, 2007) due in part to their small size and inconspicuous blows. Density in the licence area is likely to be low.

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

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader study area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site specific to oceanic and wide

ranging. Those in the region can range in size from 1.9 m long (Spinner dolphin) to 17 m (bull sperm whale).

Sperm whales are the largest of the toothed whales and have a complex, well-structured social system with adult males behaving differently from younger males and female groups. They live in deep ocean waters usually >1 000 m, occasionally coming into depths of 200 to 500 m on the shelf (Best, 2007). Seasonality of catches off the East Coast suggest that medium- and large-sized males are more abundant during winter (June-August), while female groups are more abundant in summer (December-February), although animals occur year round (Best, 2007). Sperm whales feed at great depth, during dives in excess of 30 minutes, making them difficult to detect visually. The regular echolocation clicks made by the species when diving, however, make them relatively easy to detect acoustically using Passive Acoustic Monitoring (PAM). Although considered relatively abundant worldwide (Whitehead, 2002), no current data are available on density or abundance of sperm whales in African waters. All information about sperm whales in the southern African subregion results from data collected during commercial whaling activities prior to 1985 (Best, 2007).

There are almost no data available on the abundance, distribution or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters off the shelf of South and East Coasts of South Africa. Beaked whales are all considered to be true deep water species usually being seen in waters in excess of 1 000 – 2 000 m depth (Best, 2007). Their presence in the area may fluctuate seasonally, but insufficient data exists to define this clearly.

The genus *Kogia* currently contains two recognised species, the pygmy (*K. breviceps*) and dwarf (*K. sima*) sperm whales. 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 most frequently occur in pelagic and shelf edge waters and are thus likely to occur in the licence area at low levels; seasonality is unknown. Dwarf sperm whales are associated with warmer tropical and warm-temperate waters, however, abundance in the licence area is likely to be very low.

Killer whales have a circum-global distribution being found in all oceans from the equator to the ice edge (Best, 2007). Killer whales occur year round in low densities off the South African coast (Best *et al.,* 2010) and are known to occur in all depths from the coast to deep open ocean environments. As such, killer whales may be encountered at low levels in Licence Block 11B/12B. Although the false killer whale is globally recognised 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). The species has a tropical to temperate distribution and most sightings off southern Africa have occurred in water deeper than 1 000 m (although a few sightings have also been made close to shore) (Findlay *et al*., 1992). False killer whales usually occur in groups ranging in size from 1-100 animals (mean 20.2) (Best, 2007), and are thus likely to be fairly easily seen in most weather conditions. However, 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, between St Helena Bay and Cape Agulhas). There is no information on population numbers or conservation status and no evidence of seasonality in the region (Best, 2007).

Long-finned pilot whales display a preference for temperate waters and are usually associated with the continental shelf or deep water adjacent to it (Mate *et al.,* 2005; Findlay *et al.,* 1992; Weir, 2011). They are regularly seen associated with the shelf edge by marine mammal observers (MMOs) and fisheries

observers and researchers 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 the vast majority of pilot whales encountered in Licence Block 11B/12B will be long-finned. However, due to the influence of the Agulhas Current in the area, the occurrence of short-finned pilot whales cannot be excluded. Pilot whales are likely to be among the most commonly encountered odontocetes in the licence area.

Two species of bottlenose dolphins occur around southern Africa, the smaller Indo-Pacific bottlenose dolphin (*aduncus* form) which occurs exclusively to the east of Cape Point in water usually less than 30 m deep and generally within 1 km of the shore (Ross, 1984), and the larger common bottlenose dolphin (*truncatus* form) which on the South Coast occurs further offshore. Their distribution is essentially continuous from Cape Agulhas eastwards to southern Mozambique, although along the KZN coast the Indo-Pacific bottlenose dolphins seem to have 'preferred areas' (Ross *et al*., 1987; Cockcroft *et al*., 1990, 1991). The areas in which they are more frequently encountered are about 30 km apart, and are thought to correspond to discrete home ranges within a resident population occurring along the KZN coast. There are also seasonal movements of a genetically distinct 'migratory stock' of Indo-Pacific bottlenose dolphins along the South and East Coasts in association with the 'sardine run' (Natoli *et al*., 2008). Although listed as 'Data deficient' in the IUCN Red Data book, the *aduncus* form in general is listed as 'Vulnerable' in the South African Red Data Book, while the migratory subpopulation is considered 'Endangered' (Peddemors & Oosthuizen, 2004). Little is known about the offshore form of the species, and nothing about their population size or conservation status. They sometimes occur in association with other species such as pilot whales or false killer whales (Best, 2007) and are likely to be present year round in waters deeper than 200 m.

Two species of common dolphin are currently recognised, the short-beaked common dolphin (*Delphinus delphis*) and the long-beaked common dolphin (*D. capensis*). Although common dolphins occur world-wide in warm-temperate and tropical waters, off South Africa the short-beaked dolphin appears to prefer offshore habitats, whereas the long-beaked species seems to be distributed as a series of disjunct populations in nearshore waters <500 m deep. During winter they migrate from the Eastern Cape into KZN waters following the 'sardine run' (Cockcroft & Peddemors, 1990; O'Donoghue *et al*., 2010a, 2010b, 2010c). In 1988/89 the population of long-beaked common dolphins between Port Elizabeth and Richard's Bay was estimated at 15 000 – 20 000 animals, although this is thought to be an underestimate. The species most likely to be encountered in the licence area is the short-beaked common dolphin, but estimates of the population size and seasonality for the subregion is lacking.

The Indo-Pacific humpback dolphin has a more or less continuous distribution from Danger Point in the Western Cape to Mozambique, Tanzania, Kenya, the Comoros Islands and the western coast of Madagascar. It is primarily a shallow-water species restricted to <50 m depth. Localised populations in the Plettenberg Bay - Algoa Bay region are concentrated around shallow reefs. Seasonal movements and migrations are not characteristic of the species, but in Algoa Bay sightings rate and group size appears to increase between January and April, and again in September. This was accompanied by an apparent influx of previously unidentified individuals into the bay. In Algoa Bay the population was estimated at 466 individuals of all age groups, with modelled population growth estimated to vary between -3% and 2% annually. The population for South Africa numbers no more than 1 000 individuals. There is considerable concern over the future of this species in the subregion resulting in it being listed as 'Vulnerable' in the South African Red Data Book (Peddemors *et al*., 2004), but 'Data deficient' by the IUCN. Encounters with this species in Licence Block 11B/12B are likely to be very low.

Several other species of dolphins that might occur in the deeper waters of licence area at low levels include the pygmy killer whale, Risso's dolphin, Fraser's 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 licence area but encounters would likely be rare.

Beaked whales were never targeted commercially and their pelagic distribution means they are 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). The beaked whales that may be encountered in the licence 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 difficult to detect visually. Beaked whales are particularly vulnerable to certain types of man-made noise, such as mid-frequency naval sonar. The exact reason for this sensitivity is not yet fully understood, but necropsy of stranded animals has revealed gas embolisms and haemorrhage in the brain, ears and acoustic fat - injuries consistent with decompression sickness (acoustically mediated bubble formation may also play a role) (Fernadez *et al.,* 2005).

(b) Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) is the only seal species that has breeding colonies along the South Coast, namely at Seal Island in Mossel Bay, on the northern shore of the Robberg Peninsula in Plettenberg Bay and at Black Rocks (Bird Island group) in Algoa Bay.

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

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

While the Cape fur seal was historically exploited for its luxurious pelt, subsequent protection of the species has resulted in recovery of the populations and as such, the species is currently not regarded as threatened.

Table 4-6: Cetacean occurrence off the South Coast of South Africa, their seasonality and likely encounter frequency and conservation status (adapted from S.Elwen, Mammal Research Institute, pers.comm, Best, 2007).

Common Name	Species	Shelf (<200 m)	Offshore (>200 m)	Seasonality (note: letters refer to months of the year)	Likely encounter freq.	IUCN Conservation Status
Delphinids						
Common bottlenose dolphin	*Tursiops truncatus*	Yes	Yes	Year round	Monthly	Least Concern
Indo-Pacific bottlenose dolphin	*Tursiops aduncus*	Yes		Year round	Monthly	Data Deficient
Common (short beaked) dolphin	*Delphinus delphis*	Yes	Yes	Year round	Monthly	Least Concern
Common (long beaked) dolphin	*Delphinus capensis*	Yes		Year round	Monthly	Data Deficient
Fraser's dolphin	*Lagenodelphis hosei*		Yes	Year round	Occasional	Least Concern
Spotted dolphin	*Stenella attenuata*	Yes	Yes	Year round	Occasional	Least Concern
Striped dolphin	*Stenella coeruleoalba*		Yes	Year round	Occasional	Least Concern
Indo-Pacific humpback dolphin	*Sousa chinensis*	Yes		Year round	Monthly	Near Threatened
Long-finned pilot whale	*Globicephala melas*		Yes	Year round	<Weekly	Data Deficient
Short-finned pilot whale	*Globicephala macrorhynchus*		Yes	Year round	<Weekly	Data Deficient
Killer whale	*Orcinus orca*	Occasional	Yes	Year round	Occasional	Data Deficient
False killer whale	*Pseudorca crassidens*	Occasional	Yes	Year round	Monthly	Data Deficient
Risso's dolphin	*Grampus griseus*	Yes (edge)	Yes	Year round	Occasional	Data Deficient
Pygmy killer whale	*Feresa attenuata*		Yes	Year round	Occasional	Least Concern
Sperm whales						
Pygmy sperm whale	*Kogia breviceps*		Yes	Year round	Occasional	Data Deficient
Dwarf sperm whale	*Kogia sima*		Yes	Year round	Occasional	Data Deficient
Sperm whale	*Physeter macrocephalus*		Yes	Year round	Occasional	Vulnerable
Beaked whales						
Cuvier's	*Ziphius cavirostris*		Yes	Year round	Occasional	Least Concern
Arnoux's	*Beradius arnouxii*		Yes	Year round	Occasional	Data Deficient
Southern bottlenose	*Hyperoodon planifrons*		Yes	Year round	Occasional	Not assessed
Hector's	*Mesoplodon hectori*		Yes	Year round	Occasional	Data Deficient
Layard's	*Mesoplodon layardii*		Yes	Year round	Occasional	Data Deficient
True's	*Mesoplodon mirus*		Yes	Year round	Occasional	Data Deficient
Gray's	*Mesoplodon grayi*		Yes	Year round	Occasional	Data Deficient
Blainville's	*Mesoplodon densirostris*		Yes	Year round	Occasional	Data Deficient

Table 4-6 cont.

Common Name	Species	Shelf (<200 m)	Offshore (>200 m)	Seasonality (note: letters refer to months of the year)	Likely encounter freq.	IUCN Conservation Status
Baleen whales						
Minke	*Balaenoptera bonaerensis*	Yes	Yes	>Winter	Monthly	Data Deficient
Dwarf minke	*B. acutorostrata*	Yes		Year round	Occasional	Least Concern
Fin whale	*B. physalus*		Yes	MJJ & ON, rarely in summer	Occasional	Endangered
Blue whale	*B. musculus*		Yes	MJJ	Occasional	Endangered
Sei whale	*B. borealis*		Yes	MJ & ASO	Occasional	Endangered
Bryde's (inshore)	*B brydei (subspp)*		Yes	Year round	Occasional	Data Deficient
Pygmy right	*Caperea marginata*	Yes		Year round	Occasional	Least Concern
Humpback	*Megaptera novaeangliae*	Yes	Yes	AMJJASOND	Daily	Least Concern
Southern right	*Eubalaena australis*	Yes		JJASON	Daily	Least Concern

4.4.2 NEAR-SHORE REGION

As is typical of the South African near-shore region exposed rocky shores and sandy beaches dominate the South Coast.

The last coastal sensitivity map for the South African coastline was compiled by Jackson & Lipschitz (1984). An updated sensitivity atlas is currently being established by the Department of Environmental Affairs. This will take the form of a website with customisable GIS layers including natural resources, ecosystem infrastructure and services, human infrastructure, threats etc. Harris (2012) compiled a GIS habitat map for the entire South African coastline, but the biodiversity layers, threats layers and critical biodiversity areas have not yet been published or released. This product will be incorporated into a National Biodiversity Plan for Beaches in the coming months (Linda Harris, NMMU, pers.comm., Mar 2014). A preliminary map of the identified critical biodiversity areas and conservation-priority biodiversity areas along the coast in relation to Licence Block 11B/12B is provided in Figure 4-16.

Lombard *et al.* (2004) provided an indication of the irreplaceability of intertidal habitats (see Figure 4-17), from which some indication of sensitivity can be deduced. Two totally irreplaceable areas inshore of the Block 11B/12B licence area are the sandy beaches within Algoa Bay, and the stretch of coastline between the Tsitsikamma MPA and Cape St Francis.

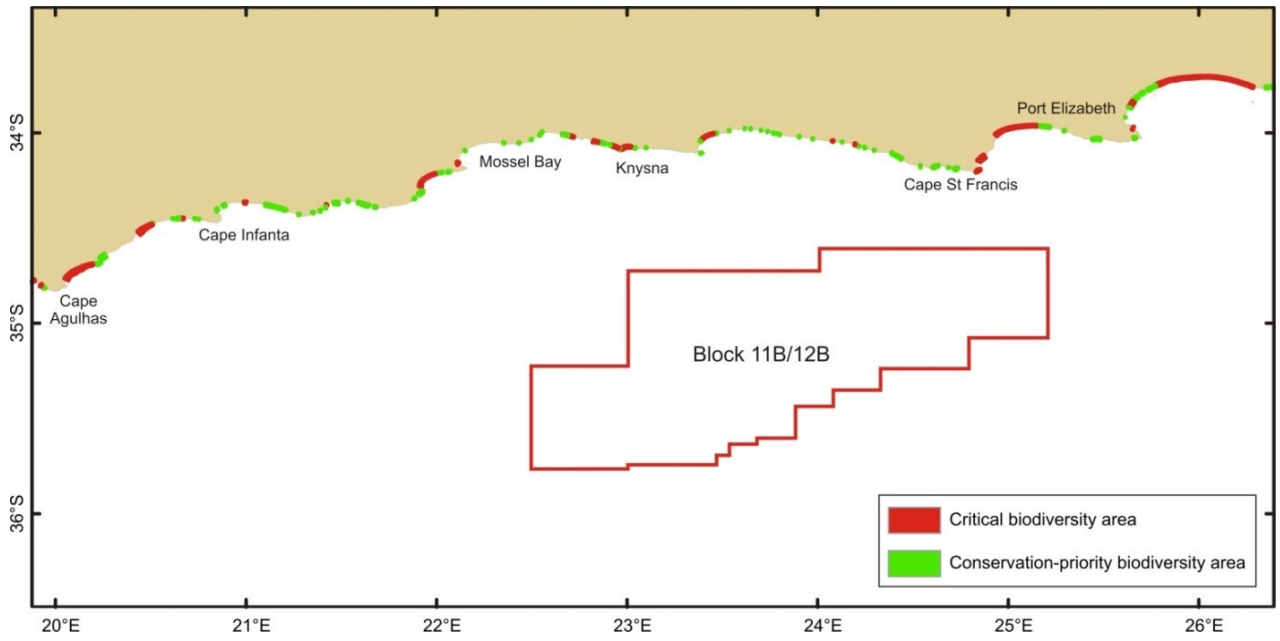

Figure 4-16: Coastal sensitivities along the South Coast in relation to Licence Block 11B/12B (after L. Harris, NMMU, unpublished data).

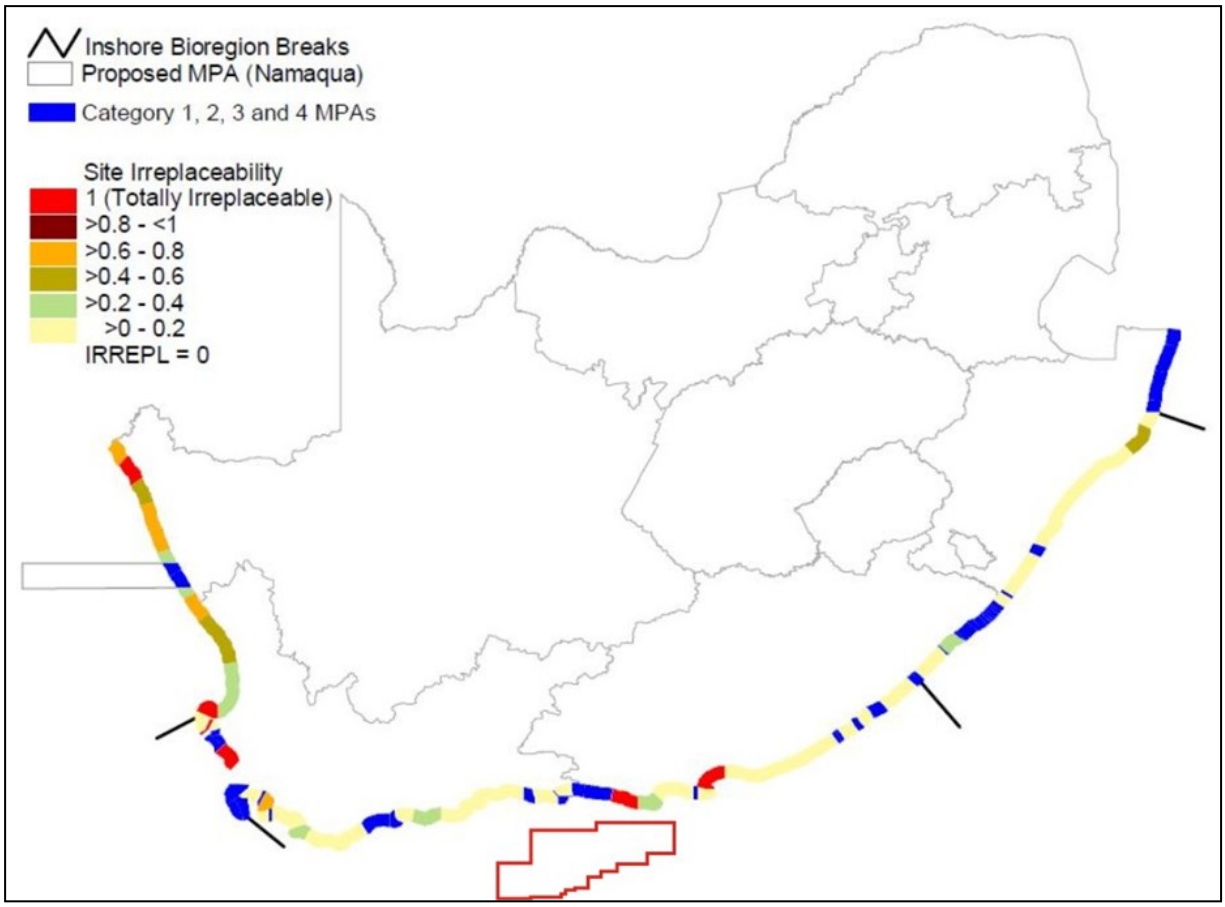

Figure 4-17: Irreplaceability analyses for intertidal habitats, in 50 km strips around South Africa, per bioregion (Lombard et al., 2004). The licence area is shown in red outline.

4.4.2.1. Rocky shores

Some 60% of the South Coast is rocky, 57% of this total comprising exposed rocky headlands, with the remainder comprising wave-cut rocky platforms (Jackson and Lipschitz, 1984). South Coast rocky intertidal fauna is more diverse than that along the West Coast or East Coast due to the presence of species of both tropical and temperate origin.

4.4.2.2. Sandy shores

Some 38% of the South Coast comprises sandy beaches (Jackson and Lipschitz, 1984). The sandy beaches of the region are generally high energy and unstable environments and despite having low diversity, biomass may be high. The surf zones off sandy beaches are important nursery areas for a variety of fish species.

4.4.2.3. Shallow subtidal

Shallow subtidal soft sediment communities are relatively simple, containing few species of large organisms, although the most common ones may be very abundant. Communities inhabiting shallow reefs are more diverse.

4.4.2.4. Estuaries

Thirty-six estuarine systems are found along the South Coast, of which 15 are permanently open (Jackson & Lipschitz, 1984). These open systems are important recruitment sites for some inshore linefish species, while certain systems are important roosting and breeding sites for estuarine birds. The Heuningnes estuary, located within the De Mond Nature Reserve, is a Ramsar site (Cowan, 1995).

4.5 HUMAN UTILISATION

4.5.1 FISHERIES

The South African fishing industry consists of up to 14 commercial sectors operating within the country's 200 nm Exclusive Economic Zone (EEZ) (see Table 4-7). In addition to commercial sectors, recreational fishing is active along the coastline comprising of shore angling and small, open boats generally less than 10 m in length. These sectors are managed and monitored by Department of Agriculture, Forestry and Fisheries (DAFF). All catch and effort data provided in this section have been sourced from DAFF and referenced to a latitude and longitude position. It should be noted that data for 2013 has not yet been published.

4.5.1.1. Fishery sectors operating within the vicinity of the licence area

The following fisheries are active within Licence Block 11B/12B or the surrounding area (see Figure 4-18):

- Demersal trawl;
- Small pelagic purse-seine;
- Demersal long-line (hake- and shark-directed);
- Pelagic long-line (tuna- and shark-directed);
- Traditional line fish;
- South Coast rock lobster;
- Squid jig; and
- Mid-water trawl.

Table 4-7: South African offshore commercial fishing sectors up to December 2012[1].

Sector	Areas of Operation	Number of Vessels (2012)	Rights Holders (2012)	Landed Catch (2012)
Tuna pole	West Coast, South Coast	128	170	~4 000 t
Pelagic long-line	West Coast, South Coast, East Coast	31	30	1 570 t
Mid-water trawl	South Coast	6	19	18 942 t
Small pelagics	West Coast, South Coast	101	111	487 274 t
Hake long-line	West Coast, South Coast	64	146	9 257 t
Hake hand-line	West Coast, South Coast	100	86	non-operational
Traditional line fish	West Coast, South Coast, East Coast	450	-	11 855 t
Demersal shark long-line	South Coast	6	7	834 t
Hake deep sea trawl	West Coast, South Coast	45	49	166 925 t
Hake/ sole inshore trawl	South Coast	31	18	6 990 t
West coast rock lobster	West Coast	105	240	1 879 t
South coast rock lobster	South Coast	12	15	609 t

[1] Note that at the time of preparation of this review the new rights allocations were in process for the tuna pole, linefish, squid, demersal shark and crustacean trawl sectors.

Sector	Areas of Operation	Number of Vessels (2012)	Rights Holders (2012)	Landed Catch (2012)
Crustacean trawl	East Coast	5	8	383 t
Squid jig	South Coast	138	121	6 110 t

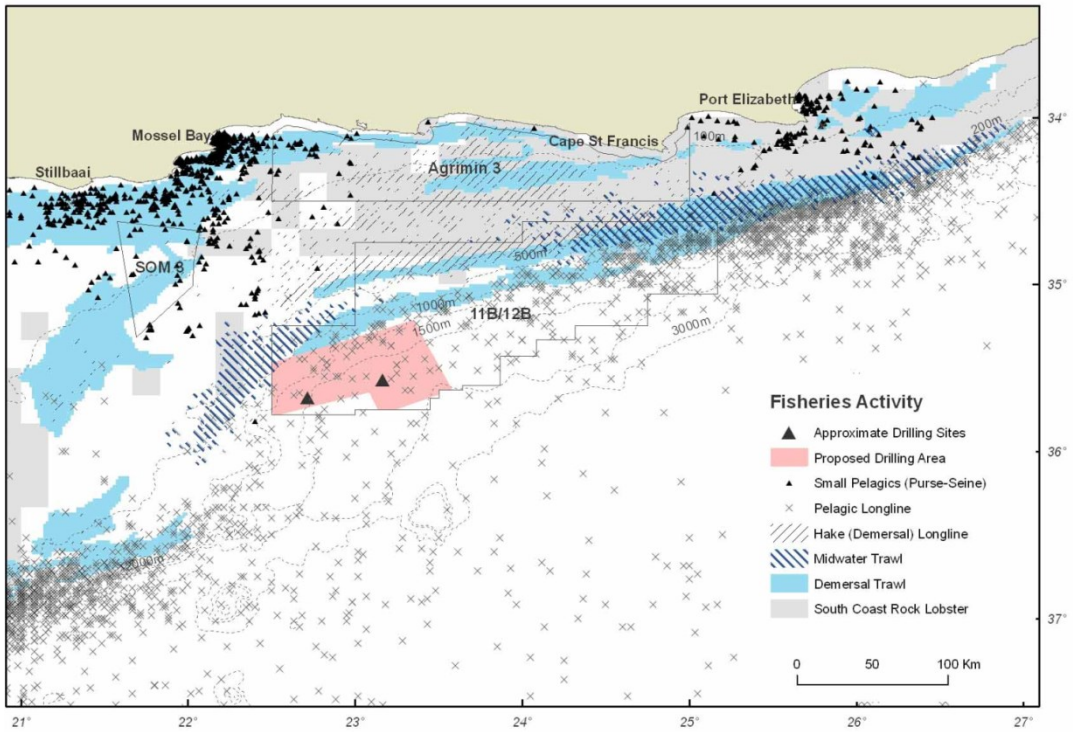

Figure 4-18: All fisheries activity in relation to Licence Block 11B/12B (supplied by Capfish, 2010)

(a) 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 two sub-sectors namely, an offshore ('deep-sea') sector which is active off both the South and West Coasts and a smaller inshore sector which is only active off the South Coast. The offshore fishery targets the Cape hakes (*Merluccius paradoxus* and *M. capensis)* while the inshore sector targets hake (*M. capensis*) and East Coast sole (*Austroglossus pectoralis*). On the South Coast, the offshore sector is not permitted to fish at depths shallower than 200 m. No depth restriction is applied to the inshore fishery however it may not occur west of 20°E longitude and is limited to vessels smaller than 30 m in length. The main by-catch species in the deep-sea fishery includes monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*), horse mackerel (*Trachurus trachurus capensis)* and snoek (*Thyrsites atun*). The inshore fishery has a significantly higher by-catch and diversity of species than the deep-water sector due to its shallow water focus. Table 4-8 and Table 4-9 detail the average catch estimates for the offshore and inshore demersal trawl sectors respectively.

Off the South Coast, offshore hake-directed vessels generally fish the western edge of the Agulhas Bank and are prevalent in the north-western portion of Licence Block11B/12B in water depths shallower than 1 000 m. The inshore trawling sector is localised mainly around Mossel Bay and Port Elizabeth and is separated into hake-directed vessels and sole-directed vessels. Sole directed vessels operate close to the shore and tend to be smaller than hake-directed vessels.

Table 4-8: Average catch estimates and percentages of South Coast species from 2008 -2012, based on offshore demersal trawl data (Smith *et al.,* 2013).

Common name	Scientific name	South Coast Catch (t)	South Coast % of the total catch
Hake	*Meluccius capensis & M. paradoxus*	53474	74.09
Horse mackerel	*Trachurus t. capensis*	4891	6.78
Kingklip	*Genypterus capensis*	2852	3.95
Ribbonfish	*Lepidopus caudatus*	2843	3.94
John dory	*Zeus faber*	1997	2.77
Snoek	*Thyrsites atun*	1349	1.87
Monk	*Lophius vomerinus*	518	0.72
Jacopever	*Helicolenus dactylopterus*	422	0.58
Chokka squid	*Loligo vulgaris*	175	0.24
Panga	*Pterogymnus laniarius*	152	0.21
Mackerel	*Scomber japonicus*	90	0.13
Octopus	*Octopus spp*	88	0.12
Atlantic pomfret	*Brama brama*	86	0.12
Gurnard (uni)	*Chelidonichthys spp*	62	0.09
Ommastrephid squids	*Ommastrephidae spp*	34	0.05
Alfonsino	*Beryx splendens*	34	0.05
Red Mullet	*Mullidae spp*	25	0.03
Oreo Dory	*Pseudocyttus maculatus*	21	0.03
St Joseph shark	*Callorhinchus capensis*	6	0.01
Sardine	*Sardinops ocellatus*	4	0.01
Skates	*Raja spp*	4	0.01
East coast sole	*Austroglossus pectoralis*	1	0.00
Other species		3044	4.22
TOTAL		**72171**	**100.00**

Table 4-9: Annual average catch estimates for the inshore trawl fleet, 2003–2006, based on unsorted samples by observers (Attwood et al., 2011).

Common name	Scientific name	Inshore South Coast Catch (t)	South Coast % of the total catch
Horse mackerel	*Trachurus t. capensis*	1345	7.71
Panga	*Pterogymnus laniarius*	1050	6.02
Skate unidentified	*Raja spp*	833	4.78
Gurnard unid	*Chelidonichthys spp*	824	4.73
East coast sole	*Austroglossus pectoralis*	504	2.89
St Joseph	*Callorhinchus capensis*	504	2.89
Deep water hake	*Meluccius paradoxus*	428	2.45
Dogshark unid	*Squalus spp*	409	2.35
Silver kob	*Argyrosomus inodorus*	294	1.69
Squid (chokka)	*Loligo vulgaris*	283	1.62
White stumpnose	*Rhabdosargus globiceps*	231	1.32
Kingklip	*Genypterus capensis*	216	1.24
Carpenter	*Argyrozona argyrozona*	107	0.61
Monk	*Lophius vomerinus*	87	0.50
Geelbeck	*Atractoscion aequidens*	84	0.48
Houndshark unid	Mustelus spp	82	0.47
Snoek	*Thyrsites atun*	57	0.33
Ribbonfish	*Lepidopus caudatus*	44	0.25
John dory	*Zeus faber*	41	0.24
Soupfin shark	*Galeorhinus galeus*	38	0.22
Mackerel	*Scomber japonicus*	36	0.21
Other species		283	1.62
TOTAL		**17434**	**100.00**

Note: more recent data not analysed – proportions assumed unchanged.

The Total Allowable Catch (TAC) of hake across all sectors is set at 156 075 tons (2013), of which the majority is landed by the demersal trawl sector. In 2012, of a TAC of hake of 144 671 tons, 82% was

landed by the demersal trawl sector. Of this, the large majority (115 465 tons) was caught by the offshore fishery and 3 223 tons was caught by the inshore trawl fishery. Over the period 2008 to 2012, the average effort directed by the demersal trawl fishery within the licence area amounted to 5 900 trawling hours per year with a catch of 11 164 tons per annum (see Figure 4-19). This represents approximately 5.0 % of the total national effort and 8.6 % of the total catch landed by the hake trawl sector.

A fleet of 45 and 31 trawlers operate within the offshore and inshore sectors respectively. Offshore vessels are distinguished as wetfish or freezer vessels and differ in size accordingly. Wetfish vessels range between 24 m and 56 m in length while freezer vessels are usually larger, ranging up to 80 m in length. Trawl gear is deployed astern of the vessel and typically consists of steel trawl warps, a pair of trawl doors, net footropes, net and cod-end (see Figure 4-20). Generally, trawlers tow their gear at 3.5 knots for two to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net opening may be up to 50 m in width and 10 m in height and the swept area on the seabed between the doors may be up to 150 m.

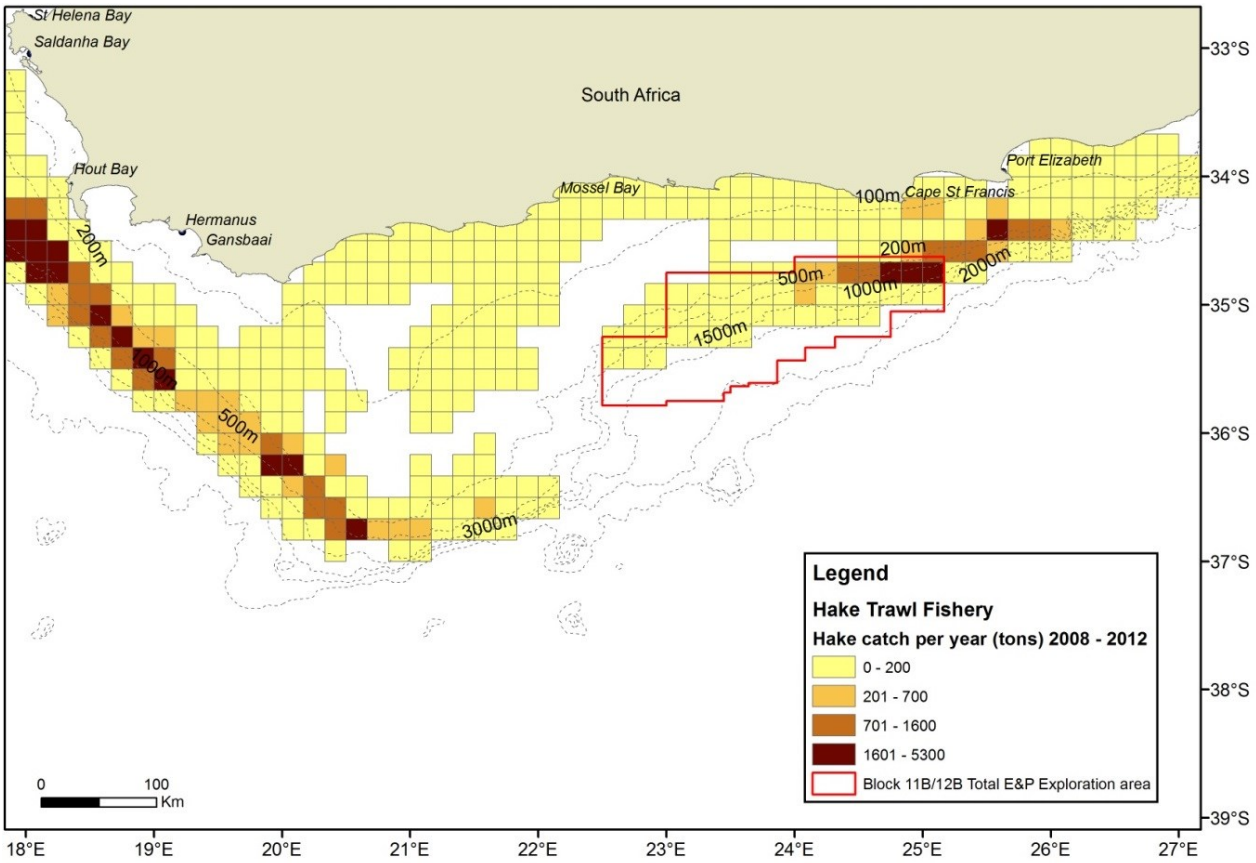

Figure 4-19: Distribution of Catch (t) reported by the demersal trawl fishing sector in relation to Licence Block 11B/12B showing areas of highest densities (2008-2012).

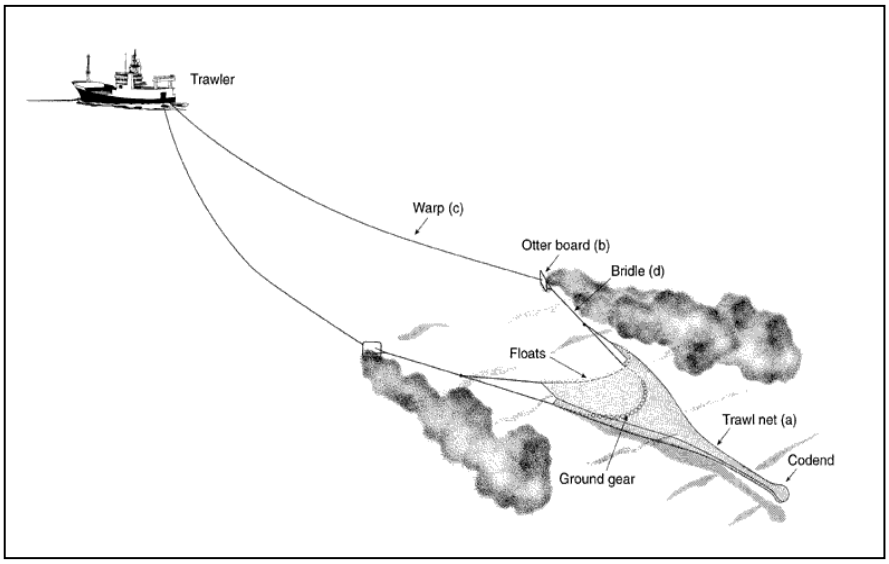

Figure 4-20: Typical gear configuration used by demersal trawlers (offshore) targeting hake.

(b) Small pelagic purse-seine

The South African small pelagic purse seine fishery is the largest fishery by volume and the second most important in terms of value. The two main targeted species are sardine and anchovy, with associated by-catch of round herring (red-eye) and juvenile horse mackerel. Small pelagic species abundance and distribution fluctuates considerably in accordance with the upwelling ecosystem in which they exist. Annual landings have fluctuated between 300 000 and 600 000 tons over the last decade, with average landings of 391 000 tons per annum recorded between 2008 and 2012. Figure 4-10 lists the catch composition (by species and mass) of the South Coast purse seine fleet. Sardines dominate the landings of the purse-seine fishery sector in the South Coast region. The dispersed and subsurface distribution of anchovy along the South Coast during its spawning season results in smaller catches than along the West Coast. Catches of round herring along the South Coast are also small although there is potential for larger catches of the species should the required improvements in equipment be developed.

The pelagic purse-seine fishery operates predominantly on the West Coast and to a lesser extent on the South Coast and Eastern Cape Coast up to a maximum distance of 100 km offshore, but usually closer inshore. Recent annual catch of small pelagic species indicates that fishing grounds on the South Coast range from the 35°S line of latitude northwards and within 100 km of the shoreline. As such, minimal catch is expected within the shallower section of Licence Block 11B/12B (see Figure 4-21). Over the period 2008 to 2012, the average effort directed by the small pelagic purse-seine fishery within the licence area amounted to 4 hours per year with a catch of 71 tons per year. This amounts to less than 0.02% of the total national catch and effort. It is likely that these recorded fishing events within the licence area were erroneous reports as vessels usually fish within 20 nautical miles from port. The majority of the fleet of 101 vessels operates from St Helena Bay, Laaiplek, Saldanha Bay and Hout Bay which are well to the west of the licence area. Fewer vessels operate on the South Coast, from the harbours of Gansbaai, Mossel Bay and Port Elizabeth. Ports of deployment correspond to the location of canning factories and fish reduction plants along the coast.

Table 4-10: Annual catches (tons) in the small pelagic purse fishery for the years 2000 – 2012

Year	Sardine (Tons)	Anchovy (tons)	Horse mackerel (tons)	Round herring (tons)	Mackerel (tons)	TOTAL (tons)
2000	135198	267263	4503	37277	40	444282
2001	191531	287512	916	55331	122	535411
2002	260884	213446	8149	54798	82	537358
2003	289995	258877	1012	42529	250	592663
2004	373828	190093	2048	47234	480	613682
2005	246714	282728	5628	28394	343	563806
2006	217282	134185	4824	41892	95	398278
2007	139412	252784	1898	47918	404	442416
2008	90893	265823	2281	64234	873	424105
2009	94326	174465	2087	40492	616	311987
2010	112374	217043	4383	88488	641	422928
2011	112137	119876	10990	64640	240	307883
2012	109437	307303	2199	68301	67	487307

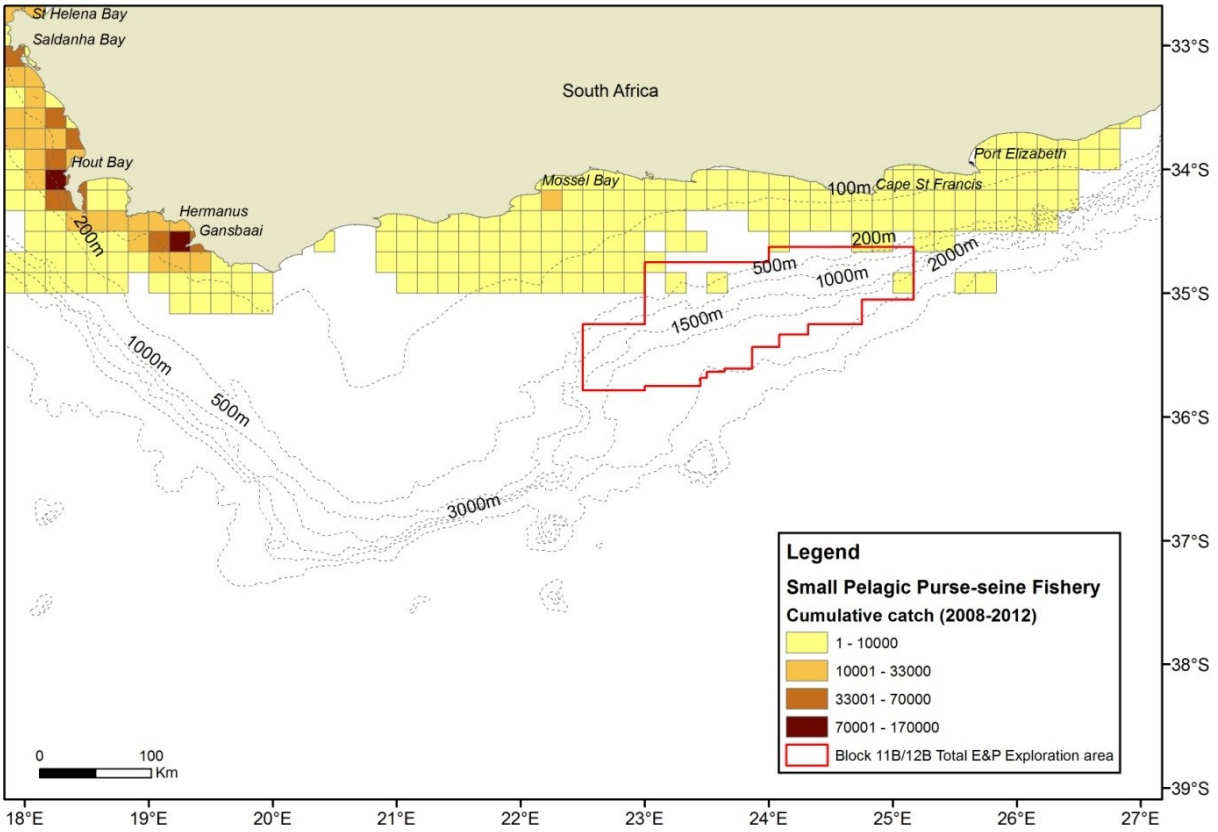

Figure 4-21: Distribution of the recent catch of small pelagic species landed by the purse seine fishery in relation to the licence area (2008-2012).

The small pelagic sector operates throughout the year with a short break from mid-December to mid-January. The geographical distribution and intensity of the fishery is largely dependent on the seasonal fluctuation and distribution of the targeted species. The sardine-directed fishery tends to concentrate effort in a broad area extending from Lambert's Bay, southwards past Saldanha Bay and Cape Town towards Cape Point and then eastwards along the coast to Mossel Bay and Port Elizabeth. The anchovy-directed fishery takes place predominantly on the South-West Coast from Lambert's Bay to Kleinbaai (19.5°E) and is most active in the period from March to September. Round herring (non-quota species) is targeted when available and specifically in the early part of the year (January to March) and is distributed

from south of Cape Point to Lambert's Bay. This fishery may extend further offshore than the sardine and anchovy-directed fisheries.

The fleet consists of wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 11 m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel steams around it and encircles it with a large net, extending to a depth of 60 to 90 m (see Figure 4-23). Netting walls surround aggregated fish, preventing them from escaping by diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped onboard into the hold of the vessel. It is important to note that after the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered onboard and this may take up to 1.5 hours.

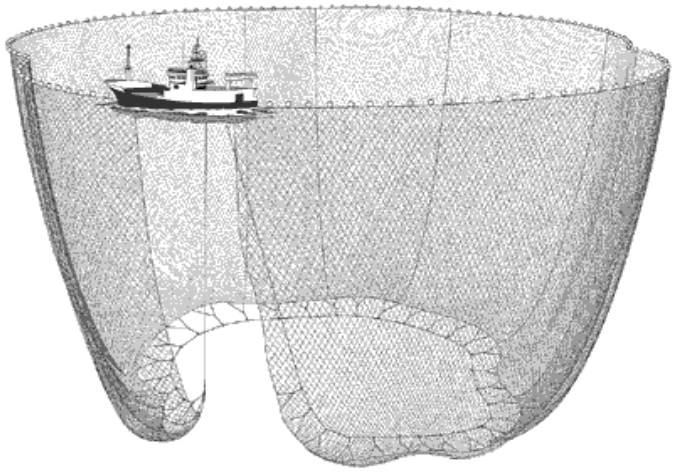

Figure 4-22: Typical gear configuration of a pelagic purse-seine vessel targeting small pelagic species.

c) Demersal long-line

The demersal long-line fishing technique is used to target bottom-dwelling species of fish (see Figure 4-23). A demersal long-line vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor. Steel anchors, of 40 kg to 60 kg, are placed at the ends of each line to anchor it, and are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. The top-line is more buoyant than the bottom line and is raised off the seafloor, minimising the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically between 10 km and 20 km in length, carrying between 5 000 and 20 000 hooks each. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m). Gear is usually set at night at a speed of between 5 and 9 knots. Once deployed the line is left to soak for up to eight hours before it is retrieved. A line hauler is used to retrieve gear (at a speed of approximately one knot) and can take six to ten hours to complete. Long-line vessels vary in length from 18 m to 50 m and remain at sea for four to seven days at a time.

Two fishing sectors utilise this method of capture, namely:

- The hake long-line fishery
  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. The catch is landed mostly as prime quality hake for export to Europe and is packed whole unfrozen on ice. Operations are *ad hoc* and intermittent, subject to market demand. Since 2012, large proportions of the hake long-line catch have been processed as headed and gutted frozen.

  Fishing takes place along the West and South-east coasts in areas similar to those targeted by the demersal trawl fleet. There are currently 64 vessels licensed within the sector, most of which are based at Cape Town and Hout Bay harbours. 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 fishery is directed in both inshore and offshore areas. Of the hake TAC of 144 671 tons set for 2012, the catch taken by the long-line fleet amounted to 8 399 tons (approx. 6%) and 9 257 tons including all other non-hake species landed. Over the period 2008-2012, the fishery set an average of 28.9 million hooks and landed 8 368 tons of hake per year.

  Lines are usually set parallel to bathymetric contours, extending along the shelf edge to the 1 000 m contour in places. Long-line fishing activity would be expected to occur within the northern half of Licence Block 11B/12B in water depths shallower than 500 m (see Figure 4-24). Approximately 25.3% of the total national effort is conducted within the licence area annually and 18% of the total national catch is taken in this area.

- The shark long-line sector fishery
  The demersal shark fishery targets soupfin shark (*Galeorhinus galeus*), smooth-hound shark (*Mustelus spp*.), spiny dogfish (*Squalus* spp), St Joseph shark (*Callorhinchus capensis*), *Charcharhinus* spp., rays and skates. Other species which are not targeted but may be landed include Cape gurnards (*Chelidonichthys capensis*), jacopever (*Sebastichthys capensis*) and smooth hammerhead shark (*Sphyrna zygaena*). Catches are landed at the harbours of Cape Town, Hout Bay, Mossel Bay, Plettenberg Bay, Cape St Francis, Saldanha Bay, St Helena Bay, Gansbaai and Port Elizabeth and currently six permit holders have been issued with long-term rights to operate within the fishery. Pelagic shark species are caught mainly in the large pelagic long-line fishery.

  The shark long-line fishery operates inshore of the 100 m isobaths (see Figure 4-25). The licence area lies beyond the 100 m isobaths and thus would not coincide with the demersal shark-directed long-line fishing grounds.

(d) Large pelagic long-line

The large pelagic long-line fishery operates extensively within the South African EEZ and primarily targets tuna and swordfish. Tuna, billfish and other tuna-like species are migratory and stocks straddle the EEZ of a number of countries and international waters. As such they are managed as a “shared resource” amongst various countries. There are currently a total of 50 commercial large pelagic fishing rights (30 for tuna directed long-line and 20 for swordfish) issued for South African waters of which 31 rights and vessels are active in the fishery. Many rights holders employ Asian long-line vessels fishing under joint ventures with South African companies.

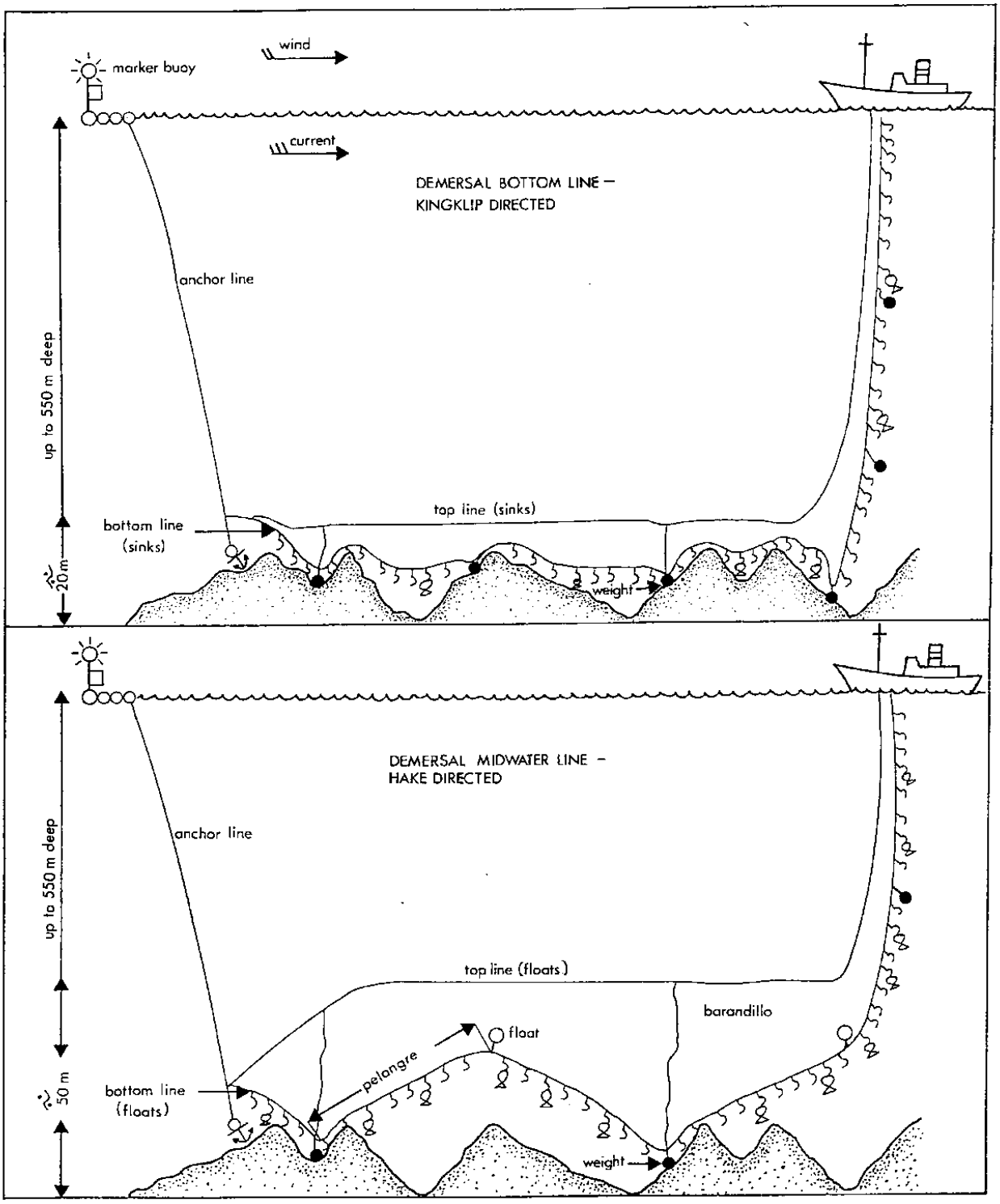

Figure 4-23: Schematic diagram showing a typical configuration of long-line gear used to target demersal fish species in South African waters.

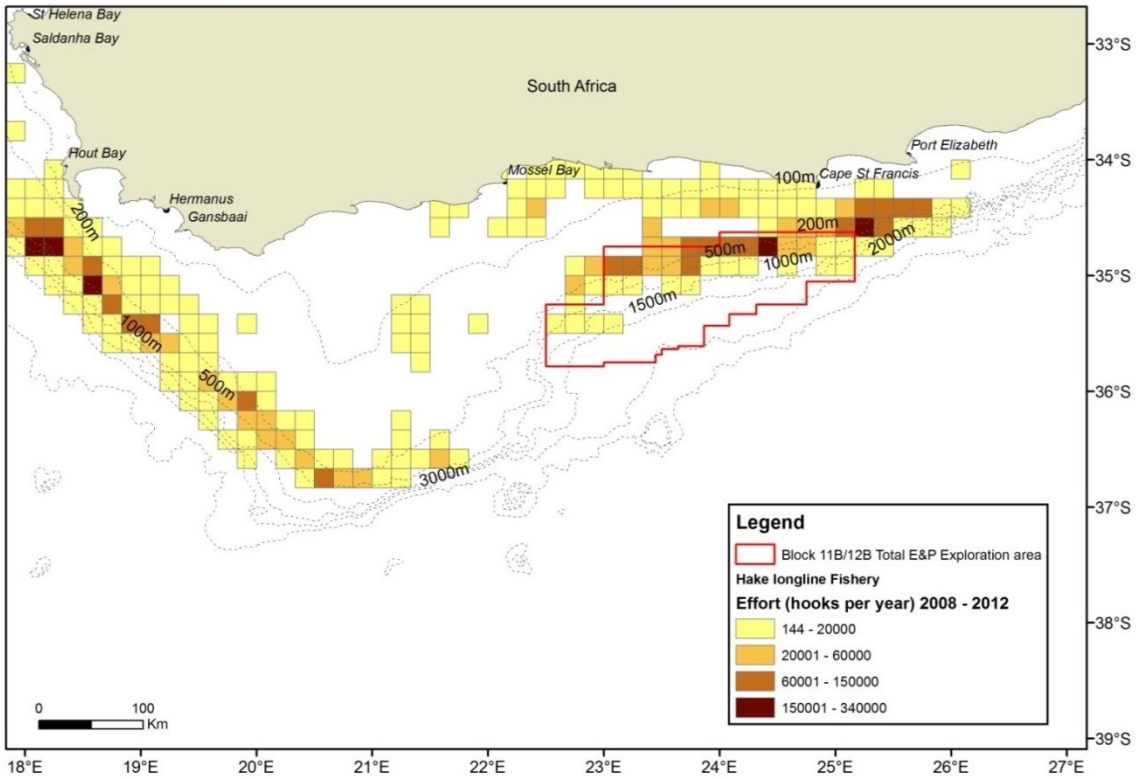

Figure 4-24: Distribution of fishing effort expended by the hake-directed demersal long-line sector in relation to the licence area. Effort is shown as the average annual number of hooks set for the years 2008 to 2012[2].

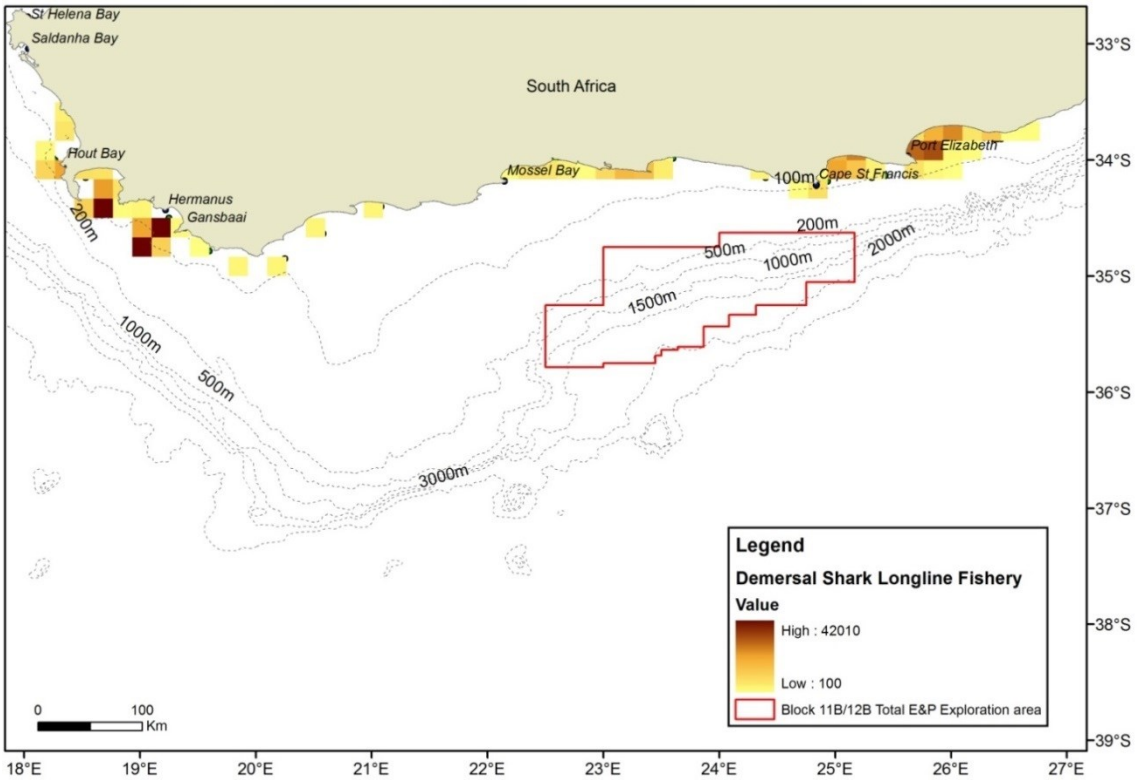

Figure 4-25: Distribution of fishing effort expended by the demersal long-line fishery targeting shark species in relation to the licence area (2008 – 2012).

[2] Note: data provided by DAFF – effort deeper than the shelf margin (>600 m) considered erroneous (outliers).

The fishery has an extensive operational area throughout the year from the continental shelf break into deeper waters. Fishing activity rarely occurs at depths shallower than 200 m; pelagic long-line effort for tuna extends along and offshore of the 500 m isobath, whilst pelagic shark species are targeted primarily along the 200 m isobath. Pelagic long-line vessels can be expected across the licence area and are likely to be especially concentrated where the continental slope is at its steepest (see Figure 4-26). Between 2008 and 2012, effort directed within the licence area amounted to 128 000 hooks (56 lines) with a catch of 72.4 tons per annum. This represents approximately 3.7 % of the total national effort and 2.9 % of the total catch landed by this sector.

Pelagic long-line vessels range from 18 m to 54 m in length. A drifting mainline (between 25 km and 100 km in length) is kept near the surface or at a certain depth (20 m below) by means of buoys connected via "buoy-lines", which are spaced apart at regular intervals along the length of the mainline (see Figure 4-27). Baited 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 a considerable length of time 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. Lines are not easily detectable and their movement is unpredictable given that they drift freely in the water column.

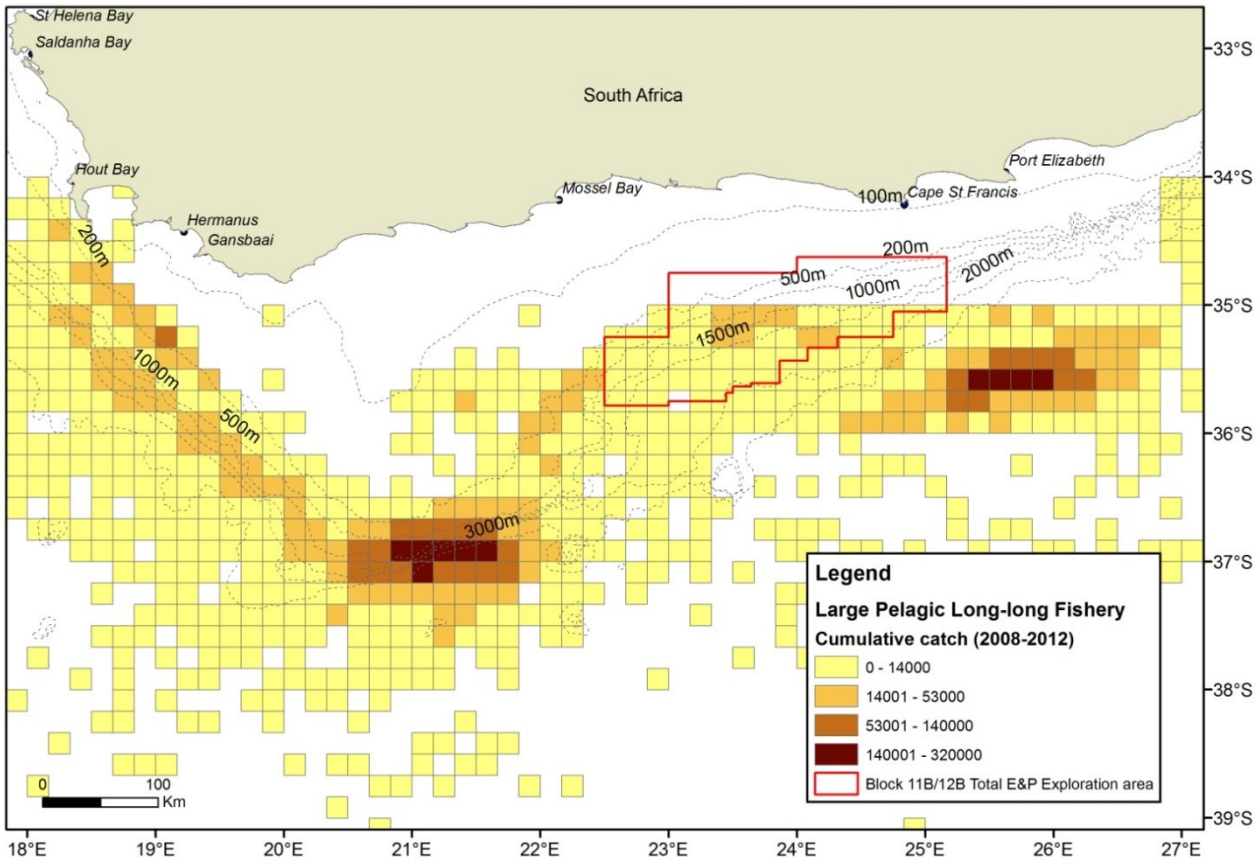

Figure 4-26: Distribution of large pelagic species caught by the domestic and foreign pelagic long-line sector (all species) in relation to Block 11B/12B (2008-2012).

(e) Traditional line fish

The South African line fishery includes commercial, subsistence and recreational sectors. The commercial line fishery is the country's third most important fishery in terms of total tonnage landed and economic value. The bulk of the fishery catch is made up of about 35 different species of reef fish (*Sparidae* and *Serranidae)* as well as pelagic (*Carangidae* and *Scombridae*) and demersal (*Sciaenidae)* species which are mostly marketed locally as "fresh fish".

The fishery operates nearshore up to a maximum depth of 200 m from the Namibian border on the West Coast to the Kei River in the Eastern Cape. Effort is managed geographically with the spatial effort of the fishery divided into three zones. The majority of the catch (up to 95%) is landed by the Cape commercial fishery (West Coast). Fishing vessels generally range up to a maximum of 40 nm offshore, although fishing at the outer limit and beyond this range would be sporadic (C. Wilke, pers. comm.). Annual catches for the sector were reported as 13 081 tons over the period 2000 to 2012 (Table 4-11). However, annual catches, fishing rights and numbers of fishers in this sector are likely to change in 2014.

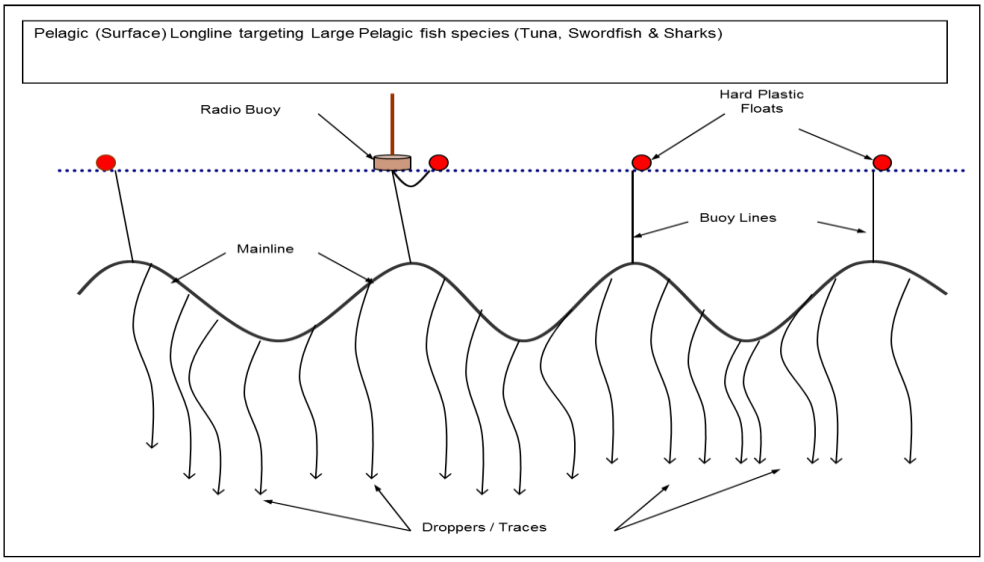

Figure 4-27: Typical pelagic long-line configuration targeting tuna, swordfish and shark species.

Line fishing techniques consist of hook and line gear (up to 10 hooks per line), and differ from the pelagic long-line fishing technique in that the use of set long-lines is not permitted. Recreational permit-holders fish via skiboat 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). 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. Up to 3 000 boats are involved in the fishery on the national level, 450 of which are involved in the commercial fishery, and range in size from 3 m beach-launched dinghy's to 20 m harbour-based vessels that may remain at sea for up to 30 days (Mann, 2000). Vessels are restricted to water depths of approximately 100 m due to the fast-flowing Agulhas current. There have been no records of historical or recent fishing effort by the traditional linefish sector within the area of interest (see Figure 4-28).

Table 4-11: Common commercially caught linefish species and proportion of total catch caught in traditional linefish fisheries for the years 2000 – 2012.

Common name	Scientific name	Catch (kg)	% of the total catch
Squid	*Loligo vulgaris*	52673950	30.97
Hake	*Meluccius capensis &*	13143696	7.73
Geelbeck	*Atractoscion aequidens*	6142262	3.61
Silver kob	*Argyrosomus inodorus*	4990799	2.93
Yellow tail	*Seriola Lalandi*	4675549	2.75
Carpenter	*Argyrozona argyrozona*	3443701	2.03
Albacore	*Thunnus alalunga*	2886877	1.70
Slinger	*Chrysoblephus puniceus*	1996356	1.17
Hottentot	*Pachymetopon blochii*	1867688	1.10
Shark unid	*Selachii*	1637084	0.96
Soupfin shark	*Galeorhinus galeus*	972233	0.57
Santer	*Cheimerius nufar*	879876	0.52
White stumpnose	*Rhabdosargus globiceps*	569269	0.33
Yellowfin tuna	*Thunnus albacares*	392826	0.23
Rockcods and	*Epinephelus*	392500	0.23
Redfish	*Teleostei redfish*	387209	0.23
Panga	*Pterogymnus laniarius*	367600	0.22
Mackerel	*Scomber japonicus*	331389	0.19
Fish unid	*Teleostei*	302395	0.18
Roman	*Chrysoblephus laticeps*	245787	0.14
Copper shark	*Carcharhinus brachyurus*	211441	0.12
Tuna unid	*Thunnus spp*	170940	0.10
Other species		2104170	1.24
TOTAL		**170058859**	
ANNUAL		**13081 t**	

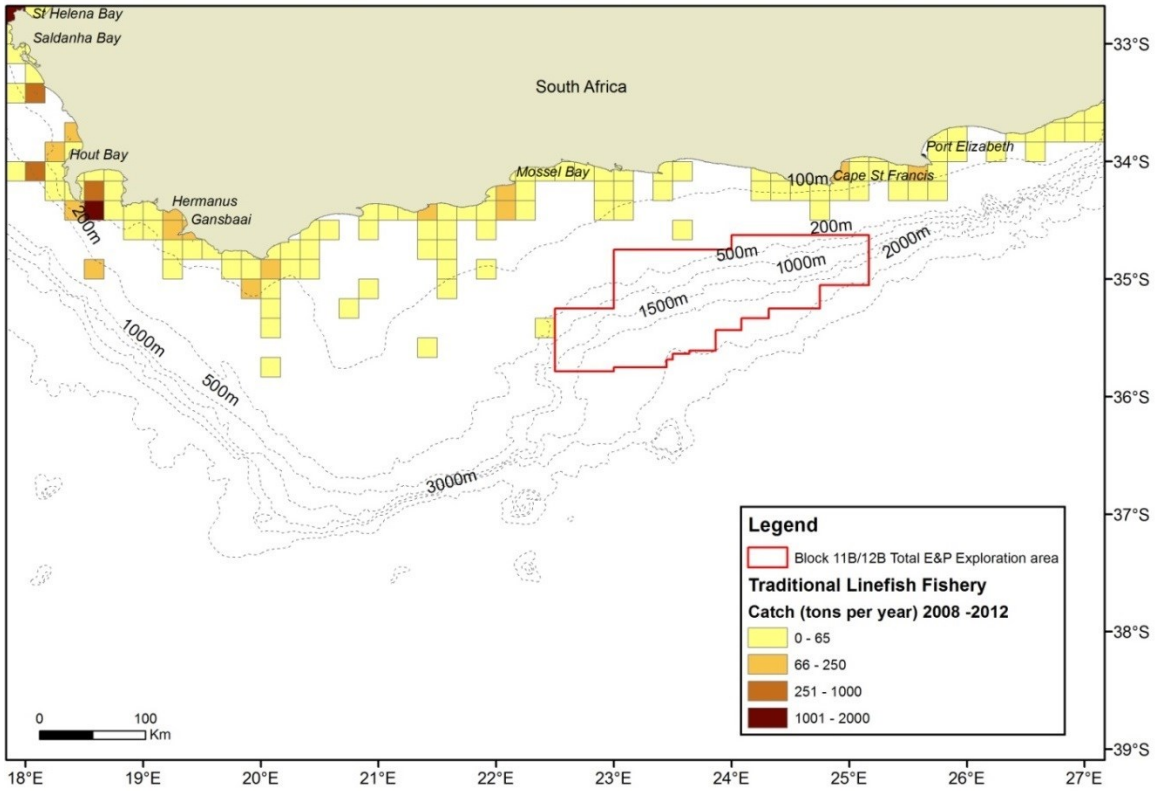

Figure 4-28: Distribution of catch landed by the traditional linefish sector in relation to Block 11B/12B (2008-2012).

(f) South Coast rock lobster

The South Coast rock lobster (*Palinurus gilchristi*) occurs on the continental shelf of the South Coast between depths of 50 m and 200 m. Two areas are commercially viable to fish on the South Coast, the first is approximately 200 km offshore on the Agulhas Bank and the second is within 50 km of the shoreline between Mossel Bay and East London (see Figure 4-29). The fishery is restricted by the Agulhas Current from operating far offshore, but would be expected to operate within the licence area, particularly on the Agulhas Bank and inshore of the 200 m isobath. The South Coast rock lobster fishery is a deep-water long-line trap fishery and fishing generally occurs at depths of 80 to 300 m. Within the licence area an average of 328 000 traps were set per annum between 2008 and 2012. This is approximately 17.4% of the total effort conducted within South African water by the fishery. During this time the catch of rock lobster taken from the area amounted to 42.5 tons (tail) which is 15.7% of the total catch taken by the fishery. Fishing within the licence area may be expected to a maximum depth of 180 m.

Barrel-shaped plastic traps are set for periods ranging from 24 hours to several days. Each vessel typically hauls and resets approximately 2 000 traps per day in sets of 100 to 200 traps per line. They will set between 10 and 16 lines per day, each of which may be up to 2 km in length. Each line is weighted to lie along the seafloor and is connected at each end to a marker buoy at the sea surface. Vessels are large, ranging from 30 m to 60 m in length. The fishery operates year-round with the month of October showing relatively low activity within the fishery. In 2012, there were twelve authorised vessels operating within the fishery.

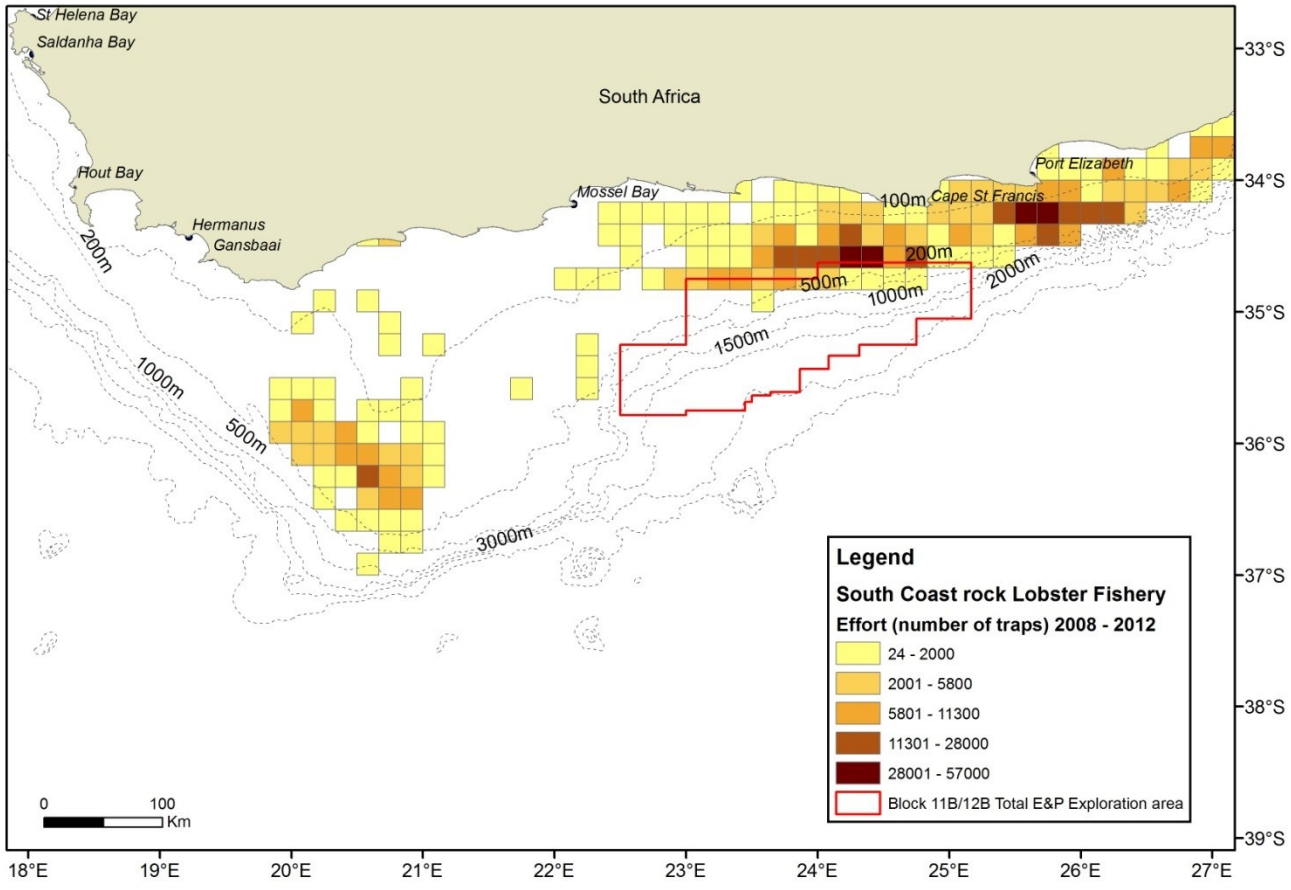

Figure 4-29: Distribution of the effort (number of traps) for the South Coast rock lobster fishery (2008 to 2012). Licence Block 11B/12B is demarcated in red.

(g) Squid jig

Chokka squid (*Loligo vulgaris reynaudii*) is an important inshore jigging fishery. The major squid jigging areas are found inshore along the eastern half of the South Coast between Plettenberg Bay and Algoa Bay, although squid is also caught as a by-catch species by demersal trawlers. The majority of squid jigging occurs inshore of the 100 m isobaths. Squid jigging is seasonal, with most effort conducted between November and March. Hand-held jigs and bright lights are used to attract squid at night.

The squid fishery is managed in terms of the Total Allowable Effort (TAE) allowed within the fishery and also sees an annual four week closure between October and November during which time DAFF undertakes a survey on spawning aggregations in the bay areas. Fishing rights were issued to 121 companies for the period 2006 to 2013 with the number of crew and vessels active within the fishery listed as 2 422 and 138, respectively. A maximum landed catch of 12 000 tons was recorded in 2003/4 with a levelling-off thereafter to 9 000 tons between 2005 and 2008. Currently the catch in the fishery is approximately 6 000 tons and annual average catch value is approximately R180 million. As described in Table 4-7, the number of rights allocations in this sector is likely to change in 2014.

The distribution of fishing effort is mostly concentrated in the bay areas around Cape St Francis and Port Elizabeth (see Figure 4-30), however the research survey conducted by DAFF has shown that squid also occurs near Cape Agulhas, False Bay and Saldahna. Nevertheless, the fishing activity takes place in the north-eastern portion of Licence Block 11B/12B. Effort within the licence area averaged 300 fishing events per year with a catch of 110.6 tons per annum between 2006 and 2012. This amounts to 1.1% of the total national effort and 1.5% of the total catch landed by the fishery.

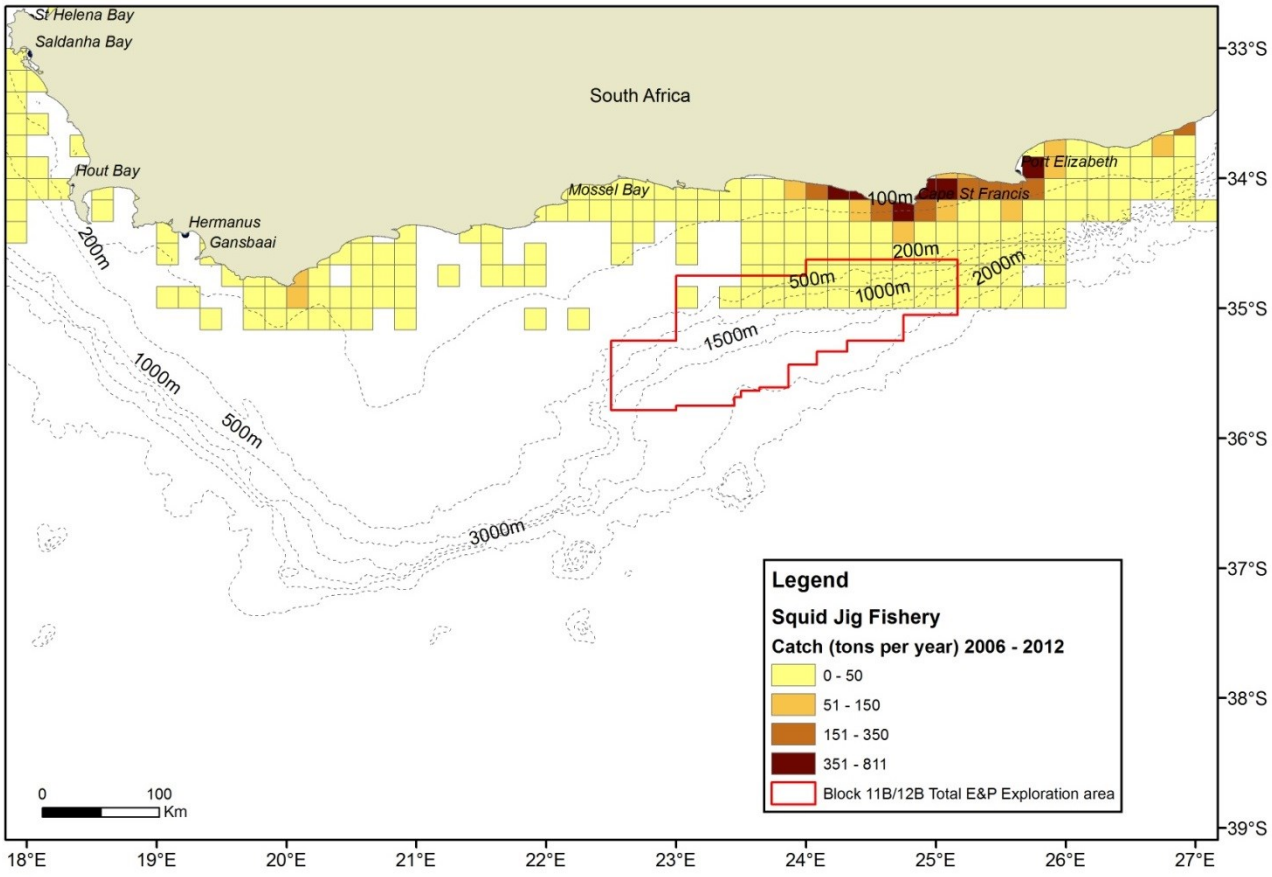

Figure 4-30: Catch (tons) distribution of the squid jig fishery in relation to the licence area (2006-2012).

(h) Mid-water trawl

The mid-water trawl fishery targets adult horse mackerel (*Trachurus capensis*), which aggregate in highest concentration on the Agulhas Bank. Horse mackerel are targeted with very large mid-water nets that are fished both close to the substrate and in mid-water (depending on the location of the shoals and on the diurnal vertical migration of the species). Shoals of commercial abundance are found in limited areas and the spatial extent of mid-water trawl activity is relatively limited when compared to that of demersal trawling. Fishing grounds are condensed into three areas on the shelf edge of the South and East Coasts:

1. Between 22ºE and 23ºE at a distance of approximately 70 nm offshore from Mossel Bay;
2. Between 24ºE to 27ºE at a distance of approximately 30 nm offshore; and
3. South of the Agulhas Bank between 21°E and 22°E.

There are currently 15 rights holders within this fishing sector, however the majority of effort is undertaken by a single dedicated vessel, which operates all year round. This large factory vessel (120 m in length) is capable of sustained operation and has made economically viable targeting of horse mackerel possible. Mid-water trawling gear configuration is similar to that of demersal trawlers, except that the net is manoeuvred vertically through the water column. The towed gear may extend up to 1 km astern of the vessel and comprises trawl warps, net and codend (see Figure 4-31). Trawl warps are between 32 and 38 mm in diameter. The trawl doors (3.5 ton each) maintain the net opening which ranges from 120 to 130 m in width and from 40 m to 80 m in height. Weights in front of, and along the ground-rope provide for vertical opening of the trawl. In addition, the cable transmitting acoustic signal from the net sounder might also provide a lifting force that maximizes the vertical trawl opening. To reduce the resistance of the gear and achieve a large opening, the front part of the trawl net is usually made from very large rhombic or hexagonal meshes. 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. Mid- water trawlers are severely restricted in their ability to manoeuvre.

The mid-water trawl grounds lie along the northern portion of the Licence Block 11B/12B in water depths of less than 1 000 m (see Figure 4-32). Between 2008 and 2012, an average effort of 350 trawls were conducted within the licence area and a catch of 11 020 tons per annum was landed by the fishery which represents 35.8 % of the total national effort and 36.8 % of the total catch landed by the sector over this period.

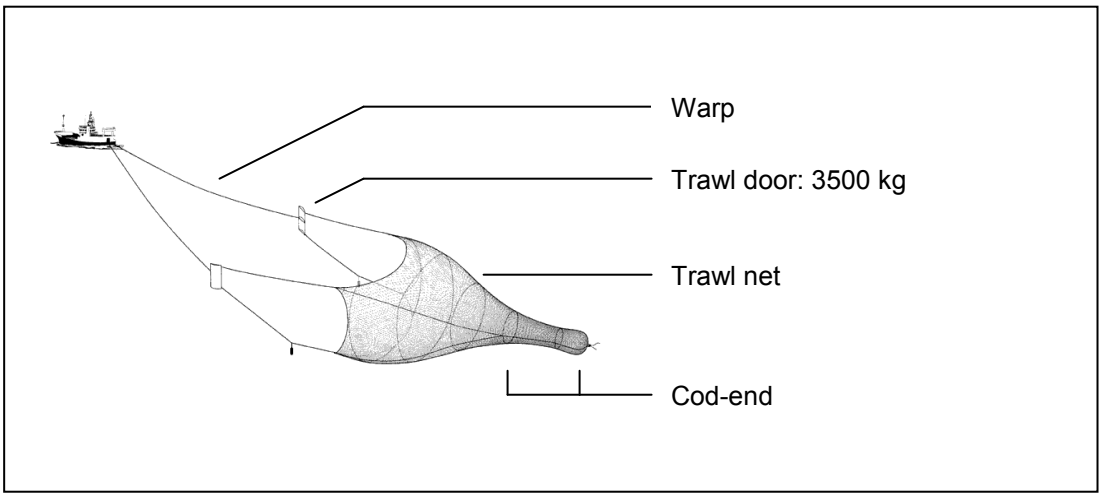

Figure 4-31:Schematic diagram showing the typical configuration of mid-water trawl gear.

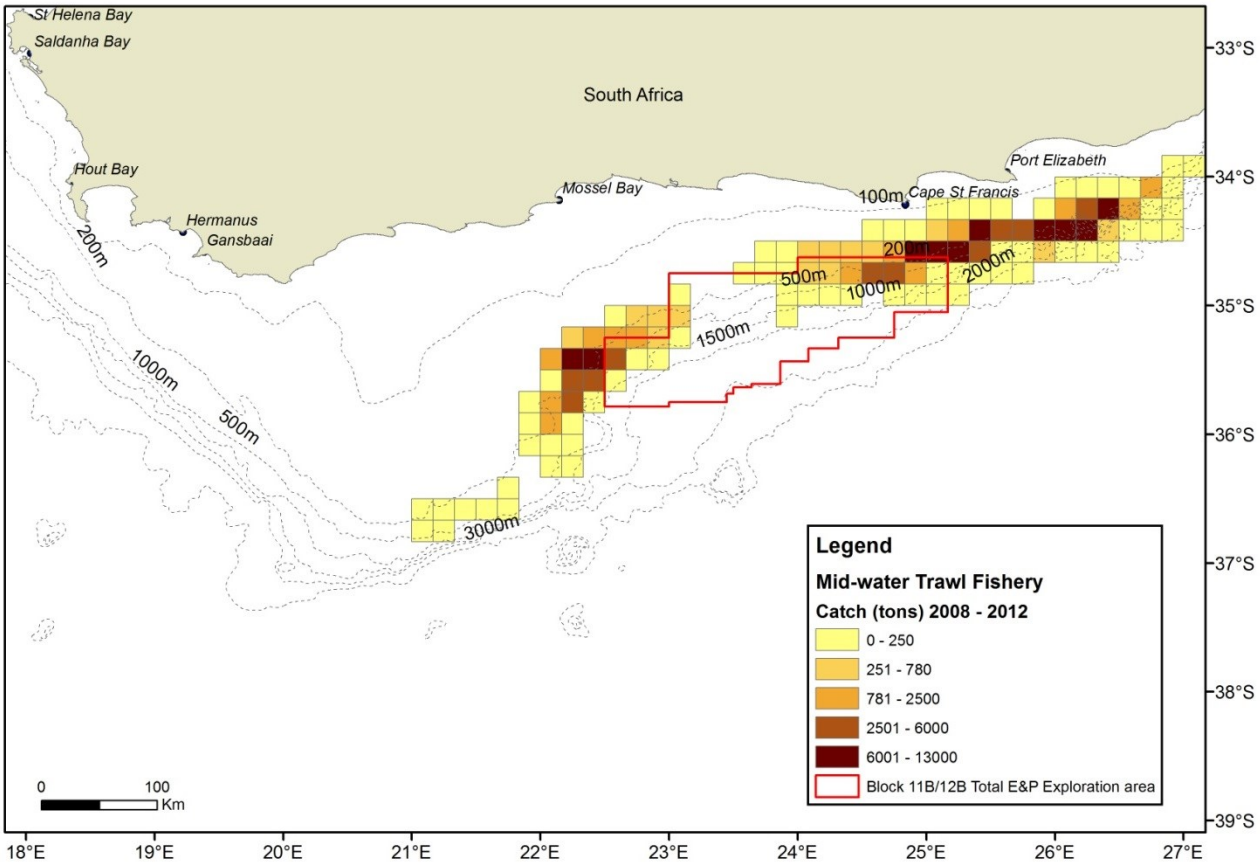

Figure 4-32: Distribution of the mid-water trawl fishery in relation to the licence area (2008-2012).

4.5.1.2. Economic value of fisheries

There are no current economic assessments of the value of South African fisheries. DAFF undertakes annual economic assessments of the fisheries sectors, however, publication of this data is always delayed by a few years. Although South Africa has an extensive coastline with diverse fisheries targeting many different species, the breakdown of these sectors into specific fisheries sectors and areas is challenging. Broadly, fisheries in South Africa contribute less than 0.5% to the country's Gross Domestic Product (GDP).

The quarterly economic review by DAFF (July 2011) suggests total export value per quarter of R556 million for all fish products or R2.224 billion annually (this is only export, no domestic estimates). The key offshore fisheries in South Africa are the hake-directed trawl sector and the small pelagic fishery. In the case of hake, the TAC approximates 150 000 tons. At an average landed value of R15 per kilogram the value would approximate R2.25 billion (U$225 million), which is consistent with the estimates by Hara *et al.* (undated) of R2.5 billion in 2005. Similarly a catch of 564 050 tons was estimated for the small pelagic fish sector in 2005, with a value of R1.15 billion (Hara *et. al.*, undated).

Within the licence area, fishery production would equate to a relatively small proportionate value, particularly if one considers that the most productive fisheries are based on the West Coast of South Africa. Given that the licence area is far offshore interaction with coastal communities is not expected and only the large industrial offshore sectors such as demersal trawl, hake long-line, deep-water lobster and large pelagic long-line fisheries would potentially be encountered in the block. Distribution of fishing

grounds within the licence area per sector and percentage contribution to the overall catch landed by each fishery is described in Section 4.5.1.1 above.

With respect to employment the available information suggests that fisheries in South Africa employ about 27 730 of which 16 853 are directly employed (in primary industry such a vessel crews and factory processors). Indirect employment relates to secondary industry such as marketing and industries that supply goods and services to the fishing industry. In the licence area only the larger industrial sectors could be encountered. A sectoral socio-economic study conducted in 2005 estimated that the capital intensive trawl sector directly employed 1 997 people, while the hake long-line, South Coast lobster and large pelagic long-line sectors employed 683, 218 and 335 persons, respectively[3]. Of these sectors, the South Coast rock lobster is the only fishery located entirely on the Agulhas Bank and overlapping in part with the licence area. The overlap of all of fishery sectors with the licence area is nevertheless proportionately small (relative to the scale of each fishery).

4.5.1.3. Key stakeholders in the fisheries industry

A number of state departments and industry bodies are considered important stakeholders in the fisheries industry off the South Coast and various fishing companies are registered on the project database. These include:

Authorities
- Department of Agriculture, Forestry and Fisheries (DAFF); and
- Department of Environmental Affairs.

Industry bodies
- Shark Long-line Association;
- South African Hake Long-line Association;
- South African Deep Sea Trawling Industry Association (SADSTIA);
- South African Marine Linefish Management Associations;
- South African Tuna Association;
- South African Fishing Industry Associations (South African Pelagic Fishing Industry Association, South African Pelagic Fish Processors Association and South African Inshore Fishing Industry Association);
- South African Midwater Trawling Association;
- South Coast Rock Lobster Association;
- South African Squid Management Industrial Association; and
- South East Coast Inshore Fishing Association (SECIFA).

Companies and organisations[4]
- Blue Continent Products;
- BMC Visserye;
- Cronje fisheries;
- Esperado Fishing;
- Eyethu Fishing;
- I&J South-east Coast Inshore Fishing Association;

[3] Note that the employment numbers quoted are valid only up to 2008 and should only be used as a rough indicator. Although there have been changes in the fishery sectors since 2008, numbers employed are unlikely to have changed significantly and they remain a fair representation of employment in fisheries in South Africa.

[4] This covers the key fishing companies in the South Coast offshore but may not be exhaustive.

- Irvin & Johnson Limited;
- Lusitania Trawling Services;
- Nkunga Fishing Corporation;
- Oceana Group Limited;
- Premier Fishing (SA);
- Risar Fishing;
- Sea Harvest Corporation;
- Sea Vuna Fishing Company;
- South African Commercial Fishing Corporation;
- Suid Kaap Fisheries;
- Tuna South Africa; and
- Viking Inshore Fishing.

4.5.2 SHIPPING TRANSPORT

A large number of vessels navigate along the South Coast on their way around the southern African subcontinent (see Figure 4-33 and Table 4-12). The majority of this vessel traffic, including commercial and fishing vessels, remains relatively close inshore and is, therefore, expected to pass inshore of the licence area.

North- and south-bound cargo vessels usually remain over the mid-shelf (100 m isobath), while tankers and bulk carriers usually remain further offshore. The latter do, however, move closer inshore to escape extremely rough conditions that develop within the Agulhas Current. Some offshore commercial traffic departs east off the East Coast. Charted Traffic Separation Schemes, which are International Maritime Organisation (IMO) adapted and other relevant information are listed in the South African Annual Notice to Mariners No 5, of 2010. Figure 4-34 shows the safe shipping routes along the South African coast, as well as the traffic separation scheme around the Alphard Banks and F-A Platform.

Table 4-12: Number of vessels calling at South African ports and sailing past Cape Point, during 1998. (from Silvermine Maritime Intelligence)

Vessel type	Number of Cape Point Roundings	Number of vessels calling at ports						
		Cape Town	Durban	East London	Mossel Bay	Port Elizabeth	Richard's Bay	Saldanha
Bulk	135	421	814	18		86	1063	159
Cargo	113	961	1444	103	4	262	287	19
Unknown	128							
Vehicle carrier	12	54	130	7		26	13	1
Container carrier	74	672	852	45		376	25	2
Miscellaneous	7							
Tanker	140	217	570	70	30	87	199	36
Total vessels / yr	**609**	**2 325**	**3 810**	**243**	**34**	**837**	**1 587**	**217**

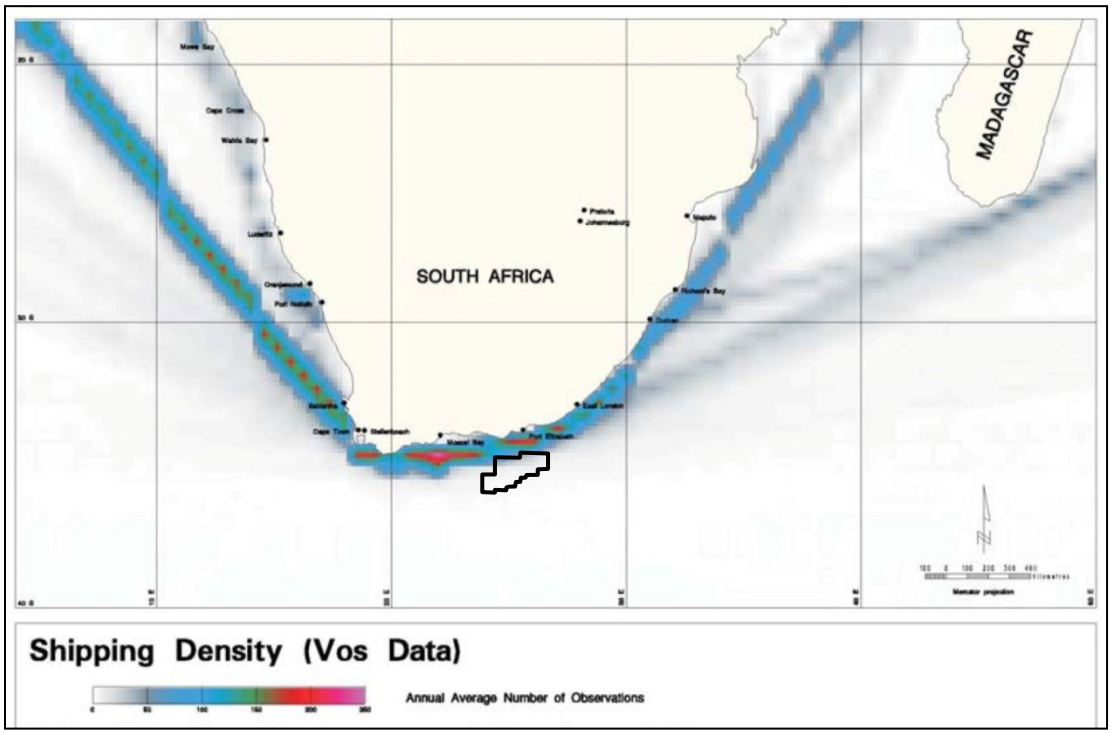

Figure 4-33: **Major shipping routes around southern Africa. The approximate location of Licence Block 11B/12B is also shown. Data from the South African Data Centre for Oceanography (image source: CSIR).**

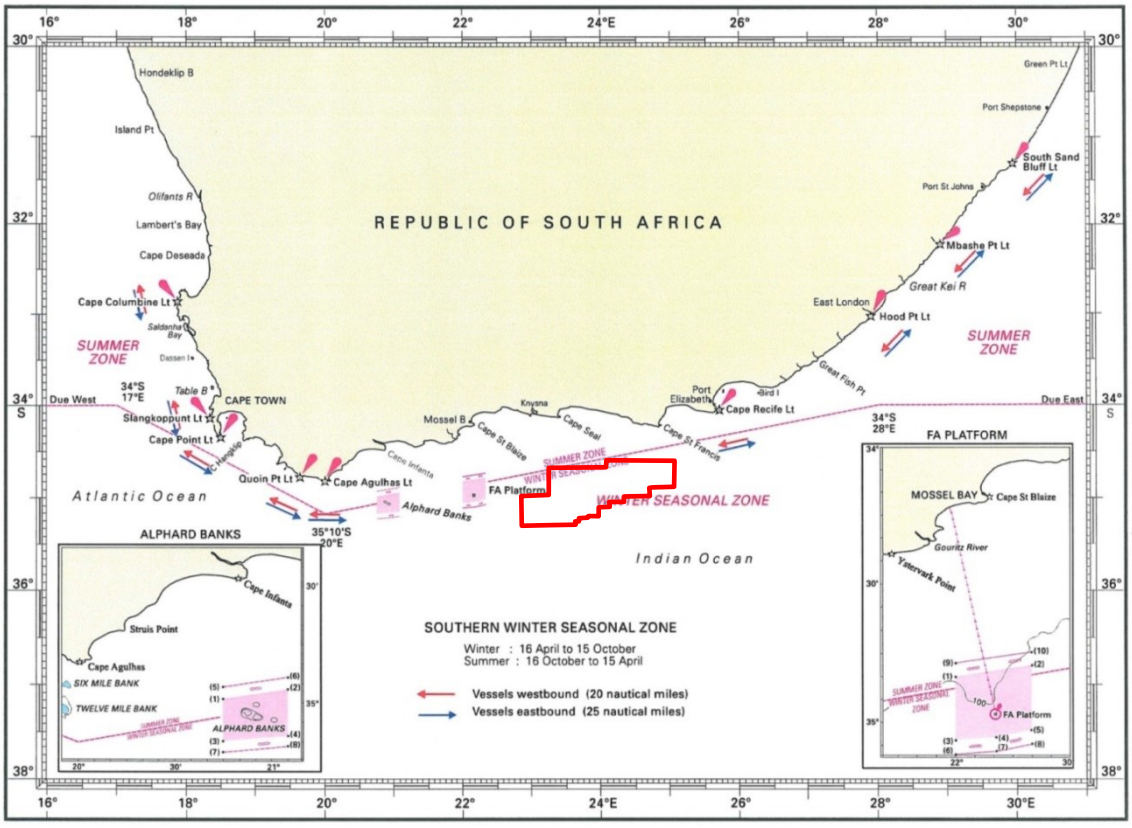

Figure 4-34: **Safe shipping routes around the coast of South Africa. From South African Notices to Mariners No 5 of 2010 with authorisation from the Navy Hydrographic Office.**

Laden tankers (carrying more than a half percent of their deadweight tonnage) are required to maintain a minimum distance of 20 nm off South Sand Bluff, Mbashe Point, Hood Point and Cape Recife when travelling westbound. They would then steer to pass through the westbound (the northern lanes) of the traffic separation schemes off the F-A Platform and Alphard Banks and maintain a minimum distance of 20 nm off Cape Agulhas, Quion Point, Cape Point, Slangkop Point and Cape Columbine. Laden tankers travelling eastwards are required to maintain a minimum distance of 25 nm when passing the landmarks mentioned above. Eastbound tankers between Cape Agulhas and Cape Recife should steer to pass through the eastbound or southern lanes of the traffic separation schemes off the Alphard Banks and F-A Platform.

Important South Coast commercial harbours include Port Elizabeth and Mossel Bay, while fishing harbours and slip-ways include Struis Bay, Arniston, Still Bay, Mossel Bay, Plettenberg Bay, St Francis Bay and Port Elizabeth.

4.5.3 EXPLORATION, PRODUCTION AND MINING

4.5.3.1. Oil and gas exploration and production

Oil and gas exploration and production is currently undertaken in a number of licence blocks off the West, South and East coasts of South Africa.

Exploration

Licence block rights holders and applicants surrounding Licence Block 11B/12B are shown in in Figure 4-35.

Numerous seismic surveys have been undertaken in the South Coast region since 1967. More than 210 wells have been drilled and of these, approximately 70% of wellheads remain on the seafloor. The F-A, E-M, South Coast Gas and F-O gas fields in Licence Block 9 have been the focus of exploration activities, together with the Bredasdorp Basin where several small oil fields have been discovered.

Production

PetroSA operates the F-A production platform, which was brought into production in 1992. The F-A platform is located 85 km south of Mossel Bay in a water depth of approximately 100 m. Gas and associated condensate from the associated gas fields (F-A, E-M, South Coast Gas and F-O) are processed through the platform. The produced gas and condensate are exported through two separate 90 km pipelines to the PetroSA Gas-to-Liquid (GTL) plant in Mossel Bay.

PetroSA has been producing oil from the Oryx/Oribi oil fields (E-AR and E-BT fields). These fields were tied back to the ORCA floating production platform, approximately 130 km south-west of Mossel Bay. The ORCA is currently in port for reclassification, after which it will likely return to continue production (Jessica Courtoreille, PetroSA, pers. comm., Jan 2014).

A 500 m statutory exclusion zone around any floating production storage and offloading unit and sea structures prohibits entry of any unauthorized vessels and aircraft. Larger safety zones around the E-M, F-A, South Coast Gas, F-O and Oryx/Oribi developments, depicted by the SA Navy Hydrographic Office (HydroSAN), prohibit any other activities that impact on the seafloor, i.e. anchoring, deploying of trawling gear, etc. to take place in these areas.

There are currently no production activities within the licence area.

4.5.3.2. Prospecting and mining of other minerals

Glauconite and phosphorite

Glauconite pellets (an iron and magnesium rich clay mineral) and bedded and peletal phosphorite occur on the seafloor over large areas of the continental shelf on the West and South Coasts. These concentrations represent potentially commercial sources of agricultural phosphate and potassium (Birch, 1979a, b; Dingle *et al.*, 1987; Rogers and Bremner, 1991).

Permits for the prospecting of glauconite and phosphorite have previously been issued for two areas off the South Coast, namely SOM 3 and Agrimin 3. However, these permits have subsequently expired (Jan Briess, Department of Mineral Resources (DMR) pers. comm., Dec 2013).

Diamond Fields International Ltd submitted an application to DMR to prospect for marine phosphates in the Outeniqua West Licence Area on the eastern Agulhas Bank between the 180 m and 500 m isobaths. The proposed Outeniqua West prospecting licence area extends from approximately longitude 20°E to 23°6 E and from latitude 34°S to 36.8°S with a surface area of 47 468 km2 (see Figure 4-36). Thus, Diamond Fields International's proposed prospecting licence area partially overlaps Licence Block 11B/12B. The application for an exploration licence was recently granted by the Minister (approximately January 2014) and is valid for a period of five years.

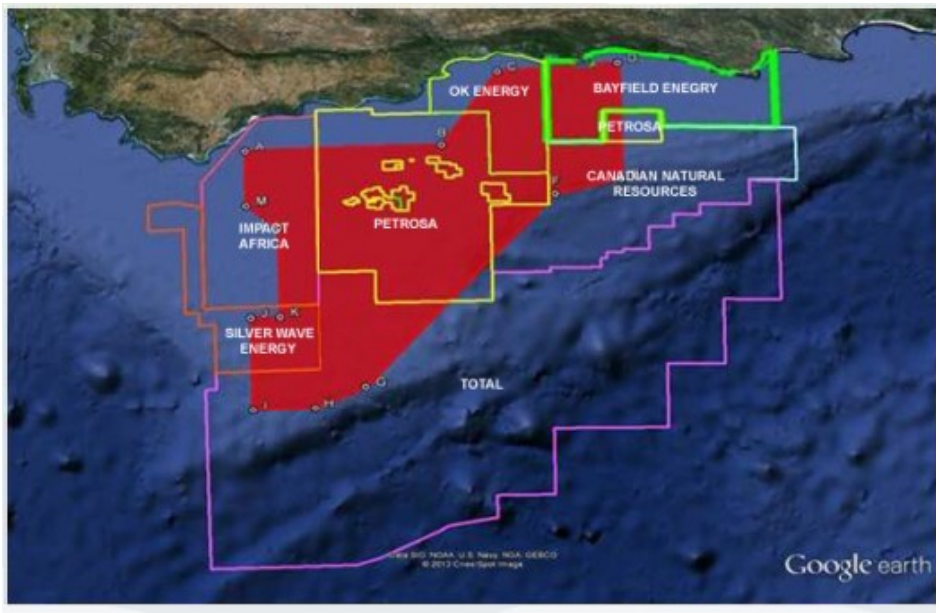

Figure 4-35: Diamond Fields International's proposed Outeniqua West prospecting licence area in relation to the licence blocks off the South Coast (extracted from the Background Information Document prepared by CSIR, February 2013).

Manganese nodules in ultra-deep water

Rogers (1995) and Rogers and Bremner (1991) report that manganese nodules enriched in valuable metals occur in deep water areas (>3 000 m) on the South and East coasts (Figure 4-36) approximately 75 km offshore of the licence area. The nickel, copper and cobalt contents of the nodules fall below the current mining economic cut-off grade of 2%.

4.5.4 RECREATIONAL UTILISATION

Coastal recreation along the South Coast may involve either consumptive or non-consumptive use of the marine environment.

Consumptive utilisation is sub-divided into two separate categories along the South Coast. The one involves subsistence fishers who rely on intertidal resources as an important source of protein. They predominantly exploit a wide variety of intertidal organisms. The second category includes recreational exploiters who do not rely on marine resources as an important protein source. They include: shore and boat-based anglers and spearfishers (Brouwer *et al.*, 1997; Mann *et al.*, 1997) who target a wide range of linefish species, some of which are also targeted by commercial anglers, skin divers who collect rock lobsters (*Panulirus homarus*) and other subtidal invertebrates, bait collectors (collecting mussels, limpets, red bait), and non-subsistence collectors of intertidal organisms (especially mussels).

Non-consumptive utilisation includes water sports, nature watching and beach recreation. Most non-consumptive utilisation practices are undertaken largely for the aesthetic value of the region.

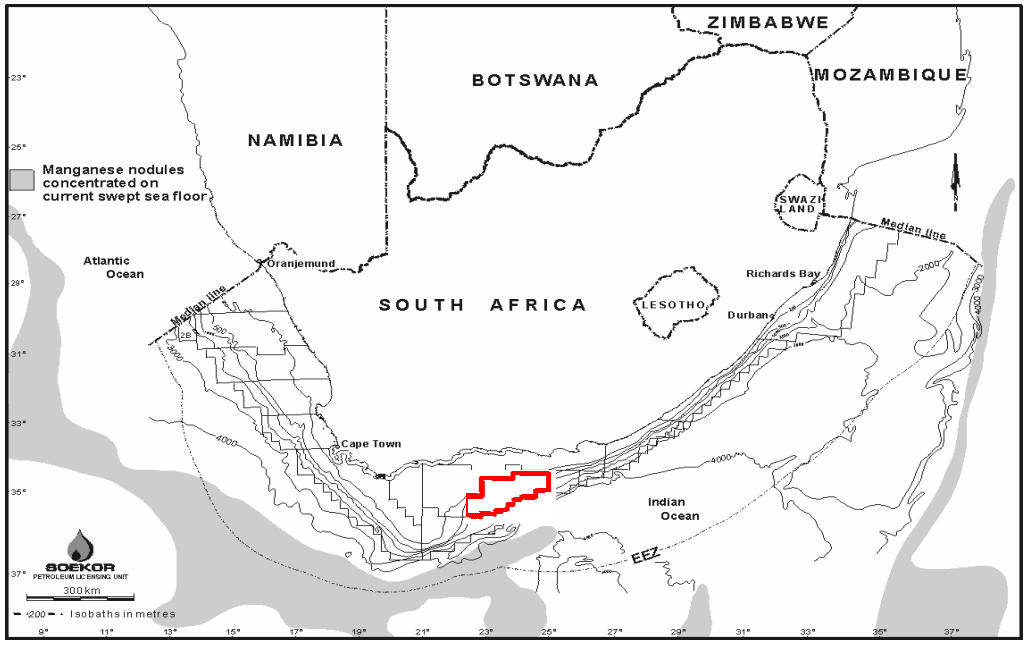

Figure 4-36: Schematic of location of manganese nodules off Southern Africa, showing petroleum licence blocks. Modified from Rogers (1995) and Fuggle & Rabie (1992). The proposed project area is highlighted in red.

4.5.5 OTHER

4.5.5.1. Anthropogenic marine hazards

Seafloor Hazards

Human use of the marine environment has resulted in the addition of numerous hazards on the seafloor. The Annual Summary of South African Notices to Mariners No. 5 or charts from HydroSAN identifies the location of different underwater hazards along the South Coast.

Undersea cables

A submarine telecommunications cable system traverses the Atlantic and the Indian Ocean (see Figure 4-37). This system is called “SAT3/WASC/SAFE” (South Atlantic Telecommunications cable no.3 / West African Submarine Cable / South Africa Far East). The 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). Between 19°E and 29°E, the SAT3 cable runs along the 4 000 m isobar which lies just to the south of Licence Block 11B/12B.

A high bandwidth fibre optic cable system, Eastern Africa Submarine Cable System (EASSy), connects countries of eastern Africa to the rest of the world (see Figure 4-37). EASSy runs from Mtunzini in South Africa to Port Sudan in Sudan, with landing points in nine countries, and connected to at least ten landlocked countries.

A new 14 000 km long West Africa Cable System (WACS), which links South Africa to London, as well as the 17 000 km long Africa Coast to Europe (ACE) cable system to link Africa to France became operational in 2012. Three new cable systems to link South America and Africa (SAex, WASACE and BRICS) are also being proposed for 2014 (see Figure 4-37). Further to this, the South Atlantic Cable System (SACS), a submarine communications cable that will link Luanda, Angola and Fortaleza, Brazil is forecast for completion in mid-2015 and will cover a distance of approximately 6 500 km.

There is an exclusion zone applicable to the telecommunication cables of 1 nm each side of the cable in which no anchoring is permitted.

4.5.5.2. Archaeological sites

Over 2 000 shipwrecks are present along the South African coastline (Gribble, 1997). The majority of known wrecks lost along the South Coast are located in relatively shallow water close inshore (Turner, 1988). These are important archaeological sites as they represent an almost complete microcosm of their historical periods. As a result, wrecks older than 50 years old are declared national monuments (Gribble, 1997). There are several known shipwrecks in the vicinity of, and possibly within, Licence Block 11B/12B, however, geographic co-ordinates in this regard are currently not available (Tara van Niekerk, South African Heritage Resources Agency, pers. comm., Feb 2014).

4.5.5.3. Conservation areas and marine protected areas

Four marine protected areas (MPAs), including Goukamma, Robberg, Tsitsikama and De Hoop, and numerous conservation areas, occur along the South Coast, although none fall within the licence area (see Figure 4-38).

The Goukamma MPA has a coastline of approximately 14 km from Buffalo Bay to Platbank and stretches 1 nm (1.85 km) out to sea. The Goukamma MPA is aimed at the protection of intertidal species (with an emphasis on protection of sought after bait species), the protection of important offshore reefs that provide habitat for commercially threatened sparid species (particularly red steenbras and black musselcracker), and the preservation of the natural functioning of marine and estuarine ecosystems. The MPA contains rocky platforms, sandy beaches, sub tidal rocky reefs and sub tidal sandy benthos. The seaward extent of the MPA does not adequately protect the reefs from utilisation by recreational or commercial fishers.

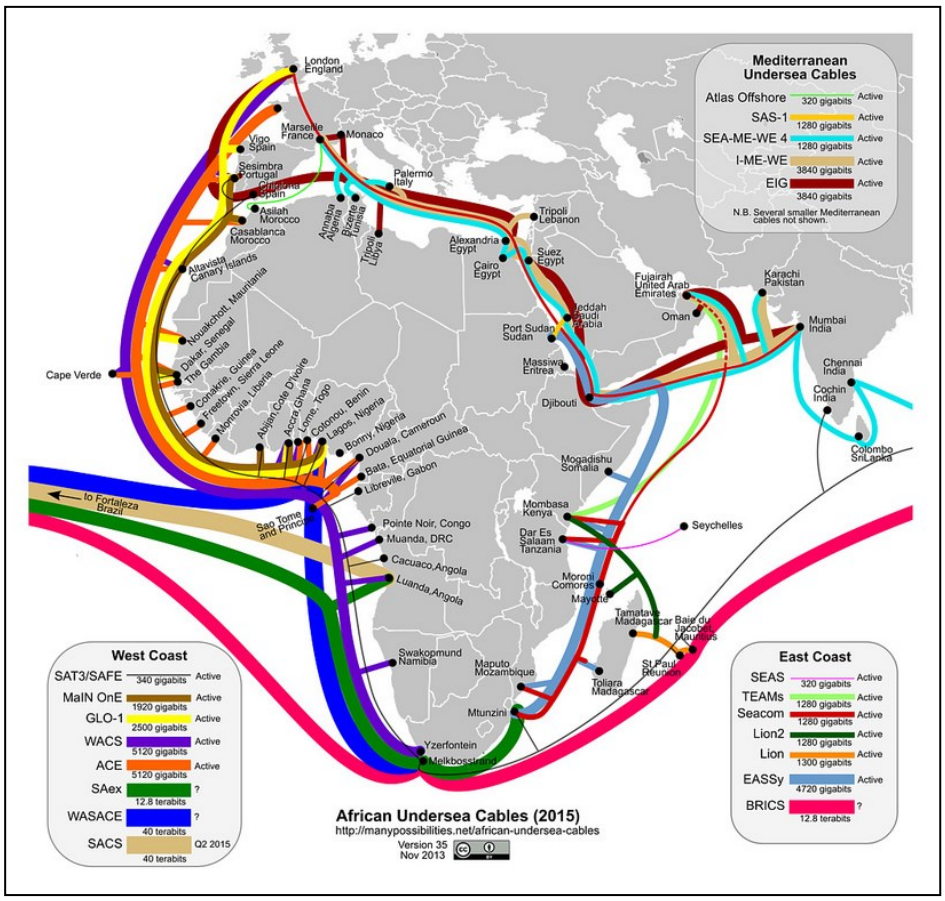

Figure 4-37: Configuration of the current African undersea cable systems as well as cables proposed for 2014 and 2015 (From http://www.manypossibilities.net).

The Robberg MPA is adjacent to Robberg Nature Reserve, in the vicinity of Plettenberg Bay. The nature reserve forms a peninsula with a single access point. The Robberg MPA shoreline stretches 9 km and includes rocky platforms, sandy beaches, subtidal rocky reefs and subtidal sandy benthos. A Cape Fur Seal colony is located on the eastern end of the Robberg peninsula.

The Tsitsikamma National Park, proclaimed in 1964, is the oldest and largest 'no-take' MPA in Africa. It extends from Groot River West (33°59‟S, 23°34‟E) to Groot River East (34°04‟S, 24°12‟E), covers 57 km of coastline and stretches 3 nm offshore. It has a total surface area of 32 300 hectares. The majority of the MPA's coastline is rugged with high rocky ridges, but boulder bays, subtidal rocky reefs and subtidal sandy benthos also occur. Considered a biodiversity 'hotspot', this MPA provides extensive reef habitats for benthic invertebrates and algae, as well as many endemic slow-growing, and long-lived linefish species, many of which are over-exploited. The MPA is thus crucial for the conservation of species such as dageraad, red stumpnose, red steenbras, seventy-four, musselcracker, poenskop, white steenbras and dusky kob.

Other MPAs in the broader study area include the De Hoop MPA, the Sardinia Bay MPA and the Bird Island MPA (in Algoa Bay) (see Figure 4-38).

The De Hoop MPA was declared in 1985; the adjacent De Hoop Nature Reserve was subsequently listed as a World Heritage Site in 2004. This MPA extends along a 46 km stretch of coastline from Stilbaai Point to Skipskop and extends 3 nm offshore covering a total area of approximately 25 300 ha. It is currently

the only conservation area that affords protection to the unique intertidal system of large, eroding, soft sandstone and limestone platforms. The intertidal biota represent both warm-water East Coast and cold-water West Coast species, resulting in highly diverse communities. The MPA has played an important role in the protection of over-exploited reef fishes (e.g. red steenbras) and provides migrant recruits of many sought-after linefish species into neighbouring fishing areas. De Hoop MPA is also critically important for the conservation of the southern right whale and, together with St. Sebastian Bay, contains 70-80% of cow-calf pairs on the South African coast, thus ranking as probably the most important nursery area for southern right whales in the world. Further to this, the MPA contains an important breeding area for the near-threatened African black oystercatcher. An African penguin breeding colony has recently established itself within the MPA, making it one of only three mainland penguin colonies in Southern Africa, the other two being Boulders and Stony Point within the Table Mountain National Park and Betty´s Bay MPAs, respectively.

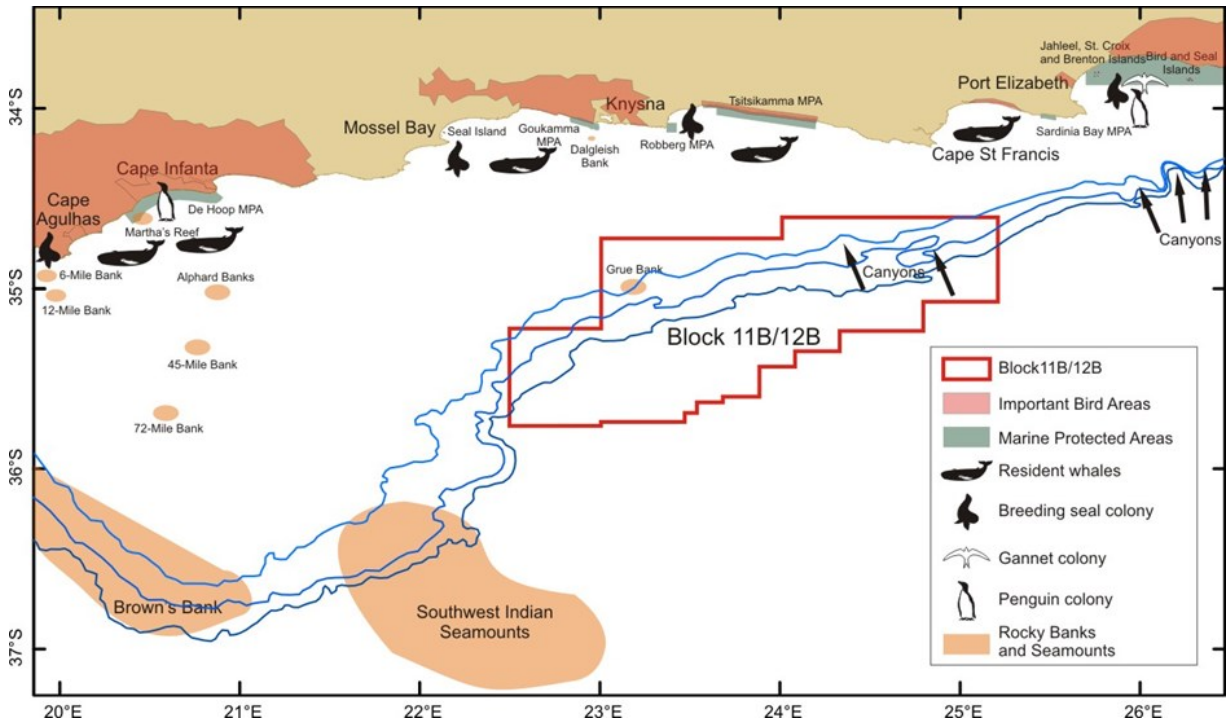

Figure 4-38: Project - environment interaction points on the South Coast, illustrating the location of seabird and seal colonies, seasonal whale populations, and marine protected areas in relation to Licence Block 11B/12B. The location of offshore banks and seamounts, which could potentially be Vulnerable Marine Ecosytems (VMEs) are also shown.

The Sardinia Bay MPA has a shoreline 7 km in length and extends one 1 nm seawards of the high-water mark. It is located between Schoenmakerskop and Bushy Park. It contains representative habitat including rocky platforms, sandy beaches, subtidal rocky reefs, and subtidal sandy benthos.

Bird Island MPA was declared in 2004 for biodiversity conservation reasons, and incorporated into the Addo Elephant National Park in 2005. The boundaries of the Algoa Bay Island nature reserve extend 500 m offshore of the islands as MPAs. However, a larger MPA of an envisaged 120 000 ha, which will form part of a national conservation area (the Greater Addo Elephant National Park) has been proposed. The Bird Island group (Bird, Seal, Stag and Black Rock) is situated at the north eastern end of Algoa Bay close to Woody Cape. These islands are the only important seabird islands along a 1 800 km stretch of

coastline between Dyer Island near Hermanus in the Western Cape and Inhaca Island in Mozambique. Together with St Croix, Jahleel and Brenton Islands (also in Algoa Bay), they are classed as Important Bird Areas (IBAs), because they regularly support significant numbers of globally threatened bird species and also hold large concentrations of seabirds. Of the 14 South African resident seabird species, 6 breed either on the islands or at the adjacent coast. The islands play an important national and international role in the conservation of the Cape Gannet (*Morus capensis*), African Penguin (*Spheniscus demersus*) and Roseate Tern (*Sterna dougallii*). Furthermore, they form ecologically distinct subtidal habitats, containing many endemic invertebrates, algae and linefish (e.g. santer and red roman). Black Rock is an important seal breeding colony, and serves as a great white shark feeding area. The Bird Island MPA is also of particular importance to the threatened abalone, as abalone poaching activities are strictly controlled.

In addition to the existing MPAs, the national plan to identify focus areas for offshore biodiversity protection (Sink *et al.,* 2011) found that various pelagic and seabed habitats on the South Coast warrant protection. In the South Coast region, the Agulhas Bank, Southwest Indian Seamounts and Offshore Port Elizabeth have been identified as areas which require protection (refer to Figure 4-39). The deep reef and palaeo-shoreline habitats are considered important for the recovery of overexploited linefish species, whereas the canyons and shelf edge are important habitats for cold water corals. Bycatch management in the crustacean trawl fishery and the protection of threatened linefish and turtles have also been identified as key objectives. The following offshore biodiversity protection areas are proposed:

- *Browns Bank*: In the Brown's Bank area, sector specific fishery management areas, seabed protection zones or MPAs would be considered. Brown's Bank is an important spawning area for hake, with large fish frequenting the area. A small closed area, including the more vulnerable hard ground habitat, would thus support the sustainability of the hake fisheries. Hard grounds in this focus area should receive formal protection from fishing and mining. The plan recommended that activities that affect the seabed be prevented from extending into deeper water along this portion of the shelf edge.

- *Agulhas Bank*: For the Agulhas Bank area, a zoned MPA is recommended to represent poorly protected mud and gravel habitats, protect vulnerable marine ecosystems (deep reefs, hard grounds) and threatened linefish species, and support sustainable inshore trawl and linefish fisheries. This would either include or supplement independent spatial management aimed at supporting by-catch management for the inshore trawl sector. A network of linked (but not necessarily contiguous) spatial management measures across the bank was considered most appropriate. Key features for inclusion include the Alphard Banks, the 45-Mile Bank (see Figure 40), unrepresented gravel and mud habitats and the different fish communities caught by the inshore trawl sector.

- *Offshore of Port Elizabeth*: The offshore Port Elizabeth area is complex and spatial management measures would include seabed protection zones, fishery management areas and the expansion of existing or proposed MPAs. The offshore features in this area have few alternative options prompting the selection of this area despite its relatively high cost values. Existing planning for the proposed Greater Addo MPA and the existing seasonal kingklip closure would be considered in the development of offshore spatial management measures for this area, with a suite of smaller appropriately zoned areas across this focus area being appropriate.

- *Southwest Indian Seamounts*: A fully protected or zoned MPA is suggested for the Southwest Indian Seamounts. Very rough ground and strong currents already offer some protection to this area, which has lower cost than many other shelf edge areas. Unprotected habitats of very limited spatial extent (e.g. shelf edge gravels) would be considered for inclusion, as would either two separate management areas or a large single zoned area. Management objectives include offshore habitat representation, protection of shelf edge and seamount benthic habitats, fisheries sustainability for small pelagic species and by-catch reduction in the large pelagic fishery.

4.5.5.4. Mariculture industries

Perlemoen, mussel and oyster farming facilities are located near Port Elizabeth (O'Sullivan, 1998). Oysters are also farmed within the Knysna Lagoon, while they are reported to be exploited commercially at numerous other sites along the South Coast (Jackson and Lipschitz, 1984).

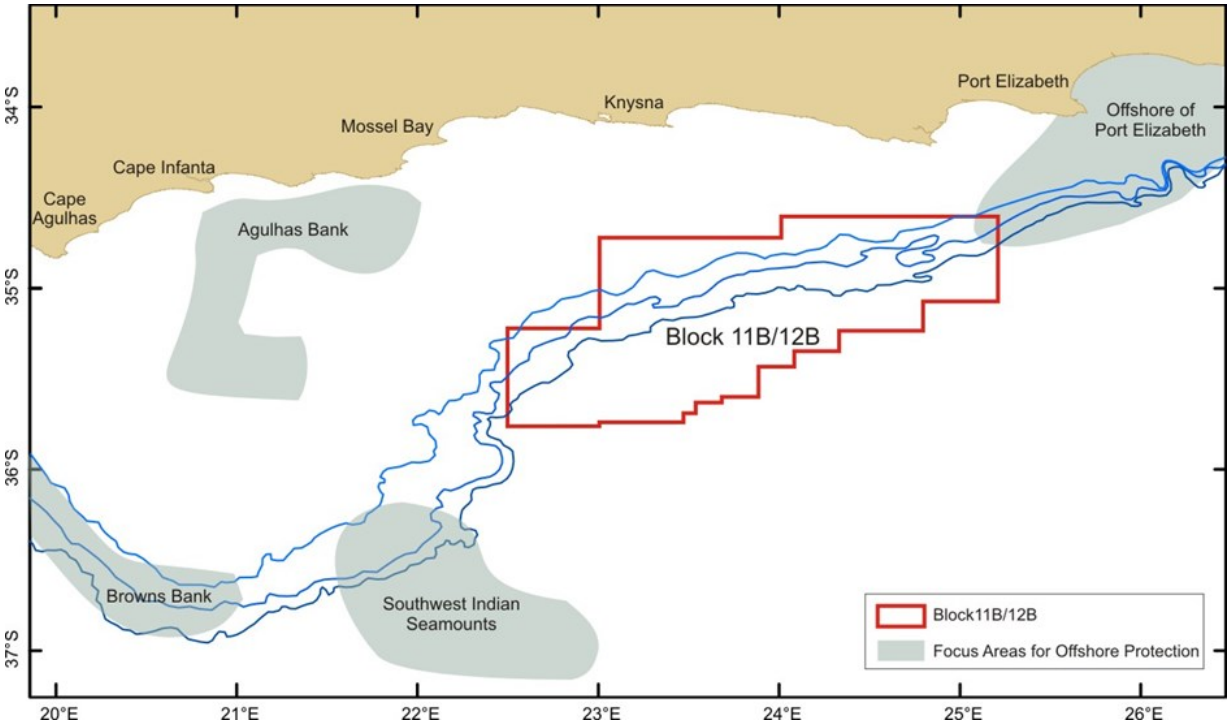

Figure 4-39: Focus Areas for offshore protection on the South Coast in relation to Licence Block 11B/12B.

4.5.5.5. Marine outfall/intake pipes

Eleven outfalls and one intake are located along the South Coast (Jackson and Lipschitz, 1984). The most important pipelines include the sewerage outfall at Port Elizabeth, which discharges 60 000 m³/day, and the PetroSA refinery outfall at Vlees Bay, which discharges approximately 8 000 m³/day of saline effluent. Other less important outfalls are located off Cape Recife and Drift Sands in Port Elizabeth, and at Mossel Bay. A 2.5 km long product pipeline is also located off Voorbaai, which is used to import and export hydrocarbon products.

4.5.5.6. Ammunition dump sites

The location of the ammunition dumpsites situated along the South Coast and details of dumped munitions are given on the relevant SAN charts. There are no ammunition dumpsites located near the licence area.