4. THE AFFECTED ENVIRONMENT

This chapter provides a description of the biophysical and socio-economic environment focusing primarily on the study area between the Orange River mouth and St Helena Bay. However, the description has been extended into Namibia, where appropriate, to cater for any potential cross border impacts. The purpose of this biophysical and socio-economic description is to provide a baseline environmental context within which the proposed exploration drilling would take place.

4.1 MARINE ENVIRONMENT (OFFSHORE)

This section provides a general overview of the physical and biological oceanography and human utilisation of South African West Coast and, where applicable, detailed descriptions of the marine environment that may be directly affected by the proposed project.

The licence area lies within the southern zone of the Benguela Current region and is characterised by the cool Benguela upwelling system (Shillington 1998; Shannon 1985). A conceptual model of the Benguela system (see Figure 4.1) summarises much of the physical oceanography of the region.

4.1.1 METEOROLOGY

The prevailing winds in the Benguela region are controlled by the South Atlantic subtropical anticyclone, the eastward moving mid-latitude cyclones south of southern Africa and the seasonal atmospheric pressure field over the subcontinent. The south Atlantic anticyclone is a perennial feature that forms part of a discontinuous belt of high-pressure systems which encircle the subtropical southern hemisphere. This undergoes seasonal variations, being strongest in the austral summer, when it also attains its southernmost extension, lying south west and south of the subcontinent. In winter, the south Atlantic anticyclone weakens and migrates north-westwards.

These seasonal changes result in substantial differences between the typical summer and winter wind patterns in the region, as the southern hemisphere anti-cyclonic high-pressures system and the associated series of cold fronts moves northwards in winter and southwards in summer. The strongest winds occur in summer (October to March), during which winds blow 98% of the time (PRDW 2014), with a total of 226 gales (winds exceeding 18 m/s or 35 kts) being recorded over the period (CSIR 2006). Virtually all winds in summer come from the south to south-southeast (see Figure 4.2), strongly dominated by southerlies which occur over 40% of the time, averaging 20 - 30 knots (kts) and reaching speeds in excess of 100 km/h (60 kts). South-easterlies are almost as common, blowing about one-third of the time and also averaging 20 - 30 kts. The combination of these southerly and south-easterly winds drive the massive offshore movement of surface water, resulting in strong upwelling of nutrient-rich bottom waters, which characterise this region in summer.

Winter remains dominated by southerly to south-easterly winds, but the closer proximity of the winter cold-front systems results in a significant south-westerly to north-westerly component (see Figure 4.2). This ‘reversal’ from the summer condition results in cessation of upwelling, movement of warmer mid-Atlantic water shorewards and breakdown of the strong thermoclines which typically develop in summer. There are also more calms in winter, occurring about 3% of the time, and wind speeds generally do not reach the maximum speeds of summer. However, the westerlies winds blow in synchrony with the prevailing south-westerly swell direction, resulting in heavier swell conditions in winter.

Another important wind type that occurs along the West Coast are katabatic 'berg' winds during the formation of a high-pressure system (lasting a few days) over, or just south of, the south-eastern part of the subcontinent. This results in the movement of dry adiabatically heated air offshore (typically at 15 m/s). At times, such winds may blow along a large proportion of the West Coast north of Cape Point and can be intensified by local topography. Aeolian transport of fine sand and dust may occur up to 150 km offshore.

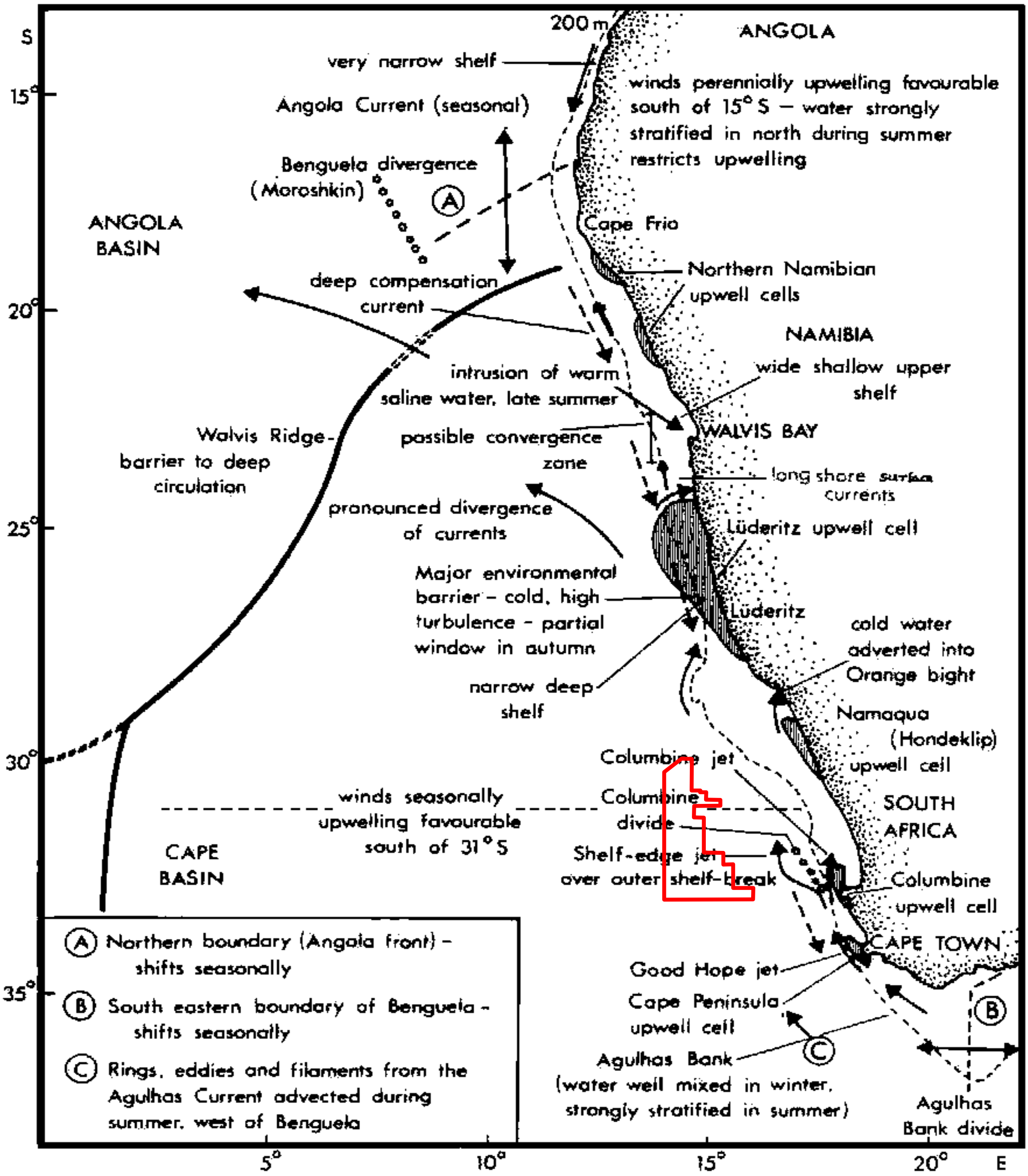

Figure 4.1: **A conceptual model of the Benguela system (after Shannon 1985). Approximate location of licence area is also indicated.**

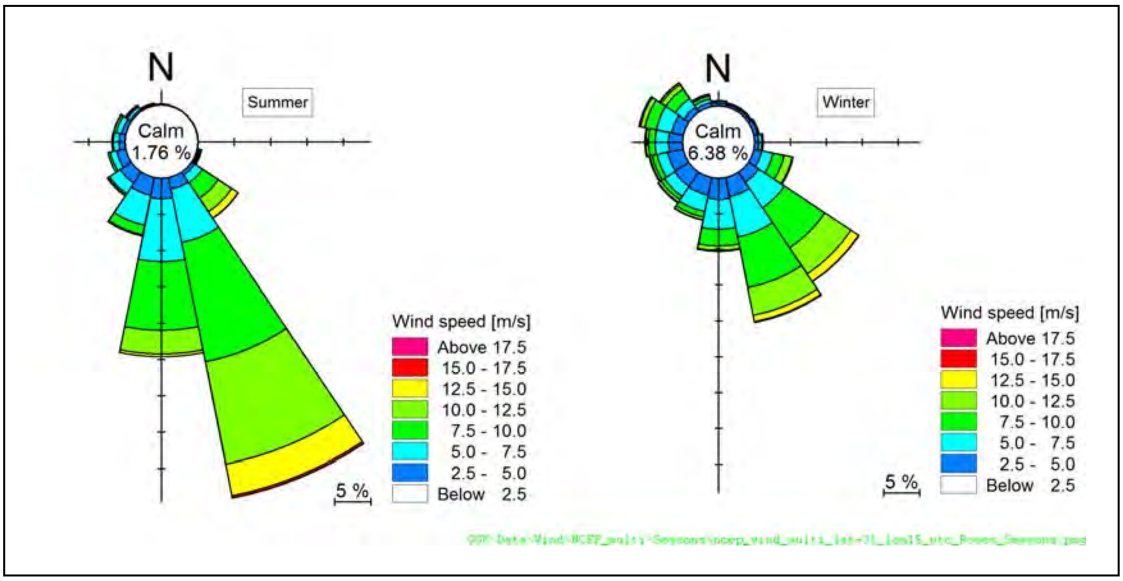

Figure 4.2: Wind Speed vs Wind Direction for NCEP hindcast data at location 15°E, 31°S (PRDW 2014).

4.1.2 PHYSICAL OCEANOGRAPHY

4.1.2.1 Waves

The direction and size of waves present at different sites along the West Coast have been reported by Heydorn and Tinley (1980), Bickerton (1981a and b, 1982) and Morant (1984).

Wave patterns along the West Coast are strongly influenced by the seasonal meteorology. The majority of swells are generated by mid-latitude cyclones to the south of the country, and thus originate from the SW. Wave period is similar and unimodal along the West Coast to the north of Cape Point. Peak energy periods range from 9.7 to 15.5 seconds.

Typical seasonal swell-height rose-plots, compiled from Voluntary Observing Ship (VOS) data off Oranjemund, are shown in Figure 4.3. The wave regime along the West Coast shows only moderate seasonal variation in direction, with virtually all swells throughout the year coming from the S and south-south-west (SSW) direction. Winter swells are strongly dominated by those from the S and SSW, which occur almost 80% of the time, and typically exceed 2 m in height, averaging about 3 m, and often attaining over 5 m. With wind speeds capable of reaching 100 km/h during heavy winter south-westerly storms, winter swell heights can exceed 10 m.

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

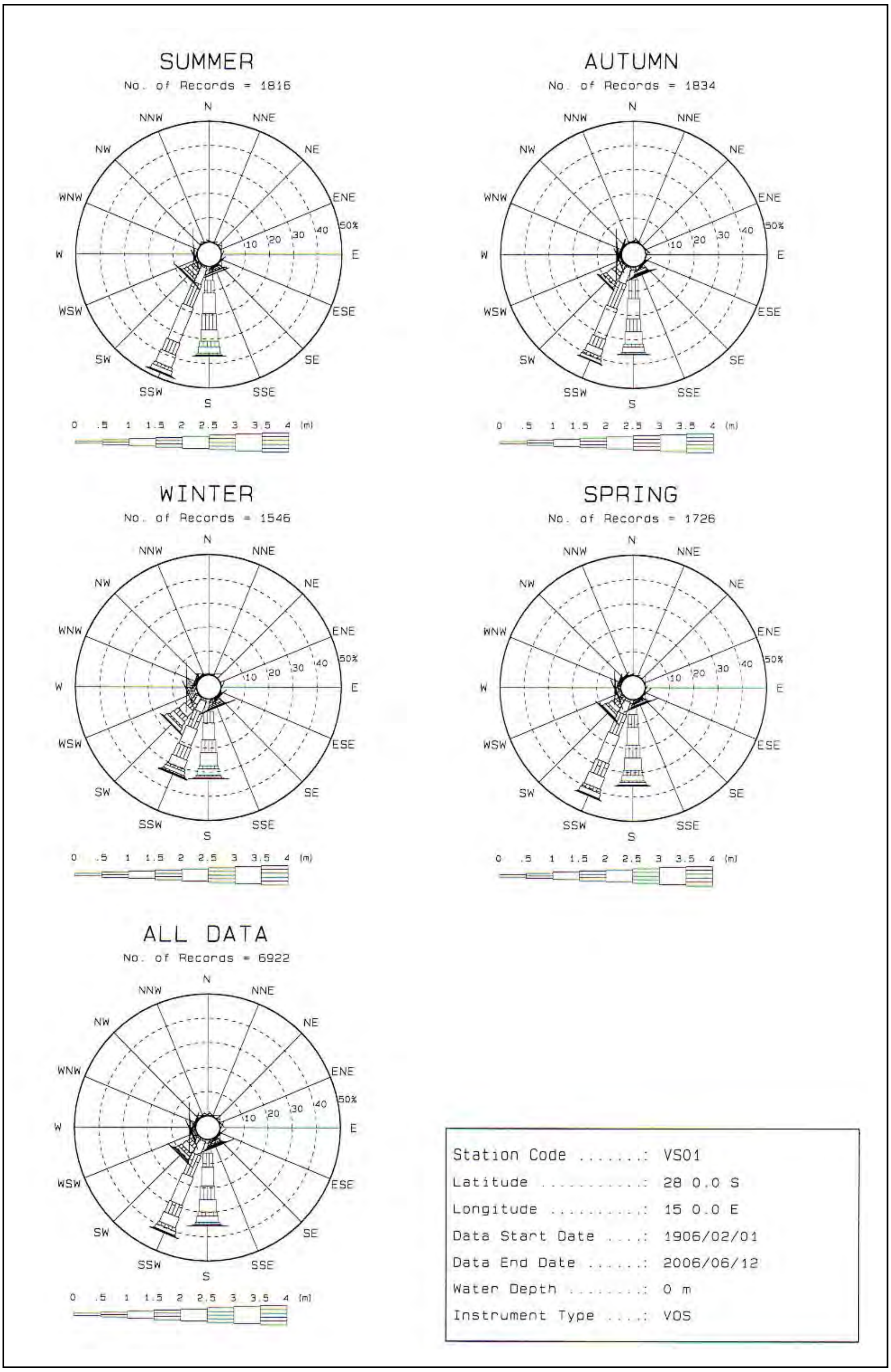

Figure 4.3: Voluntary Observing Ship (VOS) data Wave Height vs Wave Direction data for the offshore area (28°-29°S; 15°-16°E recorded during the period 1 February 1906 and 12 June 2006)) (Source: Southern African Data Centre for Oceanography (SADCO)).

4.1.2.2 Tides

Tides along the West Coast are subject to a simple semi-diurnal tidal regime with a mean tidal range of about 1.57 m (at least 50% of the time in the nearshore area), with spring tides as much as 2.24 m and neap tides in the order of 1 m. Tides arrive almost simultaneously (within 5 to 10 minutes) along the whole of the West Coast. Other than in the presence of constrictive topography, e.g. an entrance to enclosed bay or estuary, tidal currents are weak.

4.1.2.3 Bathymetry and topography

The bathymetry and topography of the West Coast offshore region has been described by Nelson and Hutchings 1983; Shannon 1985; Shannon and Nelson 1996 and Dingle *et al.* 1987.

The continental shelf along the West Coast is generally both wide and deep, although large variations in both depth and width occur (Figure 4.4). The shelf maintains a general north-north-west (NNW) trend north of Cape Point, being narrowest in the south between Cape Columbine and Cape Point (40 km) and widening to the north of Cape Columbine to its widest of the Orange River (180 km). Between Cape Columbine and the Orange River, there is usually a double shelf break, with the distinct inner (closest to shore) and outer slopes separated by a gently sloping ledge.

The immediate nearshore area consists mainly of a narrow (to about 8 km wide) rugged rocky zone which initially slopes steeply seawards to a depth of about 30 m and then gradually to about 80 m. The middle and outer shelf normally lacks relief and slope gently seawards reaching the shelf break (where the slope becomes significantly steeper) at a depth of approximately 300 m.

Banks on the continental shelf include the Orange Bank (Shelf or Cone), a shallow (160 to 190 m) zone that reaches maximal widths (180 km) offshore of the Orange River, and Childs Bank, situated about 75 km east of the area of interest. Child's Bank is the only known submarine bank within South Africa's Exclusive Economic Zone (EEZ), rising from a depth of 350 to 400 m water to less than 200 m at its shallowest point. The bank area has been estimated to cover approximately 1 450 km^2 (Sink *et al*. 2012). Tripp Seamount is a geological feature approximately 120 km north-northwest of the proposed area of interest, which rises from the seabed at approximately 1 000 m water depth to a depth of 150 m. A number of submarine canyons cut into the shelf between 31° and 35°S, the most prominent being the Cape Canyon and the Cape Point Valley.

The area of interest covers an area of approximately 900 km^2 with water depths ranging between 1 500 m and 2 100 m (see Figure 3.1).

4.1.2.4 Sediments

The distribution of seabed surface sediment types off the West Coast are illustrated in Figure 4.5. The inner shelf is underlain by Precambrian bedrock (also referred to as Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle 1973; Birch *et al*. 1976; Rogers 1977; Rogers & Bremner 1991).

As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. An almost 500 km long mud belt (of up to 40 km wide and of 15 m average thickness) is situated over the outer edge of the middle shelf between the Orange River and St Helena Bay (Birch et al. 1976). Further offshore, sediment is dominated by muddy sands, sandy muds, mud and some sand. The continental slope, seaward of the shelf break, has a smooth seafloor, underlain by calcareous ooze. Within the area of interest, sediment is dominated by muds and sandy muds (see Figure 4.5).

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

Nearshore sediments are subject to suspension by waves and longshore transport. This effect penetrates to 90 m. Natural turbidity levels range from 3 and 12 mg/l with significantly higher concentrations associated with storm waves and floods.

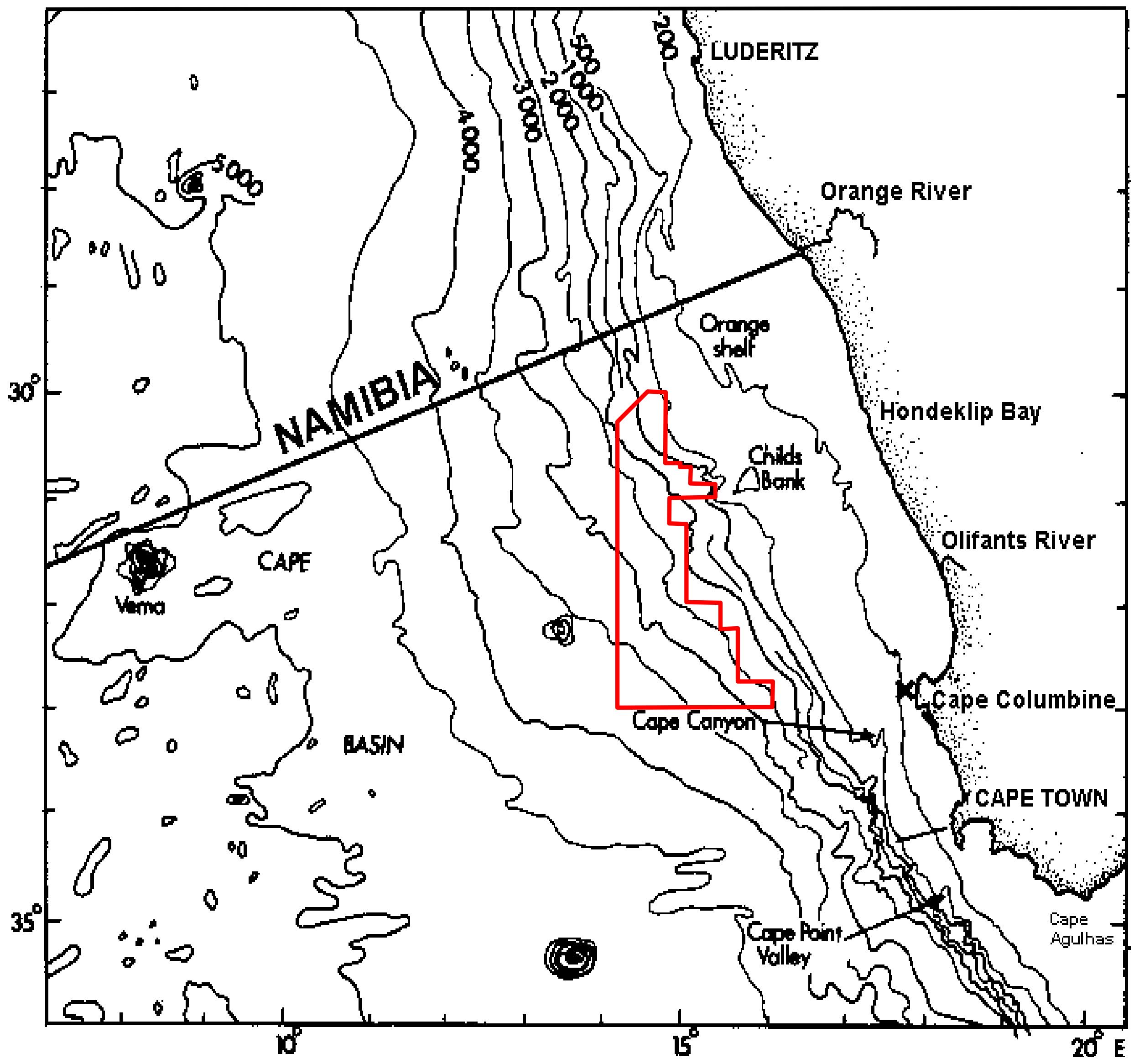

Figure 4.4: Bathymetry of the continental shelf off the West Coast of southern Africa (after Dingle *et al.* 1987). Approximate location of the licence area is also indicated.

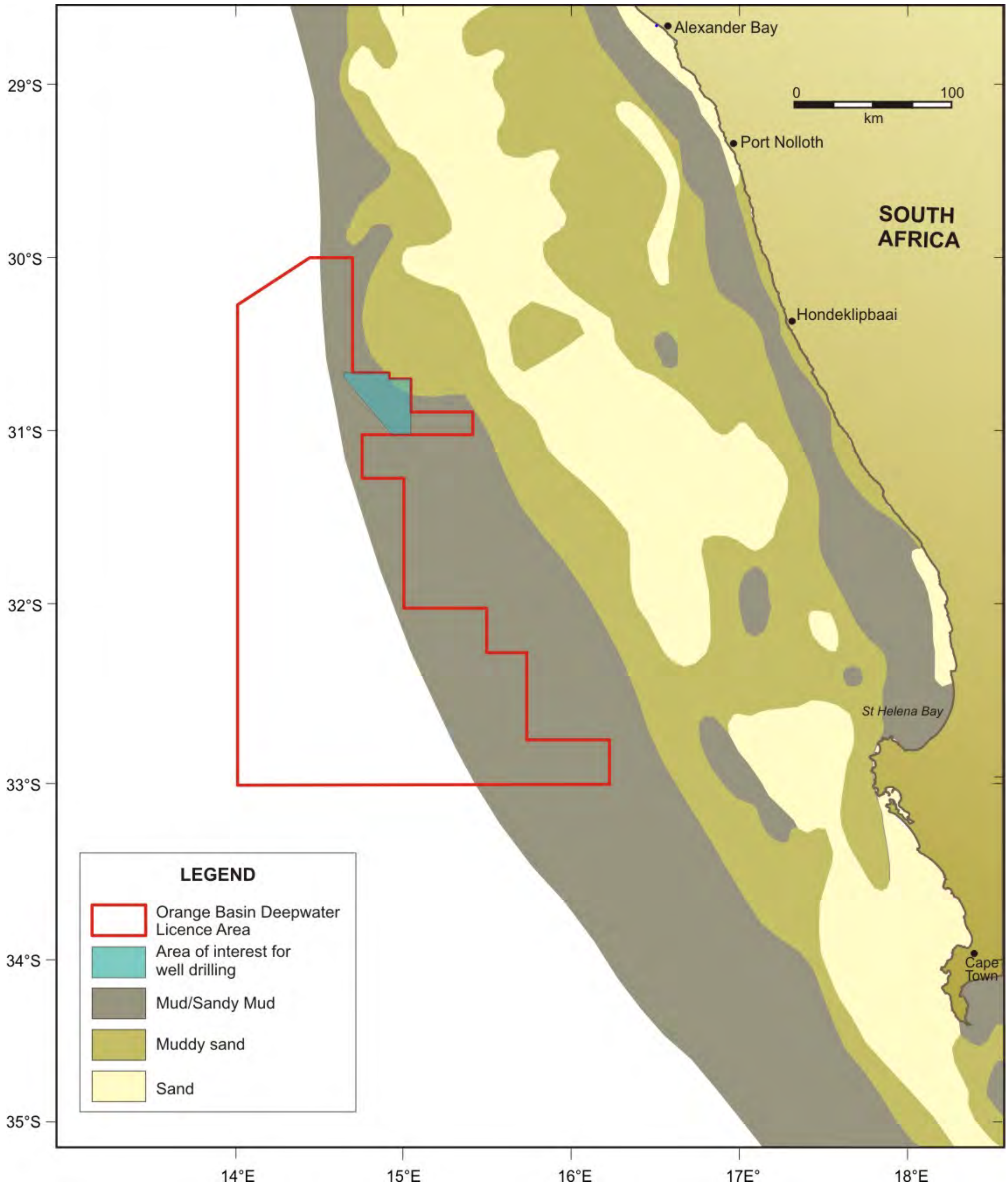

Figure 4.5: **Sediment distribution on the continental shelf of the South African West Coast (Adapted from Rogers 1977). Approximate location of the licence area is also indicated.**

4.1.2.5 Water masses and sea surface temperatures

A number of water masses are found along the West Coast, including tropical and sub-tropical surface waters, thermocline waters (comprising South Atlantic, South Indian and tropical Atlantic Central Water), Antarctic Intermediate Water (AAIW), North Atlantic Deep Water (NADW) and Antarctic Bottom Water (AABW). The thermocline water mass (6°C, 34.5 Practical Salinity Units (psu) – 16°C, 35.5 psu) is that which upwells along the coast and which constitutes the shelf waters of the Benguela, although in highly modified forms. Thermocline water overlies AAIW (34.2-34.5 psu with potential temperature 4-5°C). NADW has a potential temperature less than 3°C and salinity greater than 34.8 psu, and lies below the AAIW stratum. In the Cape Basin, it lies above the AABW, which is located deeper than about 3 800 m. AABW is cooler than 1.4°C and has a salinity of 34.82 psu.

Off the south-western Cape the upwelling of cool water occurs during the summer months stabilising the seawater temperature along this coastline to some extent so that the average sea surface temperature changes little throughout the year (13 to 15 °C). In the northern Benguela system where cool upwelling occurs during the winter months, a far more pronounced seasonal difference (12 to 17 °C) in sea surface temperatures occurs (Shannon 1985). The sea surface temperature along the coast of Namaqualand near Port Nolloth ranges from a minimum of 10 °C to a maximum of just over 20 °C, with 84 % of the temperatures falling within a range of 12 °C to 17 °C.

Over the continental margin, progressively colder waters encroach onto the continental shelf between the Orange River and the Cape Peninsula (Shannon and Nelson 1996). The area between 31°S and 33°S has the minimum shelf temperatures, with isotherms retreating into deeper water south of 34°S (Dingle and Nelson 1993).

4.1.2.6 Water Circulation

Water circulation off the West Coast is dominated by upwelling (see Section 4.1.2.7). Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest.

The ocean currents occurring off the West Coast are complex and are summarised in Figure 4.6. Data suggests that currents north of Cape Columbine are weaker and more variable than the currents to the south (Boyd *et al*. 1992). The most important is the Benguela current, which constitutes a broad, shallow and slow NW flow along the West Coast between the cool coastal upwelled waters and warmer Central Atlantic surface waters further offshore. The current is driven by the moderate to strong S to SE winds which are characteristic of the region and is most prevalent at the surface, although it does follow the major seafloor topographic features (Nelson and Hutchings 1983).

Current velocities in continental shelf areas generally range between 10 to 30 cm/s (Boyd & Oberholster 1994), although localised flows in excess of 50 cm/s occur associated with eddies (PRDW 2014). On its western side, flow is more transient and characterised by large eddies shed from the retroflection of the Agulhas Current. This results in considerable variation in current speed and direction over the domain (see Figure 2.10 in Appendix 3.2). In the south the Benguela current has a width of 200 km, widening rapidly northwards to 750 km. The surface flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington *et al.* 1990; Nelson & Hutchings 1983) (see Figure 4.6). Fluctuation periods of these flows are 3 to 10 days, although the long-term mean current residual is in an approximate north-west (alongshore) direction. Current speeds decrease with depth, while directions rotate from predominantly north-westerly at the surface to south-easterly near the seabed. Near bottom shelf flow is mainly poleward with low velocities of typically <5 cm/s (Nelson 1989; PRDW 2014).

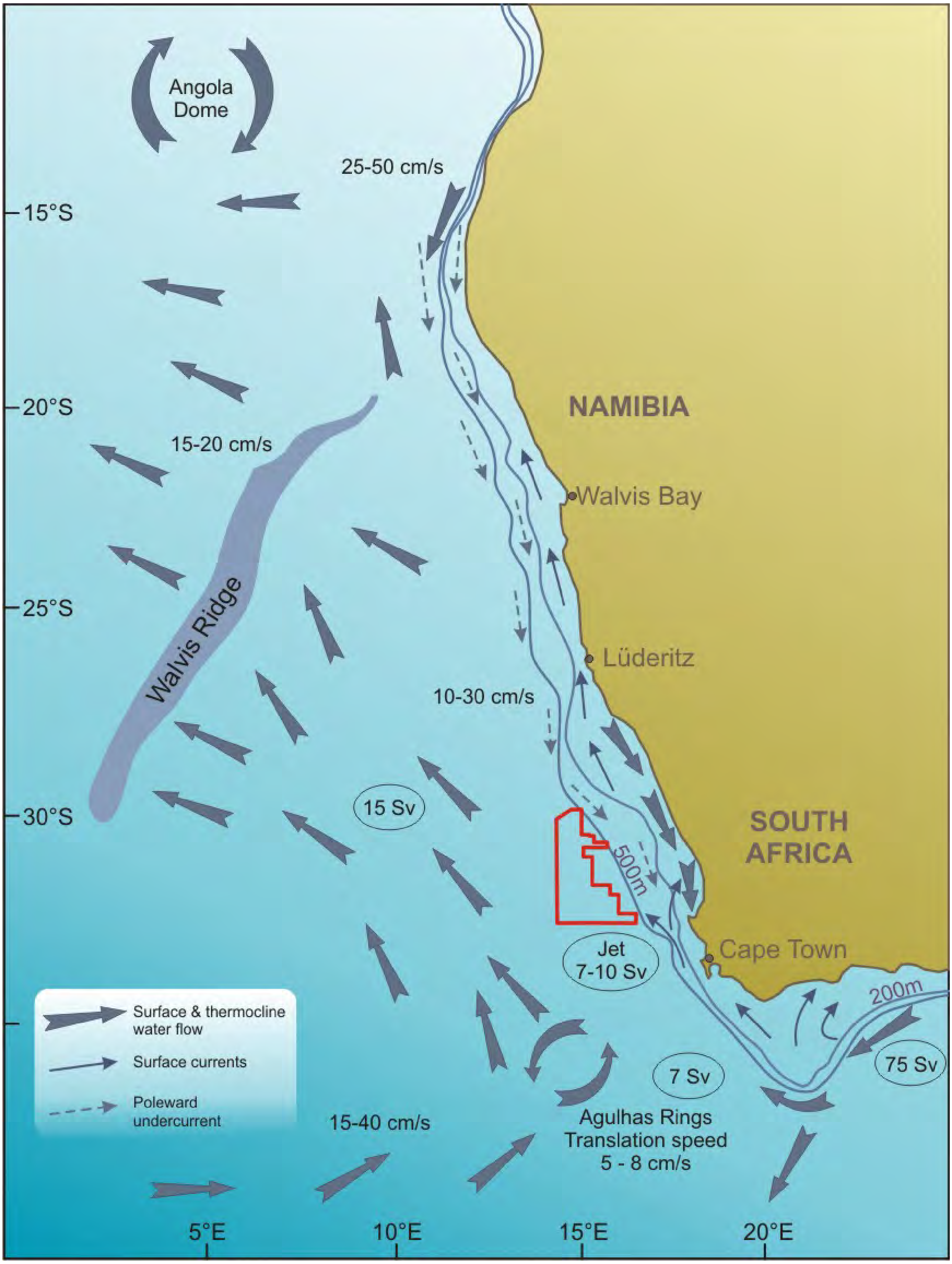

Figure 4.6: Major features of the predominant circulation patterns and volume flows in the Benguela System, along the southern Namibian and South African west coasts (re-drawn from Shannon & Nelson 1996). Approximate location of the licence area is also indicated.

4.1.2.7 Upwelling

The Benguela region is one of the world's major coastal upwelling systems, the majority of which are found off the west coasts of continents (e.g. off Chile and Peru, California and West Africa). This upwelling dominates the oceanography of the West Coast of South Africa (Andrews and Hutchings 1980; Nelson and Hutchings 1983). Upwelling is characterised by pulsed input of cold, nutrient-rich water into the euphotic zone, and in the Benguela region results from the wind-driven offshore movement of surface waters. The surface waters are replaced by cold nutrient-rich water that upwells from depth through Ekman transport. Once upwelled, this water warms and stabilises, and moves offshore where a thermocline usually develops. Nutrient-rich upwelled water enhances primary production, and the West Coast region consequently supports substantial pelagic fisheries (Heydorn and Tinley 1980; Shillington 1998).

Upwelling occurs along the West Coast from Cape Agulhas to northern Namibia. The principle upwelling centre on the West Coast lies off Lüderitz and the Lüderitz upwelling cell effectively divides the Benguela Upwelling system into a northern and southern region, which are meteorologically distinct (Pitcher *et al.* 1992). In the south upwelling-favourable SE winds are most prevalent during spring and summer, and upwelling occurs mostly between September and March. Upwelling in the southern Benguela area is highly variable on macro, meso and micro scales. Both continental shelf bathymetry and upwelling winds drive upwelling in the southern Benguela which is further influenced by local topography and meteorology (Shannon 1985), resulting in centres of enhanced upwelling off Namaqualand (30°S), Cape Columbine (33°S) and Cape Peninsula (34°S) (Figure 4.7).

The Namaqualand upwelling zone (or Hondeklipbaai Cell) is a cool wedge-shaped zone lying between Hondeklip Bay and the Orange Bight, where the narrow shelf to the south-west of Hondeklip Bay results in enhanced upwelling. Both bathymetry and orography control upwelling at Cape Columbine. Two fronts separate a divergence zone off the Columbine Peninsula, an oceanic front at the shelf edge and a shallower inshore front. Upwelling off the Cape Peninsula is among the most marked in the world with upwelling rates estimated to average 21 m/day (maximum of 32 m/day). A well-defined front exists over the shelf break off the Cape Peninsula, outside of which is a well-developed equatorward jet reaching speeds of 60 $cm.sec^{-1}$ on the surface and 120 $cm.sec^{-1}$ at 150 m (Andrews and Hutchings 1980).

Although the upwelling process is active within 10 to 20 km of the shore, the influence of cold upwelled water extends approximately 150 km (Shannon and Nelson 1996). However, distinctive cold water filaments can extend 200 km offshore perpendicular to the coast, some being more than 1 000 km long (Shannon and Nelson 1996, Shillington *et al.* 1992).

4.1.2.8 Nutrient distribution

Above thermoclines (that develop as water movement stabilises) phytoplankton production consumes nutrients, thus depleting the nutrients in the surface layer. Below the thermocline, nutrient re-enrichment occurs as biological decay occurs. As upwelled water is nutrient enriched compared to surface water, nutrient distribution on the West Coast are closely linked to upwelling (Chapman and Shannon 1985). Highest nutrient concentrations are thus located at the upwelling sites (Andrews and Hutchings 1980), offshore of which it decreases (Chapman and Shannon 1985).

Phosphate levels are low at the surface and offshore, but high (up to 3.0 μM) in bottom waters of the shelf and in newly upwelled waters. Upwelled waters can at times be enriched in phosphate as they pass over phosphorus rich shelf sediments. Phosphate is unlikely to ever become a limiting nutrient in the Benguela region.

Nitrate normally occurs in greater concentrations at the bottom than in upwelling source water, and decreases in availability at the surface (to less than 1 μM). Nitrate appears to be the limiting nutrient in the Benguela region.

Silicate levels range between 5-15 μM within the Benguela system, although these may at times be enhanced considerably over the shelf. It is not likely to be limiting in the southern Benguela.

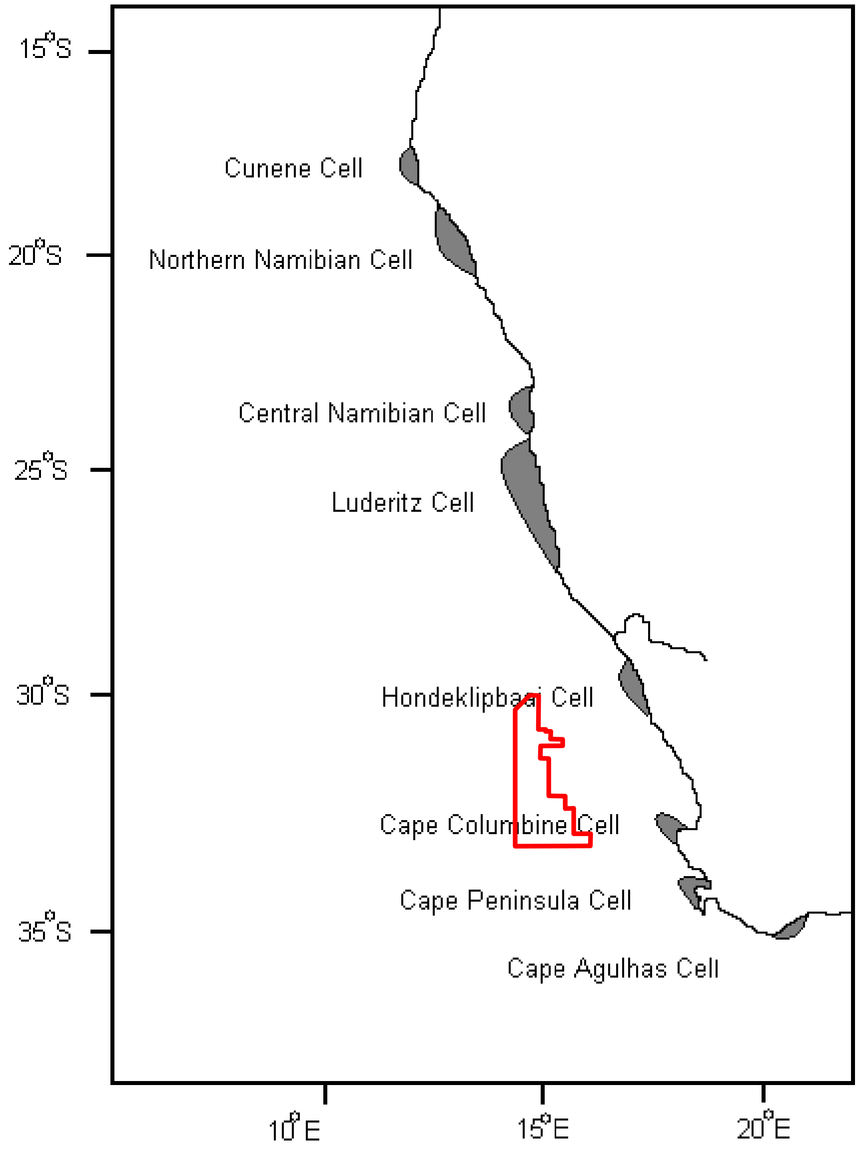

Figure 4.7: The location of three major upwelling cells along the West Coast (Shannon and Nelson, 1996). Approximate location of the licence area is also indicated.

4.1.2.9 Oxygen concentration

The Benguela system is characterised by large areas of very low oxygen concentrations with less than 40% saturation occurring frequently (Visser 1969; Bailey *et al*. 1985). The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman & Shannon 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches (see Figure 4.5), there are corresponding preferential areas for the formation of oxygen-poor water.

There are including three centres of oxygen-depleted shelf water; one of which is well north of the region (2°S to 24°S), another to the north of the Namaqualand upwelling cell and the third in St Helena Bay (Chapman and Shannon 1985). The spatial distribution of oxygen-poor water in each of the areas is subject to short- and medium-term variability in the volume of hypoxic water that develops.

Generally, oxygen concentrations appear to increase from the Orange River region southward. Surface oxygen levels are higher than bottom waters (water is regularly supersaturated) due to phytoplankton production, especially during less intense upwelling. Upwelling processes can move low-oxygen water up onto the inner shelf and into nearshore waters, often with devastating effects on marine communities.

Oxygen deficient water can affect the marine biota at two levels. It can have sub-lethal effects, such as reduced growth and feeding, and increased inter-moult period in the rock-lobster population (Beyers *et al*. 1994). Low-oxygen events associated with massive algal blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of marine biota and fish (Newman & Pollock 1971; Matthews & Pitcher 1996; Pitcher 1998; Cockcroft *et al*. 2000). The development of anoxic conditions as a result of the decomposition of huge amounts of organic matter generated by phytoplankton blooms is the main cause for these mortalities and walkouts. Algal blooms usually occur during summer-autumn (February to April) but can also develop in winter during the 'berg' wind periods, when similar warm windless conditions occur for extended periods.

4.1.2.10 Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) can be divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton and serves as a source of food for filter-feeders. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. Off the southern African West Coast, the PIM loading in nearshore waters is strongly related to natural riverine inputs. 'Berg' wind events can potentially contribute the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Shannon & Anderson 1982; Zoutendyk 1992; Shannon & O'Toole 1998; Lane & Carter 1999). For example, a 'berg' wind event in May 1979 described by Shannon and Anderson (1982) was estimated to have transported in the order of 50 million tons of sand out to sea, affecting an area of 20 000 km^2.

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/l to several tens of mg/l (Bricelj & Malouf 1984; Berg & Newell 1986; Fegley *et al*. 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/l, showing significant long-shore variation (Zoutendyk 1995). Considerably higher concentrations of PIM have, however, been reported from southern African West Coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions. During storm events, concentrations near the seabed may even reach up to 10 000 mg/l (Miller & Sternberg 1988). In the vicinity of the Orange River mouth, where river outflow strongly influences the turbidity of coastal waters, measured concentrations ranged from 14.3 mg/l at Alexander Bay just south of the mouth (Zoutendyk 1995) to peak values of 7 400 mg/l immediately upstream of the river mouth during the 1988 Orange River flood (Bremner et al. 1990).

The major source of turbidity in the swell-influenced nearshore areas off the West Coast is the redistribution of fine inner shelf sediments by long-period Southern Ocean swells. The current velocities typical of the Benguela (10-30 cm/s) are capable of re-suspending and transporting considerable quantities of sediment equatorwards. Under relatively calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow poleward undercurrent (Shillington et al. 1990; Rogers & Bremner 1991).

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

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

Offshore of the continental shelf, the oceanic waters are typically clear as they are beyond the influence of aeoloan and riverine inputs. The waters in the licence area are thus expected to be comparatively clear.

4.1.3 BIOLOGICAL OCEANOGRAPHY

South Africa is divided into nine bioregions (see Figure 4.8). The proposed area of interest area falls within the Atlantic Offshore Bioregion. The Namaqua and South-western Cape bioregions occur inshore of the licence area (Emanuel *et al*. 1992; Lombard *et al.* 2004).

The South African National Biodiversity Institute (SANBI) has initiated a process to identify potential priority areas for spatial management in the offshore environment that require protection (Sink, *et. al.,* 2012). Priority areas for protection are presented in Sections 4.1.4.6d and 4.2.3.4. The proposed Child's Bank protection area is located 75 km east of the proposed area of interest[1]. Sink, *et. al.* (2012) also mapped the ecosystem threat status of offshore benthic and pelagic habitats. The proposed area of interest area coincides with areas mapped as Least Threatened benthic habitats and Least Threatened and Vulnerable pelagic habitat, which generally occur along the shelf break (see Figure 4.9). This habitat threat status mapping concurs with SANBI's mapping of the marine benthic habitats (see Section 4.1.3.2a and Figure 4.14).

Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The near- and offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments 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.

[1] It should be noted that Shell is participating in Operation Phakisa and is in ongoing consultation with SANBI on the implications of their proposed Orange Basin MPAs. At the moment this matter is still under discussion and no agreement has been reached between the parties.

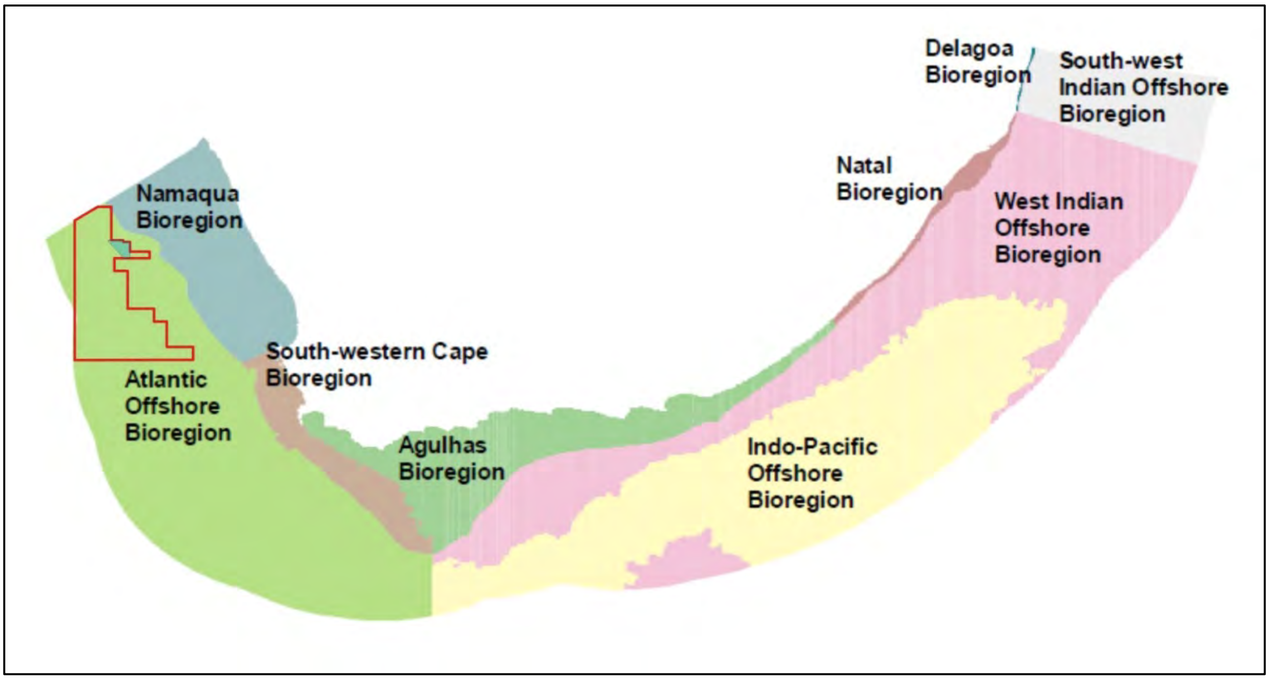

Figure 4.8: **The nine bioregions defined by the NBSA study (Lombard and Strauss 2004). The approximate location of the licence area is also shown.**

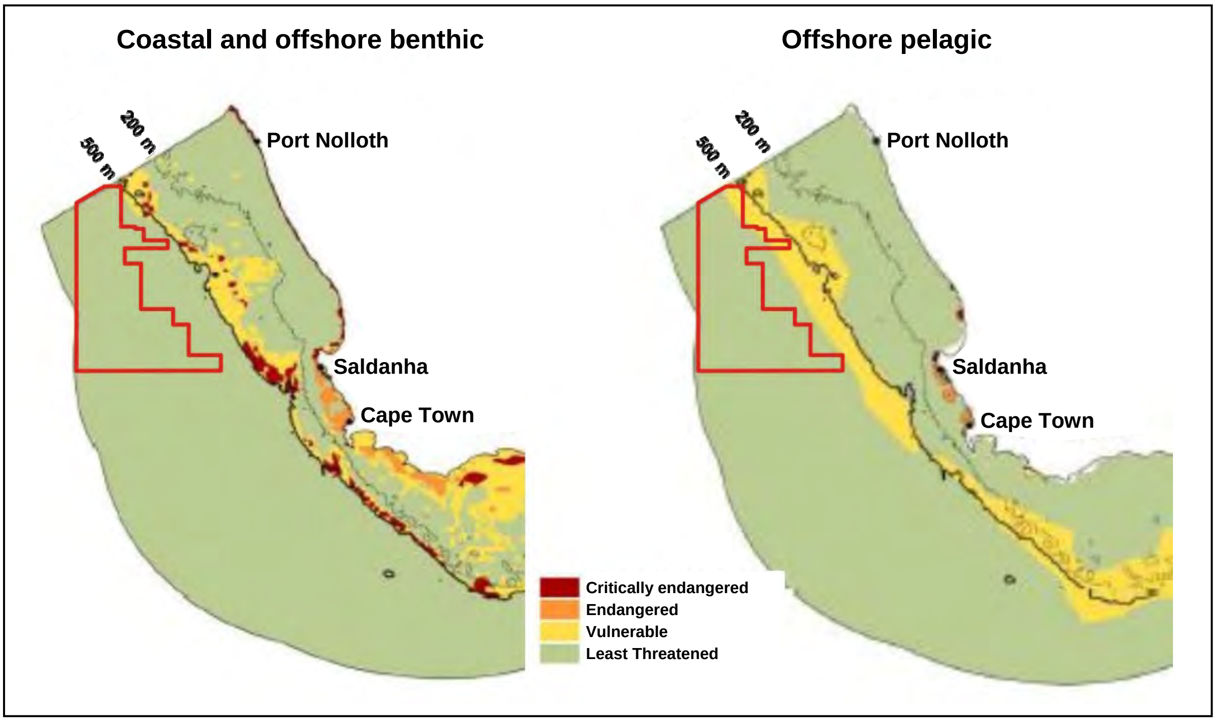

Figure 4.9: **Ecosystem threat status for coastal and offshore benthic and pelagic habitat types on the South African West Coast (adapted from Sink, et. al., 2012). The approximate location of the licence area is also shown.**

4.1.3.1 Plankton

Plankton comprises of three components:

(a) Phytoplankton

Features of phytoplankton distribution in the Benguela system are summarised in Figure 4.10.

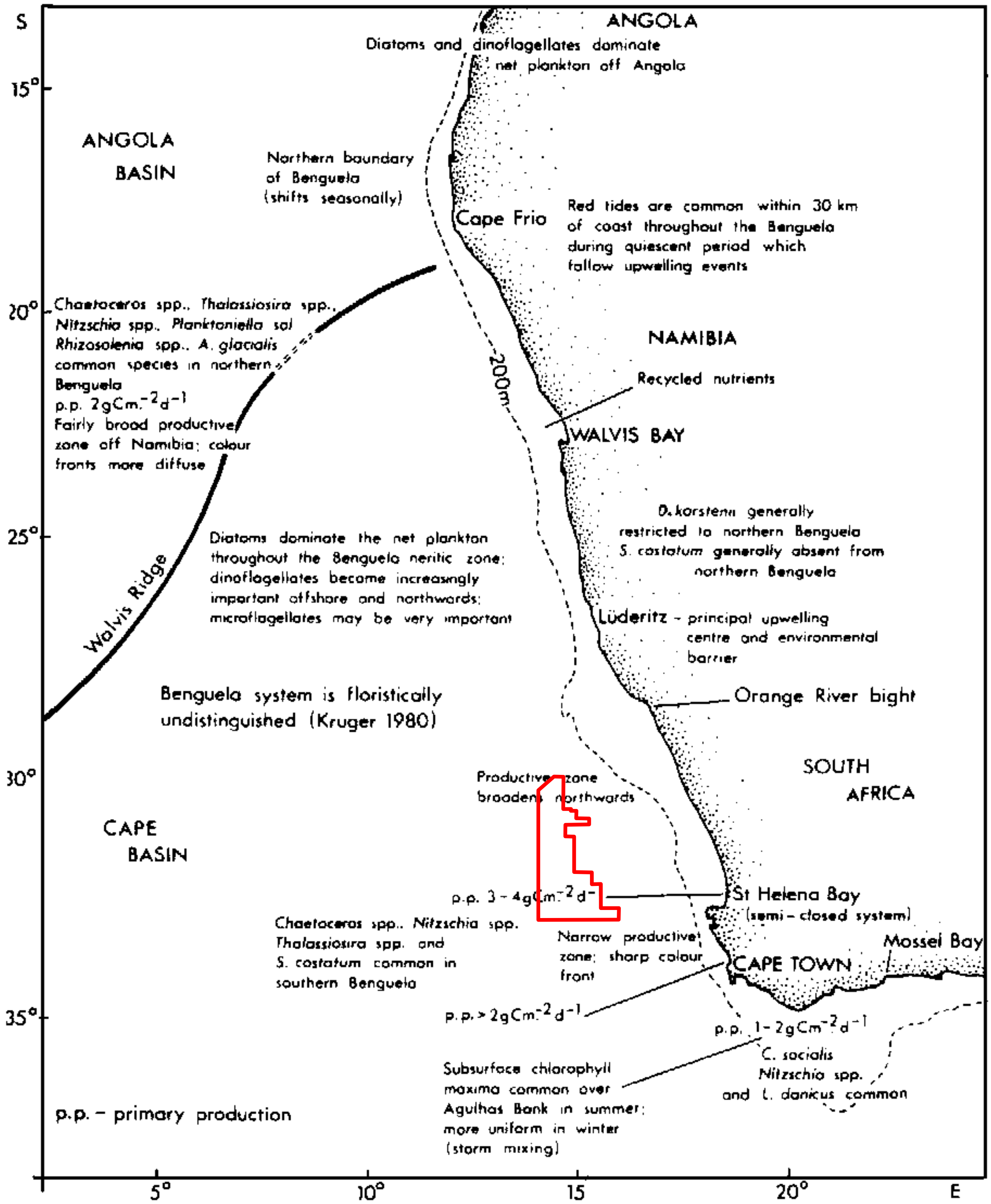

Figure 4.10: Features of phytoplankton distribution in the Benguela System (after Shannon and Pillar 1986). Approximate location of the licence area is also indicated.

Phytoplankton and "*chlorophyll a*" concentrations vary seasonally along the West Coast, being minimal in winter and summer (<1-2 mg/m³) and maximal (2-4 mg/m³) in spring and autumn. Productivity levels range from 2.5 to 3.5 g C/m^2/day for the midshelf region and decreasing to 1 g C/m^2/day inshore of 130 m (Shannon & Field 1985; Mitchell-Innes & Walker 1991; Walker & Peterson 1991).

Phytoplankton cells are greatest during upwelling. However, as phytoplankton production is related to nutrient supply, seeding and water column stability, production at the upwelling site *per se* is low (chlorophyll a levels range from 0.4 to 0.9 mg.m^{-3}), but increases offshore and 'downstream' (northward) from upwelling sites, where the water column is more stable.

Although diatoms are reported to contribute the bulk of the phytoplankton in the Benguela current (Andrews and Hutchings 1980; Olivieri 1983), dinoflagellates are also important (Chapman and Shannon 1985). An estimated 36 % of the phytoplankton is lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the West Coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds and results in the high organic content of the muds in the area.

Red tides (dinoflagellate and/or ciliate blooms or harmful algal blooms) may occur inshore along the coast north of Cape Point (especially in the Lamberts Bay to St Helena Bay region), usually during relaxation of upwelling cells in late summer to autumn. The most common species associated with red tides are Noctiluca scintillans, Gonyaulax tamarensis, G. polygramma and the ciliate Mesodinium rubrum. Gonyaulax and Mesodinium. Red tides (which can range in colour) may be toxic and animals, particularly filter feeding species, may accumulate toxins in their tissues. Furthermore, decomposition of red tides may strip the remaining oxygen from the water and turn it anoxic (known as a "black tide"), having catastrophic consequences on the inshore fauna of the affected area.

(b) Zooplankton

Features of the zooplankton distribution in the Benguela system are summarised in Figure 4.11.

Zooplankton biomass is related to that of phytoplankton, and is thus seasonal, being minimal during winter when the rate of upwelling is lower (Andrews and Hutchings 1980). Zooplankton biomass is low in newly upwelled waters, but increases as these waters age and develops substantial phytoplankton. However, zooplankton blooms lag phytoplankton blooms and thus are found even further offshore, with zooplankton biomass being maximal 40 to 100 km offshore in summer. During winter (when no upwelling occurs in the southern Benguela region) maximal zooplankton biomass is observed close inshore, values being low offshore. An estimated 5 % of the zooplankton is lost to the seabed annually.

Zooplankton is best described divided into mesozooplankton (>200 µm) and macrozooplankton (>1 600 µm). Copepods dominate the mesozooplankton (Andrews and Hutchings 1980; Hutchings *et al.* 1991; Verheye *et al.* 1994), and most are found in the phytoplankton-rich upper mixed layer of the water column. Mesozooplankton standing stock estimates in the southern Benguela range from 0.237 to 2.520 gC.m^{-2} and generally increase from south (~0.5 to ~1.0 gC.m^{-2} between Cape Point and Cape Columbine) to north (~0.5 to ~2.5 gC.m^{-2} to the north of Cape Columbine); the higher northern biomass attributed to the region being downstream of two major upwelling cells.

Euphausiids (18 species) dominate the macrozooplankton (Pillar 1986), of which *Euphausia lucens* and *Nyctiphanes capensis* are the most abundant in the shelf region with *E. lucens* dominating the region between Lüderitz and Cape Agulhas (Pillar *et al.* 1992). Other important groups contributing to the southern Benguela macrozooplankton community are chaetognaths (24 species), hyperiid amphipods (over 70 species within the southern and northern Benguela) and tunicates (42 species) (see Gibbons *et al.* 1992).

Macrozooplankton standing stocks are greatest north of Cape Columbine (0.5 gC.m^{-2}) and decline southwards and eastwards to 0.1 gC.m^{-2} at the eastern boundary of the West Coast.

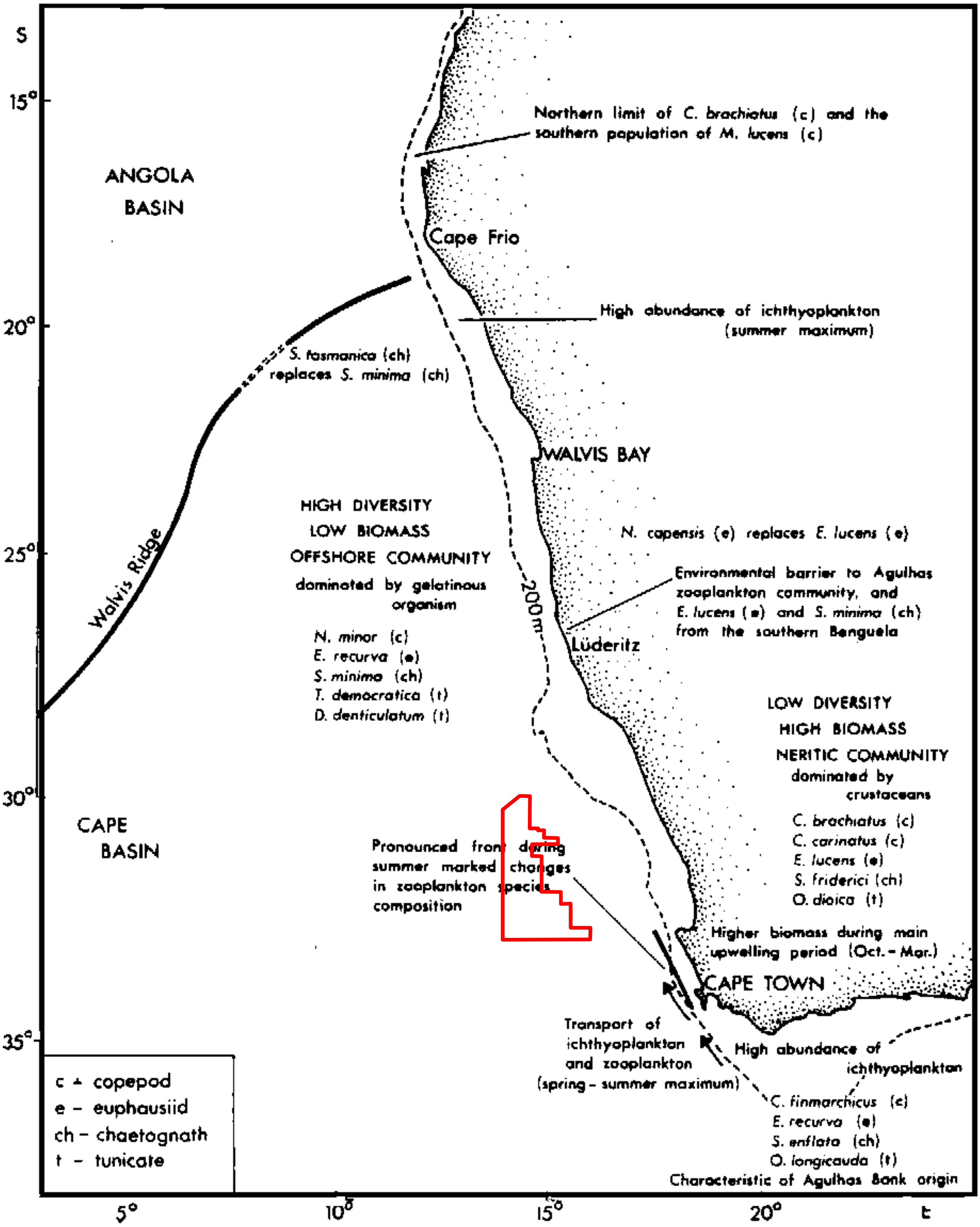

Figure 4.11: Features of zooplankton and ichtyoplankton distribution in the Benguela system (after Shannon and Pillar 1986). Approximate location of the licence area is also indicated.

(c) Ichthyoplankton

Ichthyoplankton comprises both fish eggs and larvae, and despite comprising a small component of the overall plankton, is important due to commercial fisheries. Features of the ichthyoplankton distribution in the Benguela system are summarised in Figure 4.11 (Shannon and Pillar 1986).

Spawning areas for pilchard (*Sardinops sagax*), anchovy (*Engraulis japonicus*) and round herring (*Etrumeus Whiteheadi*) along the West Coast in relation to licence area are shown in Figure 4.12. Each spring, anchovy migrate southwards from the West Coast to spawning grounds on the western Agulhas Bank (Peterson *et al.* 1992), where the fish spawn serially with frequency of spawning being dependent on food concentration (copepod biomass). Most spawning takes place to the east of Cape Point some 40 to 100 km offshore in 16 to 19°C water.

Of the demersal species, the two hake species (*Merluccius capensis* and *M. paradoxus*) spawn on the continental shelf off St Helena Bay and the western Agulhas Bank (see Figure 4.13). Hake spawning occurs in spring and early summer, with a secondary spawning peak in autumn. Kingklip (*Genypterus capensis*) spawning occurs along the southern African West Coast from Cape Point northwards (Payne 1977). Eggs and/or larvae of snoek (*Thyrsites atun*), jacopever (*Helicolenus dactylopterus*), dragonet (*Paracallionymus costatus*) and saury (*Scomberesox saurus scomberoides*) have also been reported in the southern Benguela.

Ichthyoplankton abundance in the offshore waters of the licence area is expected to be low.

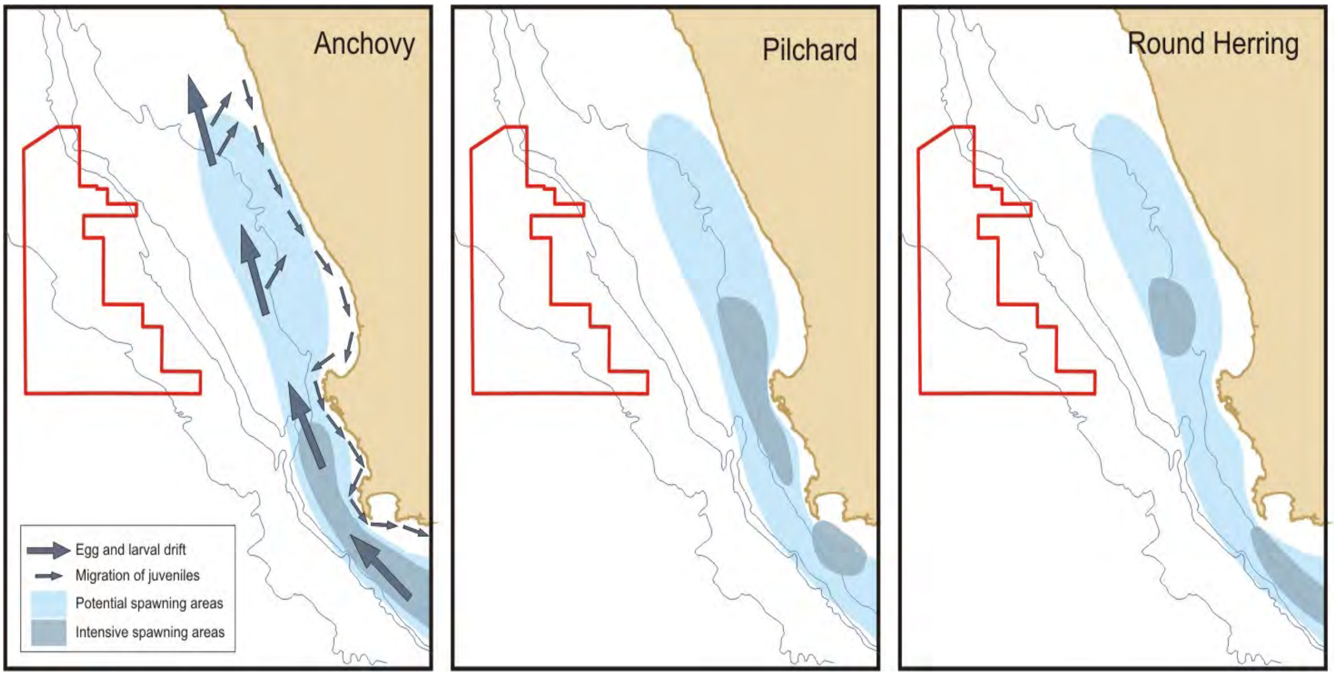

Figure 4.12: The licence area in relation to major spawning areas for different pelagic species in the southern Benguela region. Adapted from Cruikshank (1990).

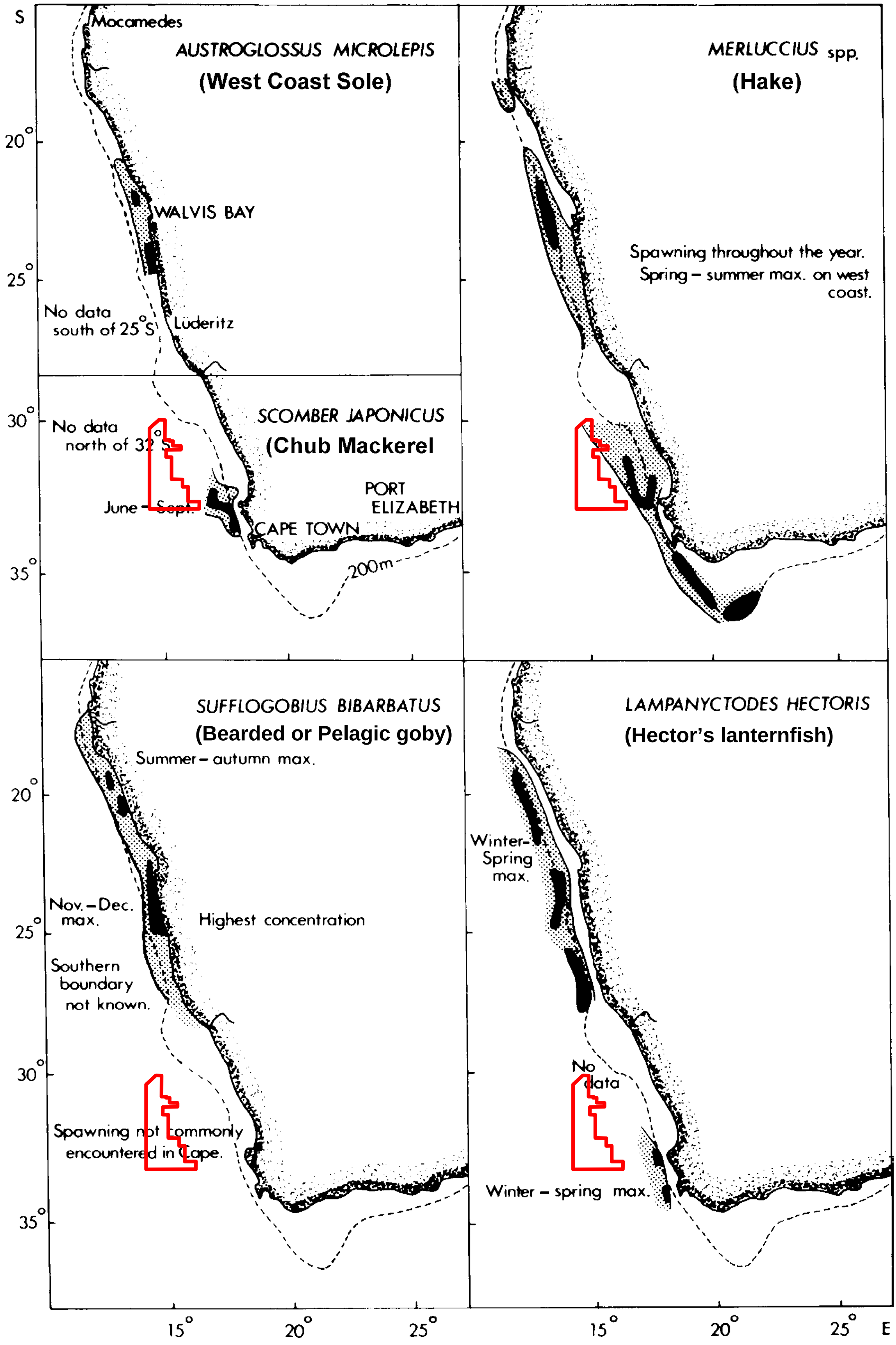

Figure 4.13: **Spawning and recruitment information for a number of pelagic and demersal fish species inhabiting the West Coast. Modified from Shannon & Pillar (1986). Approximate location of the licence area is also indicated.**

4.1.3.2 Benthic habitats and benthic invertebrate macrofauna

(a) Benthic habitats

Four benthic habitat types are found within the licence area (see Figure 4.14), namely South Atlantic Abyss (Least Threatened), South Atlantic Lower Bathyal (Least Threatened), Southern Atlantic Upper Bathyal (Least Threatened) and Southern Benguela Sandy Shelf Edge (Vulnerable). The two benthic habitats found in the proposed area of interest (namely South Atlantic Lower Bathyal and Southern Atlantic Upper Bathyal) are both considered to be Least Threatened.

(b) Benthic invertebrate macro fauna

The benthic biota of unconsolidated marine sediments constitute invertebrates that live on (epifauna) or burrow within (infauna) the sediments and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm). Although sediment distribution studies (Rogers & Bremner 1991) suggest that the outer shelf is characterised by unconsolidated sediments (see Figure 4.5), recent surveys conducted between 180 m and 480 m depth inshore of the Orange Basin Deep Water Licence Area revealed high proportions of hard ground rather than unconsolidated sediment, although this requires further verification (Karenyi unpublished data).

Benthic communities are structured by the complex interplay of a large array of environmental factors. The structure and composition of benthic soft bottom communities is primarily a function of water depth and sediment composition (Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b), but other factors such as current velocity, organic content and food abundance also play a role (Flach & Thomsen 1998; Ellingsen 2002). Water depth and sediment grain size are considered the two major factors that determine benthic community structure and distribution on the South African West Coast (Christie 1974, 1976; Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b) and elsewhere in the world (e.g. Gray 1981; Ellingsen 2002; Bergen *et al*. 2001; Post *et al*. 2006). However, studies have shown that shear bed stress (i.e. a measure of the impact of current velocity on sediment), oxygen concentration (Post *et al*. 2006; Currie *et al*. 2009; Zettler *et al*. 2009), productivity (Escaravage *et al*. 2009), organic carbon and seafloor temperature (Day *et al*. 1971) may also strongly influence the structure of benthic communities. There are clearly other natural processes operating in the deep water shelf areas of the West Coast that can over-ride the suitability of sediments in determining benthic community structure, and it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro & van der Plas 2006; Pulfrich *et al*. 2006). In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure.

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

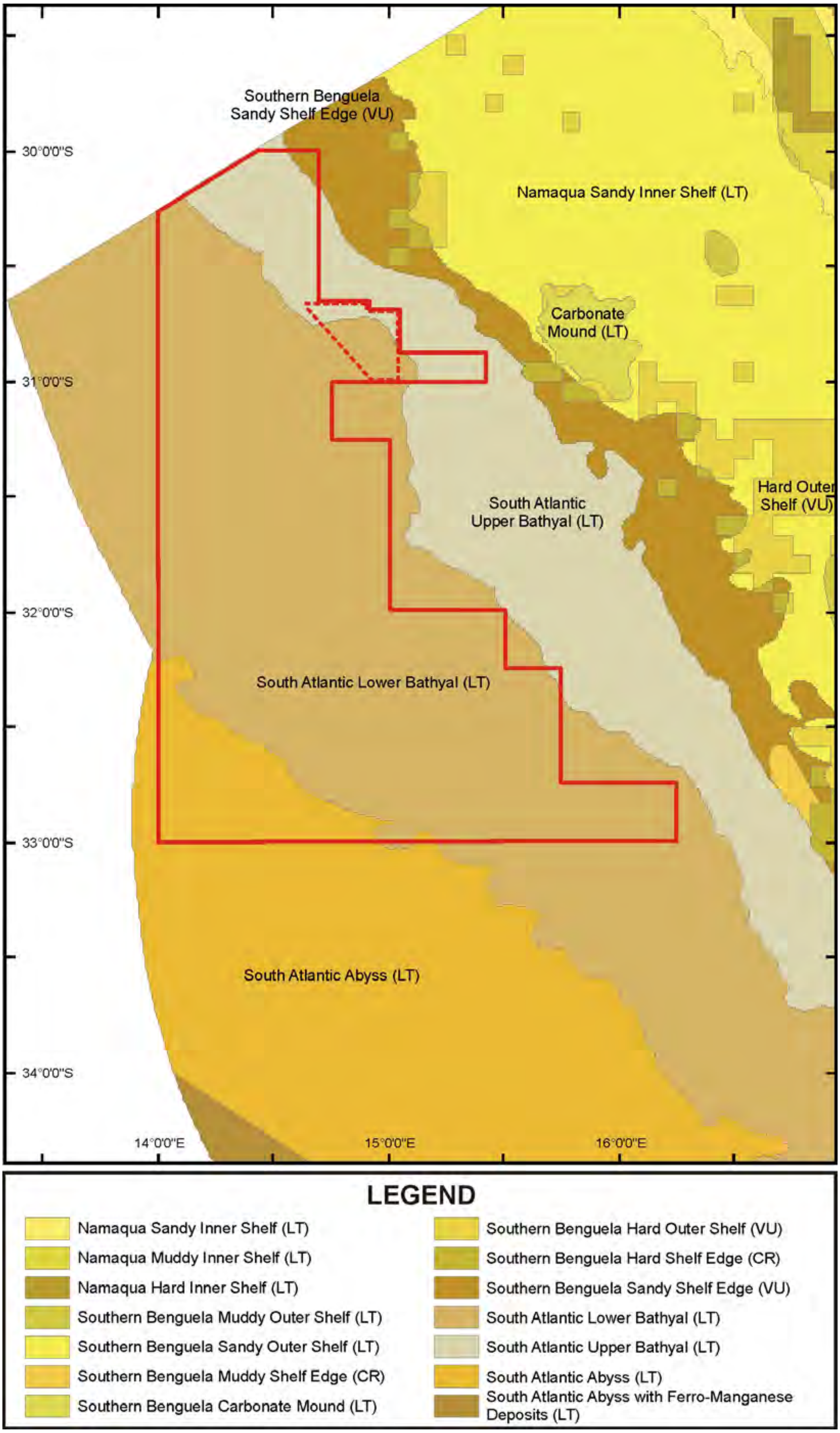

Figure 4.14: Location of the licence area and proposed area of interest in relation to benthic habitat types in the Orange Basin offshore area (mapped using SANBI's GIS data).

Three macro-infauna communities have been identified on the inner- (i.e. 0-30 m depth) and mid-shelf (i.e. 30-150 m depth, Karenyi unpublished data). The inner-shelf community, which is affected by wave action, is characterised by various mobile predators (e.g. the gastropod *Bullia laevissima* and polychaete *Nereis* sp.), sedentary polychaetes and isopods. The mid-shelf community inhabits the mudbelt and is characterised by the mud prawns *Callianassa* sp. and *Calocaris barnardi*. A second mid-shelf sandy community occurring in sandy sediments is characterised by various polychaetes (marine segmented bristle worms) including deposit-feeding *Spiophanes soederstromi* and *Paraprionospio pinnata*.

Polychaetes, crustaceans and molluscs make up the largest proportion of individuals, biomass and species on the West Coast. The distribution of species within these communities are inherently patchy reflecting the high natural spatial and temporal variability associated with macro-infauna of unconsolidated sediments (e.g. Kenny *et al*. 1998; Kendall & Widdicombe 1999; van Dalfsen *et al*. 2000; Zajac *et al*. 2000; Parry *et al*. 2003), with evidence of mass mortalities and substantial recruitments recorded on the South African West Ciast (Steffani & Pulfrich 2004). Despite the current lack of knowledge of the community structure and endemicity of South African macro-infauna off the edge of the continental shelf, the South Atlantic bathyal and abyssal unconsolidated habitat types that characterise depths beyond 500 m are rated as 'Least Threatened' (see Figure 4.9). This primarily reflects the great extent of these habitats in the South African EEZ.

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

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

4.1.3.3 Invertebrates

The West Coast supports important commercial stocks of West Coast rock lobster (*Jasus lalandii*) between Cape Agulhas and about 25º S. While larvae normally move in offshore ocean currents before settling in the shallow kelp beds of the West Coast, the adults are generally found in water depths of between 10 and about 70 m. Female West Coast rock lobsters have a well-defined moulting and spawning cycle, with moulting between May and June and the berry season between May/June and October/November. Peak hatching in October/November is synchronised with strong wind upwelling especially in the southern Benguela. Newly hatched larvae drift northwards and offshore. The return of late stage larvae is believed to be controlled by large-scale ocean circulation systems.

Studies have shown that the majority of seabed species recorded from similar areas have short life spans (a few years or less) and relatively high reproductive rates, indicating the potential for rapid recovery after natural or anthropogenic disturbance of the soft sediment environment. The only species associated with these environments that are slow growing, slow to mature, long-lived and therefore slow to recover and consequently are regarded as vulnerable are the seapens - a list of species recorded by Lopez-Gonzales *et al.* (2001) is given in Table 4.1.

Table 4.1: List of seapen species sampled by Lopez-Gonzales *et al.* (2001) during cruises in the Benguela Region.

Species	Zoogeographic Region	Depth Range (m)*
Anthoptilum grandiflorum	Widespread	238-2 500
Amphibelemnon namibiensis	Benguela	91-304
Crassophyllum cristatum	Benguela	40-650
Distichoptilum gracile	Widespread	650-4 300
Funiculina quadriangularis	Widespread	60-2 600
Halipteris africana	Benguela	459-659
Kopholobelemnon stelliferum	Widespread	400-1 180
Pennatula inflata	Widespread	457-741
Scleroptilum grandiflorum	Widespread	500-4 200
Stylatula macpheersoni	Benguela	245-318
Umbellula thomsoni	Widespread	1 300-6 200
Virgularia mirabilis	Widespread	9-400
Virgularia tuberculata	Benguela	75-1 050

*Recorded to date, but these areas are not well sampled or studied.

4.1.3.4 Deep water coral communities

There has been increasing interest in deep-water corals (depths >150 m, with some species being recorded up to 3 000 m) in recent years because of their likely sensitivity to disturbance and their long generation times. Some species form reefs while others are smaller and remain solitary. Corals add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze *et al*. 1997; MacIssac *et al*. 2001).

Deep water corals establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current over special topographical formations which cause eddies to form. Nutrient seepage from the substratum might also promote a location for settlement (Hovland *et al*. 2002). In the productive Benguela region, substantial areas on and off the edge of the shelf could thus potentially be capable of supporting rich, cold water, benthic, filter-feeding communities.

4.1.3.5 Cephalopods

On the basis of abundance and trophic links with other species, eight species of cephalopod are important and a further five species have potential importance within the Benguela system (Table 4.2). The major cephalopod resource in the southern Benguela is sepiods/cuttlefish (Lipinski 1992; Augustyn *et al.* 1995). Most of the cephalopod resource is distributed on the mid-shelf with *Sepia australis* being most abundant at depths between 60-190 m, whereas *S. hieronis* densities were higher at depths between 110-250 m. *Rossia enigmatica* occurs more commonly on the edge of the shelf to depths of 500 m. Biomass of these species is generally higher in the summer than in winter.

Cuttlefish are largely epi-benthic and occur on mud and fine sediments in association with their major prey item; mantis shrimps (Augustyn *et al.* 1995). They form an important food item for demersal fish.

Table 4.2: Cephalopod species of importance or potential importance within the Benguela System (after Lipinski 1992).

Scientific Name	Importance
Important species:	
Sepia australis	Very abundant in survey catches, prey of many fish species. Potential for fishery.
Sepia hieronis	Densities higher at depths between 110-250 m
Loligo vulgaris reynaudii	Fisheries exist, predator of anchovy and hake, prey of seals and fish.
Todarodes angolensis	Fisheries exist (mainly by-catch), predator of lightfish, lanternfish and hake, prey of seals.
Todaropsis eblanae	Some by-catch fishery, predator of lightfish and lanternfish, prey of seals and fish. Potential for fishery.
Lycoteuthis lorigera	Unconfirmed by-catch, prey of many fish species. Potential for fishery.
Octopus spp.	Bait and artinisal fishery, prey of seals and sharks.
Argonauta spp.	No fisheries, prey of seals.
Rossia enigmata	No fisheries, common in survey catches.
Potentially important species:	
Ommastrephes bartramii	No fisheries.
Abraliopsis gilchristi	No fisheries.
Todarodes filippovae	No fisheries.
Lolliguncula mercatoris	No fisheries.
Histioteuthis miranda	No fisheries.

4.1.3.6 Seamount Communities

Two geological features of note within the vicinity of the proposed area of interest include Childs Bank, situated approximately 75 km east (see Figure 4.4), and Tripp Seamount, situated approximately 120 km north-northwest of the target area. Child's Bank is described by Dingel *et al.* (1987) to be a carbonate mound (bioherm) composed of sediments and the calcareous deposits from an accumulation of carbonate skeletons of sessile organisms (e.g. cold-water coral, foraminifera or marl), such features typically have topographic relief, forming isolated seabed knolls in otherwise low profile homogenous seabed habitats (Kopaska-Merkel & Haywick 2001; Kenyon *et al*. 2003, Wheeler *et al.* 2005, Colman *et al*. 2005).

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

The enhanced fluxes of detritus and plankton that develop in response to the complex current regimes lead to the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Deep- and cold-water corals (including stony corals, black corals and soft corals) are a prominent component of the suspension-feeding fauna of many seamounts, accompanied by barnacles, bryozoans, polychaetes, molluscs, sponges, sea squirts, basket stars, brittle stars and crinoids (Rogers 2004). There is also associated mobile benthic fauna that includes echinoderms (sea urchins and sea cucumbers) and crustaceans (crabs and lobsters) (Rogers 1994). Seamounts also provide an important habitat for commercial deepwater fish stocks, such as orange roughy, oreos, alfonsino and Patogonian toothfish, which aggregate around these features for either spawning or feeding (Koslow 1996).

The coral frameworks offer refugia for a great variety of invertebrates and fish within, or in association with, the living and dead coral framework thereby creating spatially fragmented areas of high biological diversity (biological hotspots). Such complex benthic ecosystems in turn enhance foraging opportunities for many other predators, serving as mid-ocean focal points for a variety of pelagic species with large ranges (turtles, tunas and billfish, pelagic sharks, cetaceans and pelagic seabirds) that may migrate large distances in search of food or may only congregate on seamounts at certain times (Hui 1985; Haney *et al.* 1995). Seamounts thus serve as feeding grounds, spawning and nursery grounds and possibly navigational markers for a large number of species (SPRFMA 2007). Consequently, seamounts are usually highly unique and are usually, but not always, identified as Vulnerable Marine Ecosystems (VMEs). South Africa's seamounts and their associated benthic communities have not been sampled by either geologists or biologists (Sink & Samaai 2009). However, evidence from video footage taken on hard-substrate habitats to the south-east of the Child's Bank suggest that vulnerable communities, including gorgonians, octocorals and reef-building sponges, do occur on the continental shelf. Whether similar communities may thus be expected in the Orange Basin Deep Water Licence Area is, however, unknown.

4.1.3.7 Fishes

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

a) Demersal species

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

Roel (1987) showed seasonal variations in the distribution ranges of shelf communities, with species such as the pelagic goby *Sufflogobius bibarbatus*, and West Coast sole *Austroglossus microlepis* occurring in shallow water north of Cape Point during summer only. The deep-sea community was found to be homogenous both spatially and temporally. However, Atkinson (2009) identified two long-term community shifts in demersal fish communities; the first (early to mid-1990s) being associated with an overall increase in density of many species, whilst many species decreased in density during the second shift (mid-2000s). These community shifts correspond temporally with regime shifts detected in environmental forcing variables

(Sea Surface Temperatures and upwelling anomalies) (Howard *et al*. 2007) and with the eastward shifts observed in small pelagic fish species and rock lobster populations (Coetzee *et al*. 2008, Cockcroft *et al*. 2000).

(b) Pelagic species

Small pelagic species include sardine/pilchard (*Sadinops ocellatus*), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes, and generally occur within the 200 m contour and thus unlikely to be encountered in the proposed area of interest.

Most of the pelagic species exhibit similar life history patterns involving seasonal migrations between the west and south coasts. Apart from round herring which spawn offshore of the shelf break on the West Coast, the spawning areas of the major pelagic species are distributed on the continental shelf extending from south of St Helena Bay to Mossel Bay on the South Coast (Shannon & Pillar 1986). They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried around Cape Point and up the coast in northward flowing surface waters (see Figure 4.12 and 4.13).

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

Two species that migrate along the West Coast following the shoals of anchovy and pilchards are snoek (*Thyrsites atun)* and chub mackerel (*Scomber japonicas)*. Their appearance along the West and South-West coasts are highly seasonal. Snoek migrating along the southern African West Coast reach the area between St Helena Bay and the Cape Peninsula between May and August. They spawn in these waters between July and October before moving offshore and commencing their return northward migration (Payne & Crawford 1989). Chub mackerel similarly migrate along the southern African West Coast reaching South-Western Cape waters between April and August. They move inshore in June and July to spawn before starting the return northwards offshore migration later in the year. Their abundance and seasonal migrations are thought to be related to the availability of their shoaling prey species (Payne & Crawford 1989).

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

A number of species of pelagic sharks are also known to occur on the West Coast, including blue (*Prionace glauca)*, short-fin mako (*Isurus oxyrinchus)* and oceanic whitetip sharks (*Carcharhinus longimanus)*. Great whites (*Carcharodon carcharias)* and whale sharks (*Rhincodon typus)* may also be encountered in coastal and offshore areas, although the latter occurs more frequently along the South and East coasts. Of these the blue shark is listed as “Near threatened”, and the short-fin mako, whitetip, great white and whale sharks as “Vulnerable” by the International Union for Conservation of Nature (IUCN).

4.1.3.8 Turtles

Three species of turtles, namely the green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) are found along the West Coast. Loggerhead and green turtles are expected to occur only as occasional visitors along the West Coast.

The leatherback turtle is likely to be encountered within the proposed area of interest. However, their abundance is expected to be low. Leatherback turtles inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey (primarily jellyfish).

The Benguela ecosystem, especially the northern Benguela where jelly fish numbers are high, is increasingly being recognised as a potentially important feeding area for leatherback turtles from several globally significant nesting populations in the south Atlantic (Gabon, Brazil) and south east Indian Ocean (South Africa) (Lambardi *et al*. 2008, Elwen & Leeney 2011, SASTN 2011[2]). While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al*. 2004).

Leatherback turtles breed on the northern KwaZulu-Natal coastline of the East Coast and in the Republic of Congo and Gabon on the West Coast. Leatherback turtles from the east South Africa population have been satellite tracked swimming around the west coast of South Africa and remaining in the warmer waters west of the Benguela ecosystem (Lambardi *et al*. 2008) (see Figure 4.15).

Leatherback turtles are listed as Critically Endangered worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species). Loggerhead and green turtles are listed as "Endangered". As a signatory of CMS, South Africa has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles.

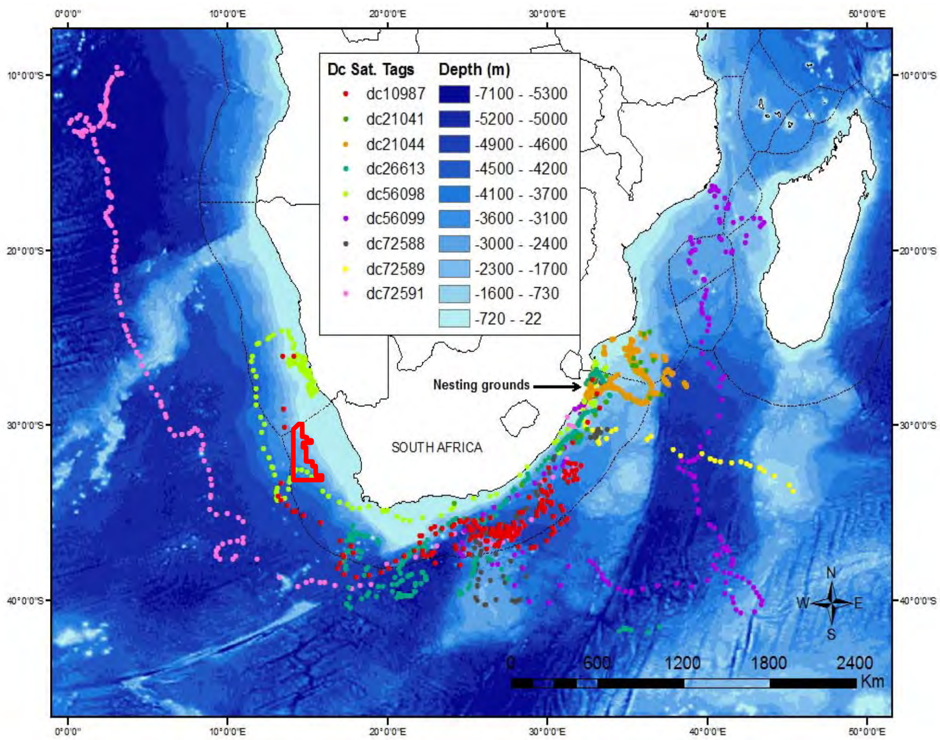

Figure 4.15: The post-nesting distribution of nine satellite tagged leatherback females (1996 – 2006; Oceans and Coast, unpublished data). The approximate location of the licence area is also shown.

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

4.1.3.9 Seabirds

There are a total of 49 species of seabirds occurring within the southern Benguela area, of which 14 are resident species, 25 are migrants from the southern ocean and 10 are visitors from the northern hemisphere. Table 4.3 provides a list of the common species occurring within the study area.

The area between Cape Point and the Orange River supports 38% and 33% of the overall population of pelagic seabirds in winter and summer, respectively. Most of the species in the region reach highest densities offshore of the shelf break (200 to 500 m depth), well inshore of the proposed area of interest, with highest population levels during their non-breeding season (winter).

The availability of breeding sites is an extremely important determinant in the distribution of resident seabirds. Although breeding areas are distributed along the whole coast, islands are especially important, particularly those between Dyer Island and Lamberts Bay. Fourteen resident species breed along the West Coast, including Cape Gannet, African Penguin, four species of Cormorant, White Pelican, three Gull and four Tern species (Table 4.4).

Cape Gannets breed only on islands and Lamberts Bay and Malgas Island are important colonies. Cape cormorants breed mainly on offshore islands (Dyer, Jutten, Seal, Dassen, Bird (Lamberts Bay), Malgas and Vondeling Islands), although the large colonies may associate with estuaries, lagoons or sewerage works. The bank and crowned cormorants are endemic to the Benguela system and both breed between Namibia and just to the west of Cape Agulhas. Although white-breasted cormorants occur between northern Namibia and the Eastern Cape in southern Africa, the majority of the population is concentrated between Swakopmund and Cape Agulhas.

Most of these resident species feed on fish (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). Feeding strategies can be grouped into surface plunging (gannets and terns), pursuit diving (cormorants and penguins) and scavenging and surface seizing (gulls and pelicans). Most of the breeding seabird species forage at sea with most birds being found relatively close inshore (10-30 km). Cape Gannets, however, are known to forage up to 140 km offshore (Dundee 2006; Ludynia 2007), and African Penguins have also been recorded as far as 60 km offshore.

African penguin colonies (*Spheniscus demersus*) occur at 27 localities around the coast of South Africa and Namibia (see Figure 4.16). The species forages at sea with most birds being found within 20 km of their colonies. African penguin distribution at sea is consistent with that of the pelagic shoaling fish, which generally occur within the 200 m isobath.

The Cape Gannet and Bank Cormorant are listed in the South African Red Data Book as "Vulnerable". The Caspian Tern, Cape Cormorant and Crowned Cormorant are listed in the South African Red Data Book as "Near-threatened", while the African Penguin and Damara Tern is listed as "Endangered". The decline in the African Penguin population is ascribed primarily to the removal of the accumulated guano from the islands during the nineteenth century. Penguins used to breed in burrows in the guano and are now forced to nest in the open, thereby being exposed to much greater predation and thermal stress.

The Cape Gannet, a plunge diver feeding on epipelagic fish, is thought to have declined as a result of the collapse of the pilchard, whereas the Cape Cormorant was able to shift its diet to pelagic goby. Furthermore, the recent increase in the seal population has resulted in seals competing for island space to the detriment of the breeding success of both gannets and penguins.

Table 4.3: Pelagic seabirds common in the southern Benguela region (Crawford *et al*. 1991).

Common Name	Species name	Global IUCN
Shy albatross	*Thalassarche cauta*	Near Threatened
Black browed albatross	*Thalassarche melanophrys*	Endangered[1]
Yellow nosed albatross	*Thalassarche chlororhynchos*	Endangered
Giant petrel sp.	*Macronectes halli/giganteus*	Near Threatened
Pintado petrel	*Daption capense*	Least concern
Greatwinged petrel	*Pterodroma macroptera*	Least concern
Soft plumaged petrel	*Pterodroma mollis*	Least concern
Prion spp	*Pachyptila* spp.	Least concern
White chinned petrel	*Procellaria aequinoctialis*	Vulnerable
Cory's shearwater	*Calonectris diomedea*	Least concern
Great shearwater	*Puffinus gravis*	Least concern
Sooty shearwater	*Puffinus griseus*	Near Threatened
European Storm petrel	*Hydrobates pelagicus*	Least concern
Leach's storm petrel	*Oceanodroma leucorhoa*	Least concern
Wilson's storm petrel	*Oceanites oceanicus*	Least concern
Blackbellied storm petrel	*Fregetta tropica*	Least concern
Skua spp.	*Catharacta*/*Stercorarius* spp.	Least concern
Sabine's gull	*Larus sabini*	Least concern

Table 4.4: Breeding resident seabirds present along the West Coast (CCA & CMS 2001).

Common name	Species name	Global IUCN Status
African Penguin	*Spheniscus demersus*	Endangered
Great Cormorant	*Phalacrocorax carbo*	Least Concern
Cape Cormorant	*Phalacrocorax capensis*	Near Threatened
Bank Cormorant	*Phalacrocorax neglectus*	Endangered
Crowned Cormorant	*Phalacrocorax coronatus*	Least Concern
White Pelican	*Pelecanus onocrotalus*	Least Concern
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	*Hydroprogne caspia*	Vulnerable
Swift Tern	*Sterna bergii*	Least Concern
Roseate Tern	*Sterna dougallii*	Least Concern
Damara Tern	*Sterna balaenarum*	Near Threatened

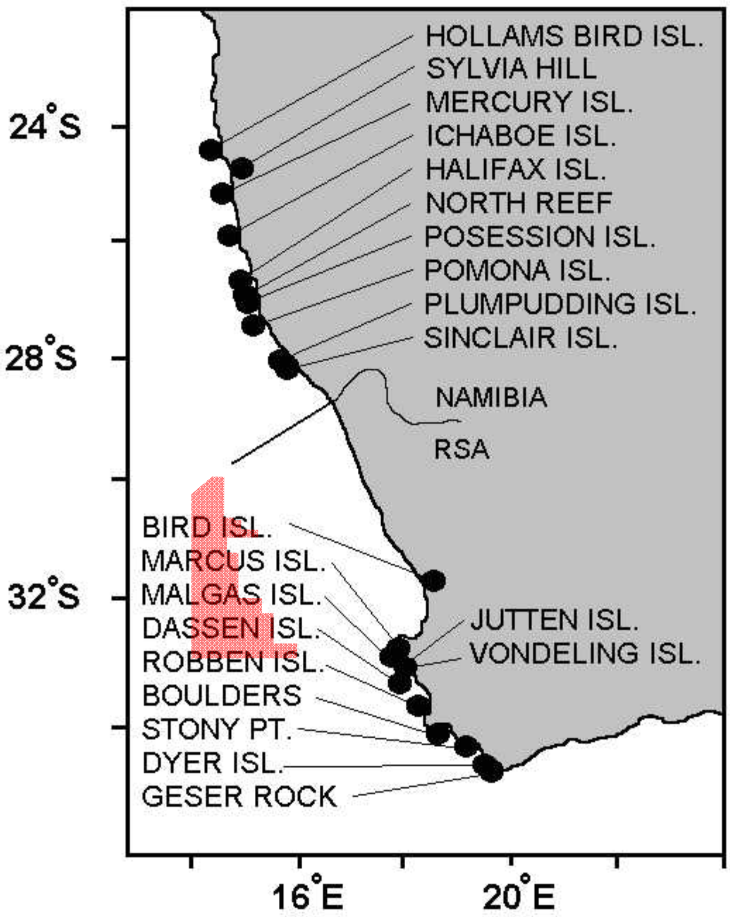

Figure 4.16: The distribution of breeding colonies of African penguins on the South African West Coast. The approximate location of the licence area is also shown.

4.1.3.10 Marine mammals

The marine mammal fauna occurring off the West Coast of South Africa, north of Cape Columbine, include whales, dolphins and seals.

(a) Cetaceans

The cetacean fauna of the West Coast comprises 33 species of whales and dolphins known or to occur here (see Table 4.5). The offshore areas have been particularly poorly studied with almost all available information from deeper waters (>200 m) arising from historic whaling records. Information on smaller cetaceans in deeper waters is particularly poor.

The distribution of whales and dolphins on the West 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. The most common species within the proposed area of interest (in terms of likely encounter rate not total population sizes) are likely to be the long-finned pilot whale and humpback whale.

Cetaceans comprised two basic taxonomic groups: the mysticetes (filter-feeding baleen whales) and the odontocetes (toothed predatory whales and dolphins).

Table 4.5: Cetaceans occurrence off the West Coast, their seasonality and likely encounter frequency.

Common Name	Species	Shelf	Offshore	Seasonality	Likely encounter frequency	IUCN Conservation Status
Delphinids						
Dusky dolphin	*Lagenorhynchus obscurus*	Yes (0- 800 m)	No	Year round	Daily	Data Deficient
Heaviside's dolphin	*Cephalorhynchus heavisidii*	Yes (0-200 m)	No	Year round	Daily	Data Deficient
Common bottlenose dolphin	*Tursiops truncatus*	Yes	Yes	Year round	Monthly	Least Concern
Common (short beaked) dolphin	*Delphinus delphis*	Yes	Yes	Year round	Monthly	Least Concern
Southern right whale dolphin	*Lissodelphis peronii*	Yes	Yes	Year round	Occasional	Data Deficient
Striped dolphin	*Stenella coeruleoalba*	No	?	?	Very rare	Least Concern
Pantropical spotted dolphin	*Stenella attenuata*	Edge	Yes	Year round	Very rare	Least Concern
Long-finned pilot whale	*Globicephala melas*	Edge	Yes	Year round	<Weekly	Data Deficient
Short-finned pilot whale	*Globicephala macrorhynchus*	?	?	?	Very rare	Data Deficient
Rough-toothed dolphin	*Steno bredanensis*	?	?	?	Very rare	Least Concern
Killer whale	*Orcinus orca*	Occasional	Yes	Year round	Occasional	Data Deficient
False killer whale	*Pseudorca crassidens*	Occasional	Yes	Year round	Monthly	Data Deficient
Pygmy killer whale	*Feresa attenuata*	?	Yes	?	Occasional	Least Concern
Risso's dolphin	*Grampus griseus*	Yes (edge)	Yes	?	Occasional	Data Deficient
Sperm whales						
Pygmy sperm whale	*Kogia breviceps*	Edge	Yes	Year round	Occasional	Data Deficient
Dwarf sperm whale	*Kogia sima*	Edge	?	?	Very rare	Data Deficient
Sperm whale	*Physeter macrocephalus*	Edge	Yes	Year round	Occasional	Vulnerable

Common Name	Species	Shelf	Offshore	Seasonality	Likely encounter frequency	IUCN Conservation Status
Beaked whales						
Cuvier's	*Ziphius cavirostris*	No	Yes	Year round	Occasional	Least Concern
Arnoux's	*Beradius arnouxii*	No	Yes	Year round	Occasional	Data Deficient
Southern bottlenose	*Hyperoodon planifrons*	No	Yes	Year round	Occasional	Not assessed
Layard's	*Mesoplodon layardii*	No	Yes	Year round	Occasional	Data Deficient
True's	*M. mirus*	No	Yes	Year round		Data Deficient
Gray's	*M. grayi*	No	Yes	Year round	Occasional	Data Deficient
Blainville's	*M. densirostris*	No	Yes	Year round		Data Deficient
Baleen whales						
Minke	*Balaenoptera bonaerensis*	Yes	Yes	>Winter	Monthly	Data Deficient
Dwarf minke	*B. acutorostrata*	Yes	Yes	Year round	Occasional	Least Concern
Fin whale	*B. physalus*	Yes	Yes	MJJ & ON, rarely in summer	Occasional	Endangered
Blue whale	*B. musculus*	No	Yes	?	Occasional	Endangered
Sei whale	*B. borealis*	Yes	Yes	MJ & ASO	Occasional	Endangered
Bryde's (offshore)	*B. brydei*	Yes	Yes	Summer (JF)	Occasional	Not assessed
Bryde's (inshore)	*B brydei (subspp)*	Yes	Yes	Year round	Occasional	Data Deficient
Pygmy right	*Caperea marginata*	Yes	?	Year round	Occasional	Least Concern
Humpback	*Megaptera novaeangliae*	Yes	Yes	Year round, higher in SONDJF	Daily*	Least Concern
Southern right	*Eubalaena australis*	Yes	No	Year round, higher in SONDJF	Daily*	Least Concern

Mysticete cetaceans occurring in the study area include the southern right, humpback, blue, fin, sei, Antarctic minke, dwarf minke and Bryde's whale. Most of these species occur in pelagic waters, with only occasional visits into shelf waters. All of these species show some degree of migration either to, or through, the latitudes encompassed by the broader 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.

- <u>Southern right and humpback whales:</u> The most abundant baleen whales off the coast of South Africa are southern right (listed as Least Concern) and humpback whales (listed as Least Concern). Southern right whales migrate to the southern Africa subcontinent to breed and calve, where they tend to have an extremely coastal distribution mainly in sheltered bays (90% <2 km from shore; Best 1990, Elwen & Best 2004). They typically arrive in coastal waters off the West Coast in June, increasing to a maximum number in September/October, with most departing in December (although animals may be sighted as early as April and as late as February). On the West Coast they are most common south of Lambert's Bay (CCA & CMS 2001), although a number of the bays between Chameis Bay (27°56'S) and Conception Bay (23°55'S) in Namibia have in recent years become popular calving sites (Currie *et al*. 2009), with sightings reported as far north as the Kunene and Möwe Bay (Roux *et al*. 2001). The Southern Right calving season extends from late June to late October, peaking in August (Best 1994; Roux *et al*. 2001), with cow-calf pairs remaining in sheltered bays for up to two months before starting their southern migration.

  The majority of humpback whales on the West Coast are migrating past the southern African continent to breeding grounds off Angola, Republic of Congo and Gabon (Rosenbaum *et al.* 2009, Barendse *et al*. 2010). On the West Coast it is thought that only a small proportion of the main migration comes close inshore, the majority choosing the shortest route to the central West African breeding grounds by following the edge of the continental shelf (Best 2007; Best & Allison 2010). Humpback whales migrate at various distances from the coast including pelagic waters (Barendse et al. 2002), and as they are likely to regularly cross the proposed area of interest, will probably be the most abundant large whale encountered. Most humpbacks reach southern African waters around April, continuing through to September/October when the southern migration begins and continues through to December. The calving season for humpbacks extends from July to October, peaking in early August (Best 2007). Cow-calf pairs are typically the last to leave southern African waters on the return southward migration, although considerable variation in the departure time from breeding areas has been recorded (Barendse *et al*. 2010).

  In the last decade, deviations from the predictable and seasonal migration patterns of these two species have been reported from the Cape Columbine – Yzerfontein area (Best 2007; Barendse *et al*. 2010). High abundances of both Southern Right and Humpback whales in this area during spring and summer (September-February), indicates that the upwelling zones off Saldanha and St Helena Bay may serve as an important summer feeding area (Barendse *et al.* 2011, Mate *et al*. 2011). It was previously thought that whales feed only rarely while migrating (Best *et al.* 1995), but these localised summer concentrations suggest that these whales may in fact have more flexible foraging habits. The offshore location of the proposed area of interest makes encounters with whales undergoing summer migrations highly unlikely.

  Since the southern right population is still continuing to grow at approximately 7% per year (Brandaõ *et al.* 2011), the population size in 2013 would number more than 6 000 individuals. Recent abundance estimates put the number of humpback whales in the west African breeding population to be in excess of 9 000 individuals in 2005 and it is likely to have increased since this time at about 5% per annum (IWC 2012).

- Bryde's whales: Two types of Bryde's whales are recorded from South African waters - a larger pelagic form described as *Balaenoptera brydei* and a smaller neritic form (of which the taxonomic status is uncertain) but included by Best (2007) with *B. brydei* for the subregion. The migration patterns of Bryde's whales differ from those of all other baleen whales in the region. The inshore population is unique in that it is resident year round on the Agulhas Bank ranging from Durban in the east to at least St Helena Bay off the West Coast, and does not migrate at all, although some movement up the West Coast in winter has been reported (Best 2007, 2001; Best *et al*. 1984). The offshore population of Bryde's whale lives off the continental shelf (>200 m depth) and migrates between wintering grounds off equatorial West Africa (Gabon) and summering grounds off the South African West Coast (Best 2001). Its seasonality within South African waters is thus opposite to the majority of the other migratory cetaceans, with abundance in the project area likely to be highest in January-February.

- Sei whales: Sei whales (listed as Endangered) spend time at high latitudes (40-50˚S) during summer months and migrate through South African waters to unknown breeding grounds further north. Their migration pattern shows a bimodal peak with numbers west of Cape Columbine highest in May and June, and again in August, September and October. Based on whaling records, all whales were caught in waters deeper than 200 m with most deeper than 1 000 m (Best & Lockyer 2002).

- Fin whales: Fin whales (listed as Vulnerable) have a bimodal peak in the catch data suggesting animals were migrating further north during May-June to breed, before returning during August-October *en route* to Antarctic feeding grounds. Some juvenile animals may feed year round in deeper waters off the shelf (Best 2007). There are no recent data on the abundance or distribution of fin whales off the west coast, although a sighting of a live animal in St Helena Bay in 2011 (MRI unpubl. data) confirm their contemporary occurrence in the region.

- Blue whales: Antarctic blue whales were historically caught in high numbers during commercial whaling activities, with a single peak in catch rates during July in Walvis Bay, Namibia and at Namibe, Angola suggesting that in the eastern South Atlantic these latitudes are close to the northern migration limit for the species (Best 2007). Only two confirmed sightings of blue whales have occurred off the entire west coast of Africa since 1973 (Branch *et al.* 2007), although search effort (and thus information), especially in pelagic waters is very low. This suggests that the population using the area may have been extirpated by whaling and there is a low chance of encountering the species in the area of interest.

- Minke whales: Two forms of minke whale occur in the southern Hemisphere, the Antarctic minke whale and the dwarf minke whale, both of which occur in the Benguela region (Best 2007, NDP unpublished data). Antarctic minke whales range from 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. The dwarf minke whale has a more temperate distribution than the Antarctic minke and they do not range further south than 60-65°S. Dwarf minkes have a similar migration pattern to Antarctic minkes with at least some animals migrating to the Southern Ocean during summer. Dwarf minke whales occur closer to shore than Antarctic minkes. Both species are generally solitary and densities are likely to be low in the project area.

- Pygmy right whale: The smallest of the baleen whales, the pygmy right whale occurs in the Benguela region (Leeney *et al.* 2013). The species is more commonly associated with cool temperate waters between 30°S and 55°S. There are no data on the abundance or conservation status of this species. As it was not subjected to commercial whaling, 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 project area is likely to be low.

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader project area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site specific to oceanic and wide ranging. There is 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 the West Coast. Beaked whales are all considered to be true deep water species usually being seen in waters in excess of 1 000 – 2 000 m depth (Best 2007). Their presence in the area may fluctuate seasonally, but insufficient data exist to define this clearly.

- Sperm whales: 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 greater than 1 000 m depth, occasionally coming into depths of 500-200 m on the shelf (Best 2007). Seasonality of catches off the West Coast suggest that medium- and large-sized males are more abundant during winter, while female groups are more abundant in autumn (March-April), 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. Sperm whales in the project area are likely to be encountered in relatively high numbers in deeper waters (>500 m), predominantly in the winter months (April - October).

- Pygmy and dwarf sperm whales: Dwarf sperm whales are associated with the warmer waters south and east of St Helena Bay. Abundance in the project area is likely to be very low and only in the warmer waters west of the Benguela current. Pygmy sperm whales are recorded from both the Benguela and Agulhas ecosystem (Best 2007) and are likely to occur in the project area at low levels in waters deeper than 1 000 m.

- Killer whales: 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 western South Africa (Best *et al.* 2010), Namibia (Elwen & Leeney 2011) and in the Eastern Tropical Atlantic (Weir *et al.* 2010). Killer whales are found in all depths from the coast to deep open ocean environments and may thus be encountered in the project area at low levels.

- False killer whales: The species has a tropical to temperate distribution and most sightings off southern Africa have occurred in water deeper than 1 000 m but with a few close to shore as well (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. There is no information on population numbers of conservation status and no evidence of seasonality in the region (Best 2007).

- Long-finned pilot whales: Long finned pilot whales display a preference for temperate waters and are usually associated with the continental shelf or deep water adjacent to it (Mate *et al.* 2005; Findlay *et al.* 1992; Weir 2011). They are regularly seen associated with the shelf edge by marine mammal observers and fisheries observers and researchers (NDP unpubl. data). 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 the project area will be long-finned.

- Common bottlenose dolphins: Two species of bottlenose dolphins occur around southern Africa, the smaller Indo-Pacific bottlenose dolphin, which occurs exclusively to the east of Cape Point in water usually less than 30 m deep, and the larger common bottlenose dolphin forms. The larger common bottlenose dolphin species occur in two forms. The inshore form occurs as a small and apparently isolated population that occupies the very coastal (usually <15 m deep) waters of the central Namibian coast as far south as Lüderitz and is considered a conservation concern. Members of this population are unlikely to be encountered in the project area. Little is known about the offshore form in terms of their population size or conservation status. They sometimes occur in association with other species such as pilot whales (NDP unpublished data) or false killer whales (Best 2007) and are likely to be present year round in waters deeper than 200 m.

- Common dolphin: The common dolphin is known to occur offshore in West Coast waters (Findlay *et al.* 1992; Best 2007). The extent to which they occur in the project area is unknown, but likely to be low. Group sizes of common dolphins can be large, averaging 267 (± *SD* 287) for the South Africa region (Findlay *et al.* 1992) and 92 (± SD 115) for Angola (Weir 2011) and 37 (± *SD* 31) in Namibia (NDP unpubl. data). They are more frequently seen in the warmer waters offshore and to the north of the country, seasonality is not known.

- Southern right whale dolphins: The cold waters of the Benguela provide a northwards extension of the normally subantarctic habitat of this species (Best 2007). Most records in the region originate in a relatively restricted region between 26˚S and 28˚S off Lüderitz (Rose & Payne 1991) in water 100 – 2 000 m deep (Best, 2007), where they are seen several times per year (Findlay *et al*. 1992; JP Roux[3] pers comm.). It is possible that the Namibian sightings represent a resident population (Findlay *et al.* 1992). Encounters in the project area are unlikely.

- Dusky dolphins: In water <500 m deep, dusky dolphins are likely to be the most frequently encountered small cetacean as they are very "boat friendly" and often approach vessels to bowride. The species is resident year round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay *et al.* 1992). Although no information is available on the size of the population, they are regularly encountered in near shore waters between Cape Town and Lamberts Bay (Elwen *et al.* 2010a; NDP unpubl. data) with group sizes of up to 800 having been reported (Findlay *et al.* 1992). A hiatus in sightings (or low density area) is reported between ~27°S and 30°S, associated with the Lüderitz upwelling cell (Findlay *et al.* 1992). This area aligns fairly closely with the proposed area of interest, which suggests that sightings during drilling may be rare. Dusky dolphins are resident year round in the Benguela.

- Heaviside's dolphins: This species is relatively abundant in the Benguela ecosystem within the region of 10 000 animals estimated to live in the 400 km of coast between Cape Town and Lamberts Bay (Elwen *et al.* 2009). Individuals show high site fidelity to small home ranges, 50 - 80 km along shore (Elwen *et al*. 2006) and may thus be more vulnerable to threats within their home range. This species occupies waters from the coast to at least 200 m depth (Elwen *et al.* 2006; Best 2007), and may show a diurnal onshore-offshore movement pattern (Elwen *et al*. 2010b), but this varies throughout the species range. Heaviside's dolphins are resident year round.

- Beaked whales (various species): Beaked whales were never targeted commercially and their pelagic distribution makes them largely inaccessible to most researchers making them the most poorly studied group of cetaceans. All the beaked whales that may be encountered in the project area are pelagic species that tend to occur in small groups usually less than five, although larger aggregations of some species are known (MacLeod & D'Amico 2006; Best 2007). The long, deep dives of beaked whales make them both difficult to detect visually.

[3] Ministry of Fisheries and Marine Resources (Namibia).

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

(b) Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) congregates at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs along the West Coast (Figure 4.17). Four other seal species may occasionally be found as vagrants along the West Coast, including southern elephant seal (*Mirounga leoninas),* subantarctic fur seal (Arctocephalus tropicalis), crabeater (Lobodon carcinophagus) and leopard seals (Hydrurga leptonyx) (David 1989).

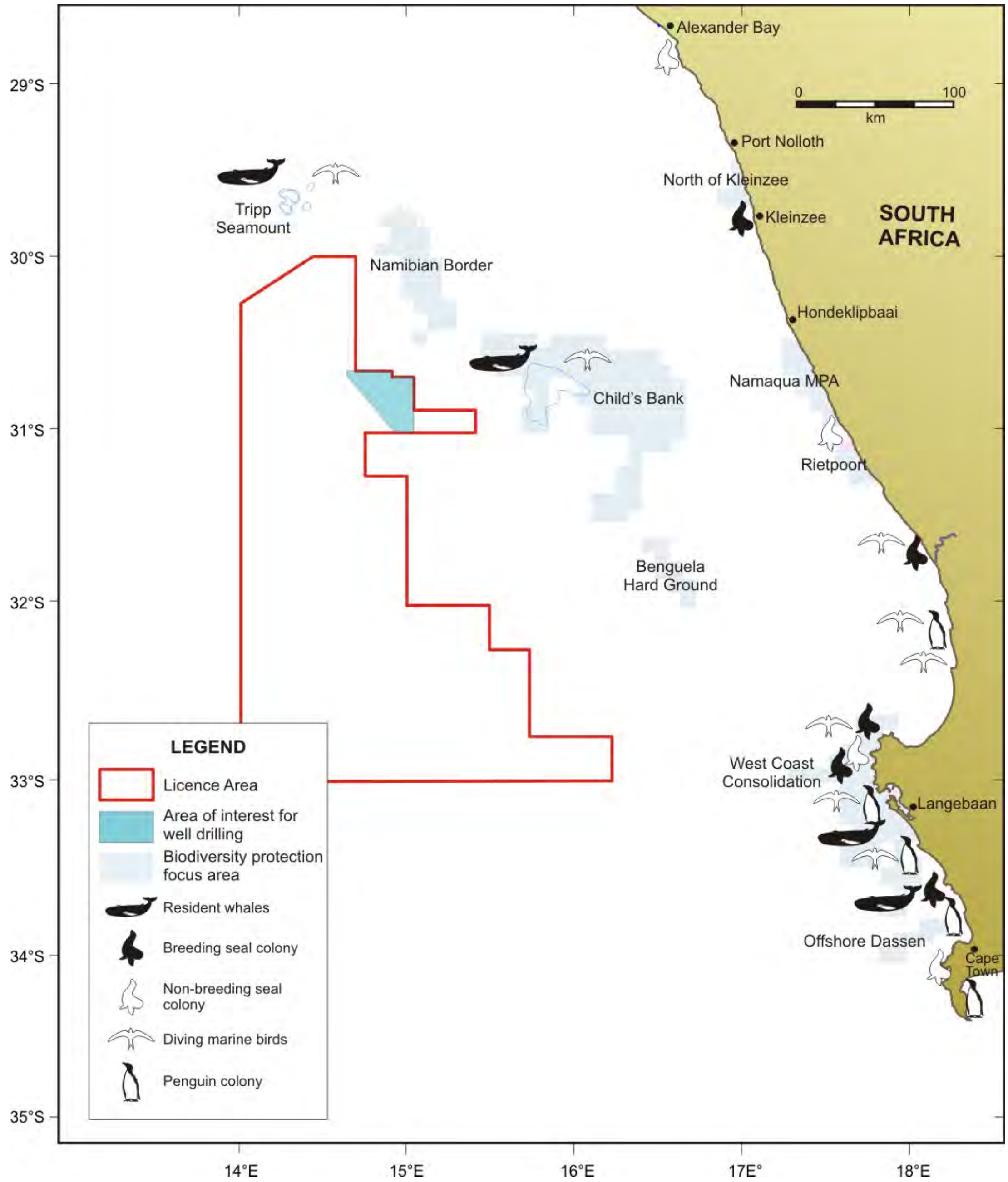

Figure 4.17: Location of the licence area in relation to seabird and seal colonies and resident whale populations. Areas identified by Majiedt *et al*. (2013) as priority areas for the protection of benthic and pelagic habitats are also shown.

There are a number of Cape fur seal colonies within the study area: at Kleinzee (incorporating Robeiland), at Bucchu Twins near Alexander Bay, and Strandfontein Point (south of Hondeklipbaai). The colony at Kleinzee has the highest seal population and produces the highest seal pup numbers on the South African Coast (Wickens 1994). The colony at Buchu Twins, formerly a non-breeding colony, has also attained breeding status (M. Meyer, SFRI, pers. comm.). Non-breeding colonies occur south of Hondeklip Bay at Strandfontein Point and on Bird Island at Lamberts Bay, with the McDougalls Bay islands and Wedge Point being haul-out sites only and not permanently occupied by seals. All have important conservation value since they are largely undisturbed at present.

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles (nm) offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991).

4.1.4 HUMAN UTILISATION

4.1.4.1 Fisheries

The South African fishing industry consists of 14 commercial sectors operating within the country's 200 nautical mile (nm) EEZ. The following fisheries are active off the West Coast:

- Demersal trawl;
- Small pelagic purse-seine;
- Demersal long-line (hake and shark);
- Large pelagic long-line;
- Tuna pole;
- Traditional line fish; and
- West Coast rock lobster.

(a) Demersal trawl

Demersal trawl is South Africa's most valuable fishery accounting for approximately half of the income generated from commercial fisheries. Demersal trawlers operate extensively around the coast primarily targeting the bottom-dwelling (demersal) species of hake (*Merluccius paradoxus* and *M. capensis*). Main by-catch species include monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*). The hake-directed trawl fishery is split into two sub-sectors: a small inshore trawling sector active off the South Coast and a large deep-sea trawl sector operating on both the South and West coasts. There are currently 45 trawlers operating within the offshore sector. The current annual hake Total Allowable Catch (TAC) of hake across all sectors is 156 075 tons (2013), of which the majority is landed by the demersal trawl sector. In 2012, of a total hake TAC of 144 671 tons, 118 688 tons (82%) was landed by the demersal trawl sector. Of this amount, 115 465 tons was landed by the offshore demersal trawl sector and 3 223 tons by the inshore trawl sector.

The deep-sea trawl sector on the West Coast operates mainly in a continuous band along the shelf edge between the 300 m and 1 000 m bathymetric contours (see Figures 4.18 and 4.19). Monk-directed trawlers tend to fish shallower waters compared to the hake-directed vessels on mostly muddy substrates. Trawl nets are generally towed along depth contours (thereby maintaining a relatively constant depth) running parallel to the depth contours in a north-westerly or south-easterly direction. Trawlers also target fish aggregations around bathymetric features, in particular seamounts and canyons (i.e. Child's Bank, Cape Columbine and

Cape Canyon), where there is an increase in seafloor slope and in these cases the direction of trawls follow the depth contours. Trawlers are prohibited from operating within 5 nm of the coastline.

Figures 4.18 to 4.19 show the demersal trawl effort and catch between 2000 and 2012 in relation to the area of interest, respectively. Over the period 2000 to 2012, the number of trawls per year averaged at 57 920 with an associated landed catch of 127 743 tons of hake and 166 902 tons of all species combined. Over the period 2008 to 2012, the demersal trawl fishery reported an average of 44 092 trawls per year with an associated catch of 113 607 tons of hake and 125 599 tons of all species landed per year. There is no evidence of any effort or catch in the area of interest.

The towed gear typically consists of trawl warps, bridles and trawl doors, a footrope, headrope, net and codend (see Figure 4.20). The monk-directed trawlers use slightly heavier trawl gear, trawl at slower speeds and for longer periods (up to eight hours) compared to the hake-directed trawlers (60 minutes to four hours). Monk gear includes the use of “tickler” chains positioned ahead of the footrope to chase the monk off the substrate and into the net.

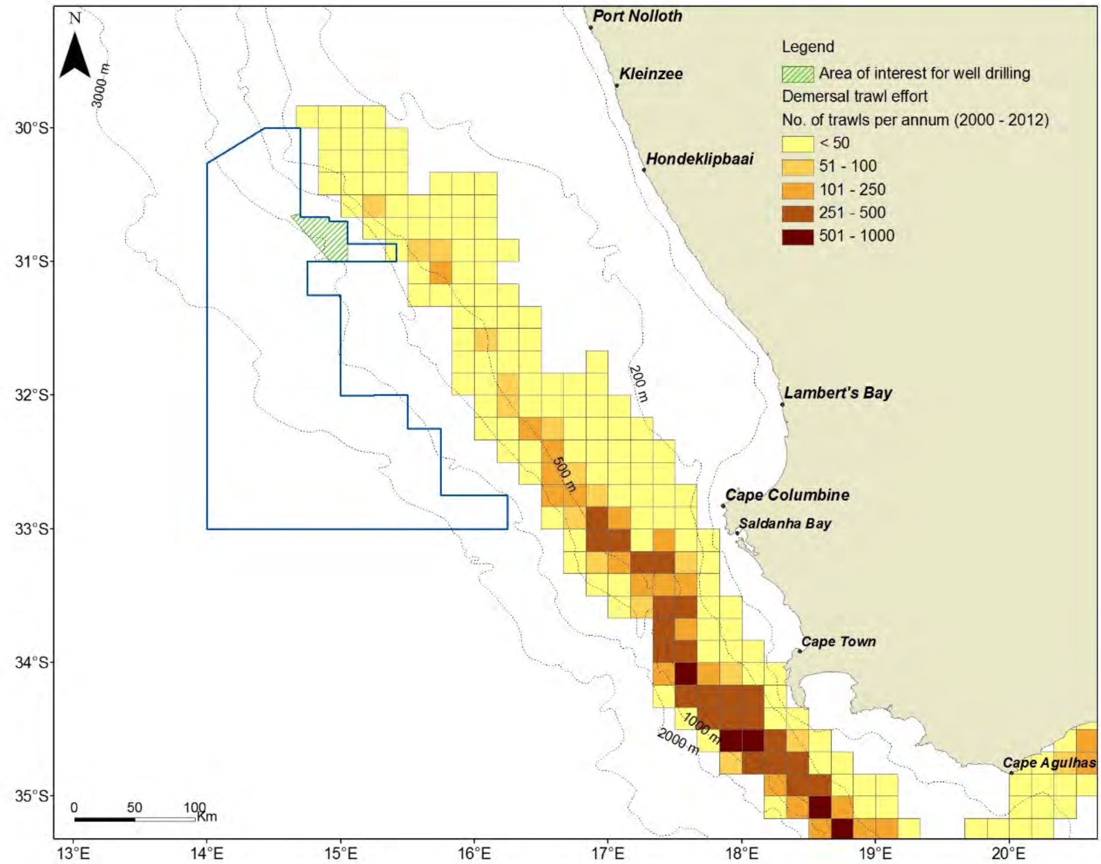

Figure 4.18: The proposed area of interest in relation to demersal trawl effort by the sector targeting hake (2000 to 2012).

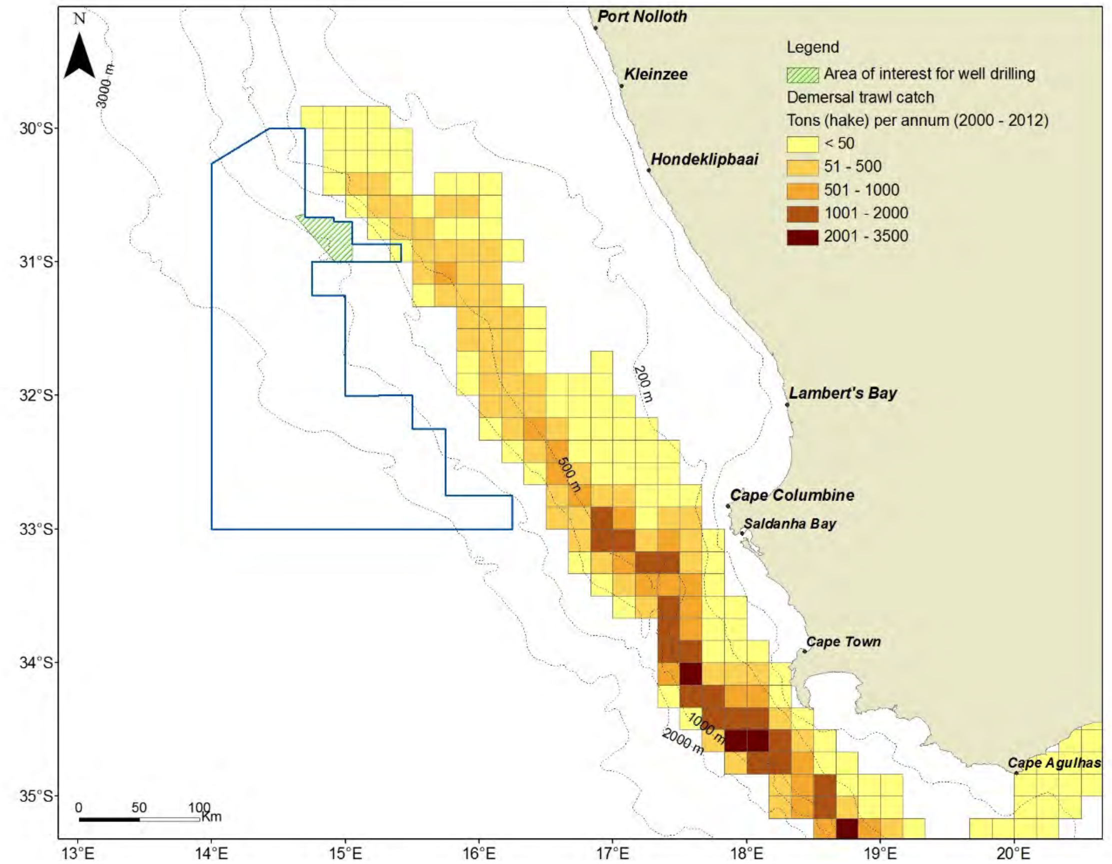

Figure 4.19: The proposed area of interest in relation to catch reported by the demersal trawl fishing sector (2000 to 2012).

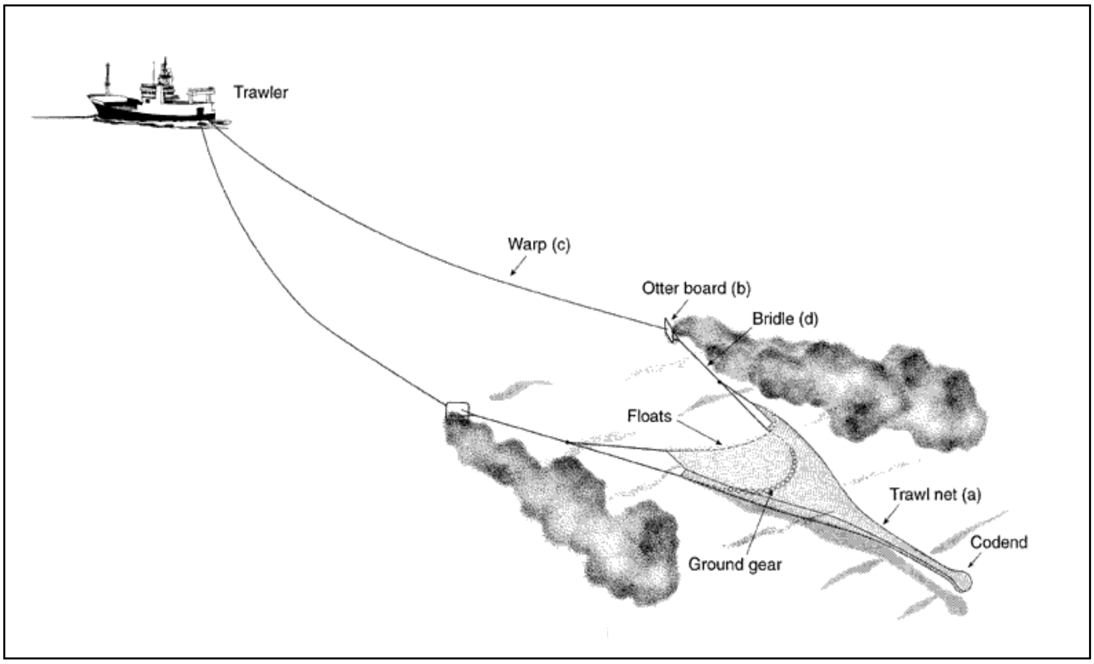

Figure 4.20: Typical gear configuration used by demersal trawlers (offshore) targeting hake.

(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 pelagic purse-seine fishery targets small mid-water and surface-shoaling species such as sardine, anchovy, juvenile horse mackerel and round herring using purse-seine fishing techniques. Annual landings have fluctuated between 300 000 and 600 000 tons over the last decade, with landings of 391 000 tons recorded per annum between 2008 and 2012.

Once a shoal has been located the vessel steams around it and encircle it with a large net. The depth of the net is usually between 60 m and 90 m. Netting walls surround aggregated fish both from the sides and from underneath, thus 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 (see Figure 4.21). Once the shoal has been encircled the net is pursed and hauled in and the fish are pumped onboard into the hold of the vessel. After the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered onboard, which may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

The South African fishery, consisting of approximately 101 vessels, is active all year round with a short break from mid-December to mid-January (to reduce impact on juvenile sardine), with seasonal trends in the specific species targeted. The geographical distribution and intensity of the fishery is largely dependent on the seasonal fluctuation and geographical distribution of the targeted species. Fishing grounds occur primarily along the Western Cape and Eastern Cape coast up to a distance of 100 km offshore, but usually closer inshore. The sardine-directed fishery tends to concentrate effort in a broad area extending from St Helena Bay, southwards past Cape Town towards Cape Point and then eastwards along the coast to Mossel Bay and Port Elizabeth. The anchovy-directed fishery takes place predominantly on the South-West Coast from St Helena Bay to Cape Point and is most active in the period from March to September. Round herring (non-quota species) is targeted when available and specifically in the early part of the year (January to March) and is distributed South of Cape Point to St Helena Bay. The fishing grounds of the small pelagic purse-seine fishery do not extend into the proposed area of interest, which is located approximately 180 km from the small pelagic purse-seine fishing grounds (see Figures 4.22 to 4.23).

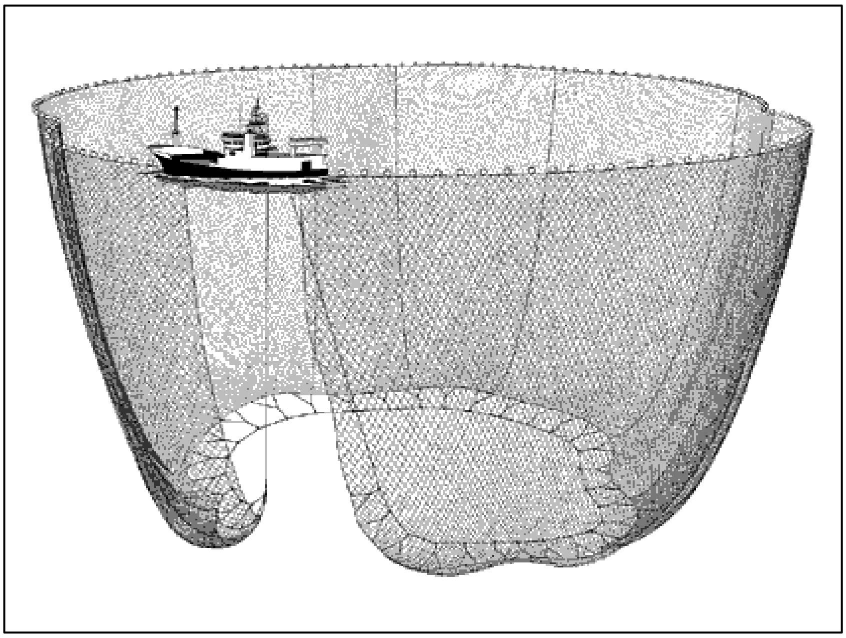

Figure 4.21: Pelagic purse-seine gear configuration.

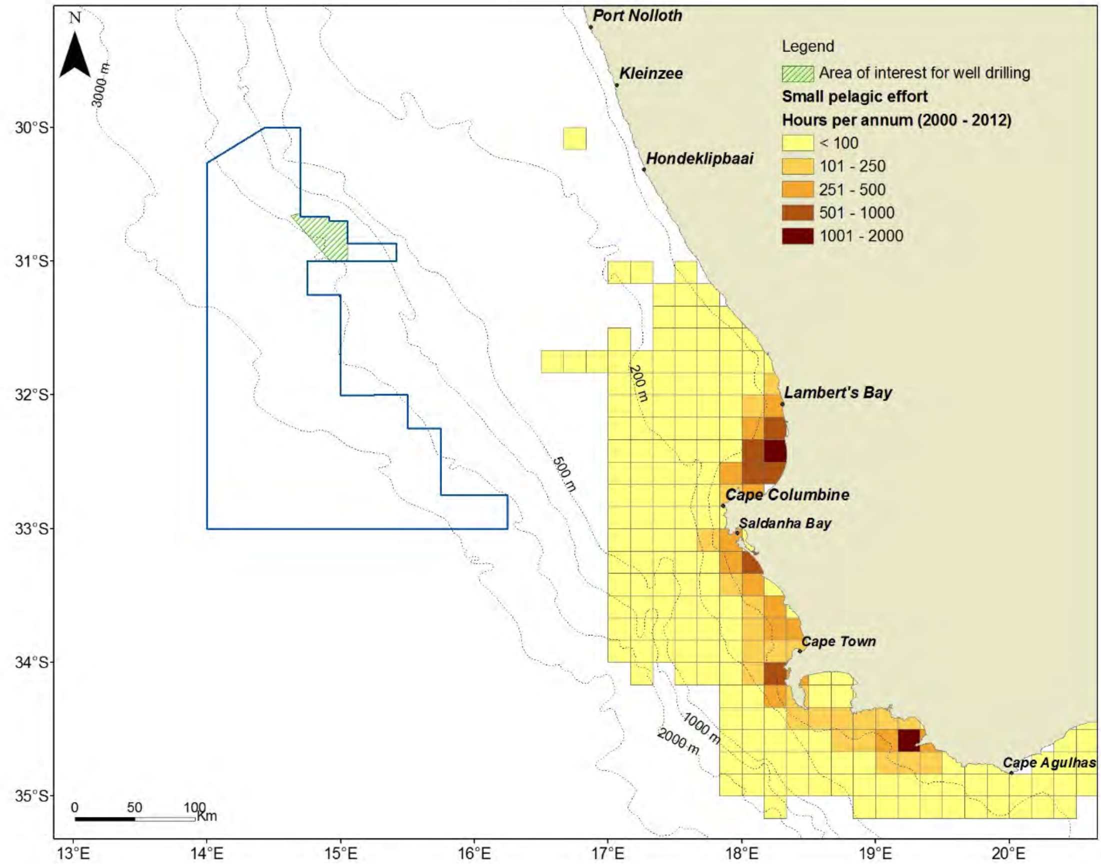

Figure 4.22: The proposed area of interest in relation to pelagic purse-seine effort (2000 - 2012).

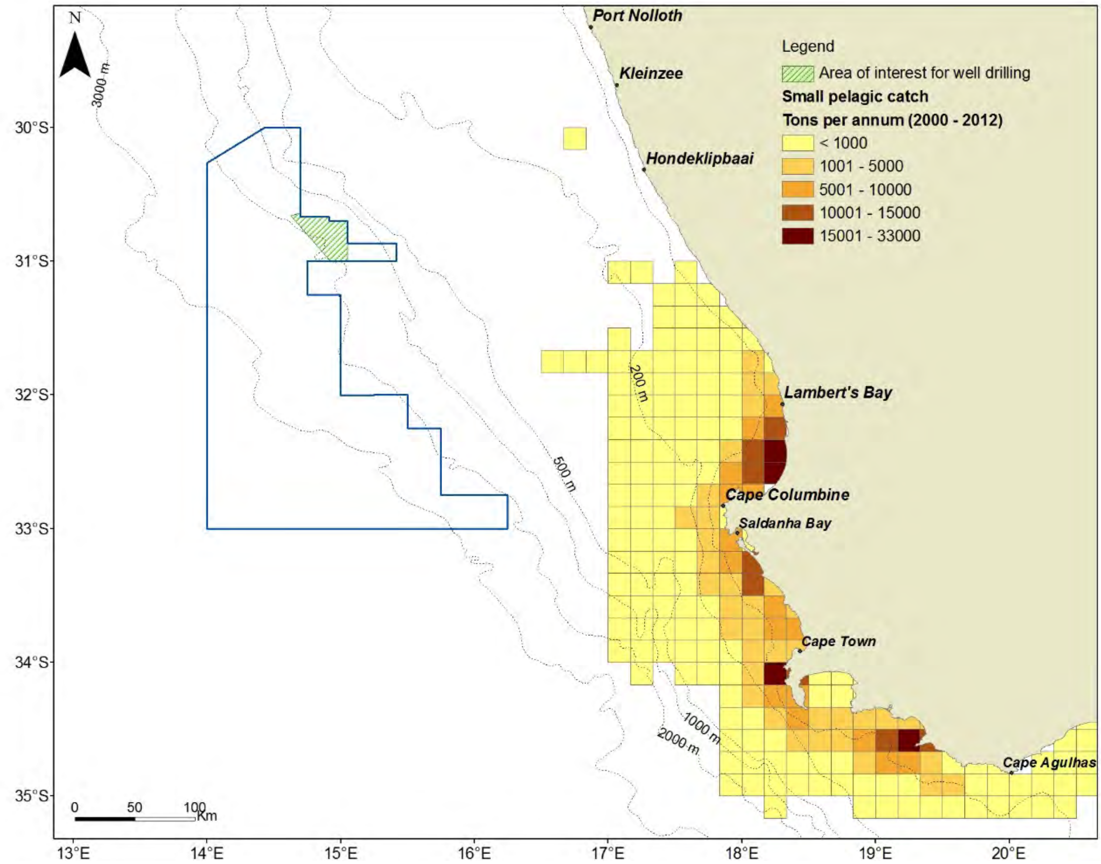

Figure 4.23: The proposed area of interest in relation to pelagic purse-seine catch (2000 - 2012).

(c) Demersal long-line

In South Africa the demersal long-line fishery operates in well-defined areas extending along the shelf break from Port Nolloth to Cape Agulhas and is comprised of the hake-directed, with a small non-targeted commercial by-catch that includes kingklip, and shark-directed demersal long-line sectors.

Bottom-set long-line gear is robust and comprises two lines as well as dropper lines with subsurface floats attached (see Figure 4.24). Lines are typically between 10 km and 20 km in length, carrying between 6 900 and 15 600 hooks each. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of between five and nine knots. Once deployed the line is left 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. During hauling operations a demersal long-line vessel would be severely restricted in manoeuvrability.

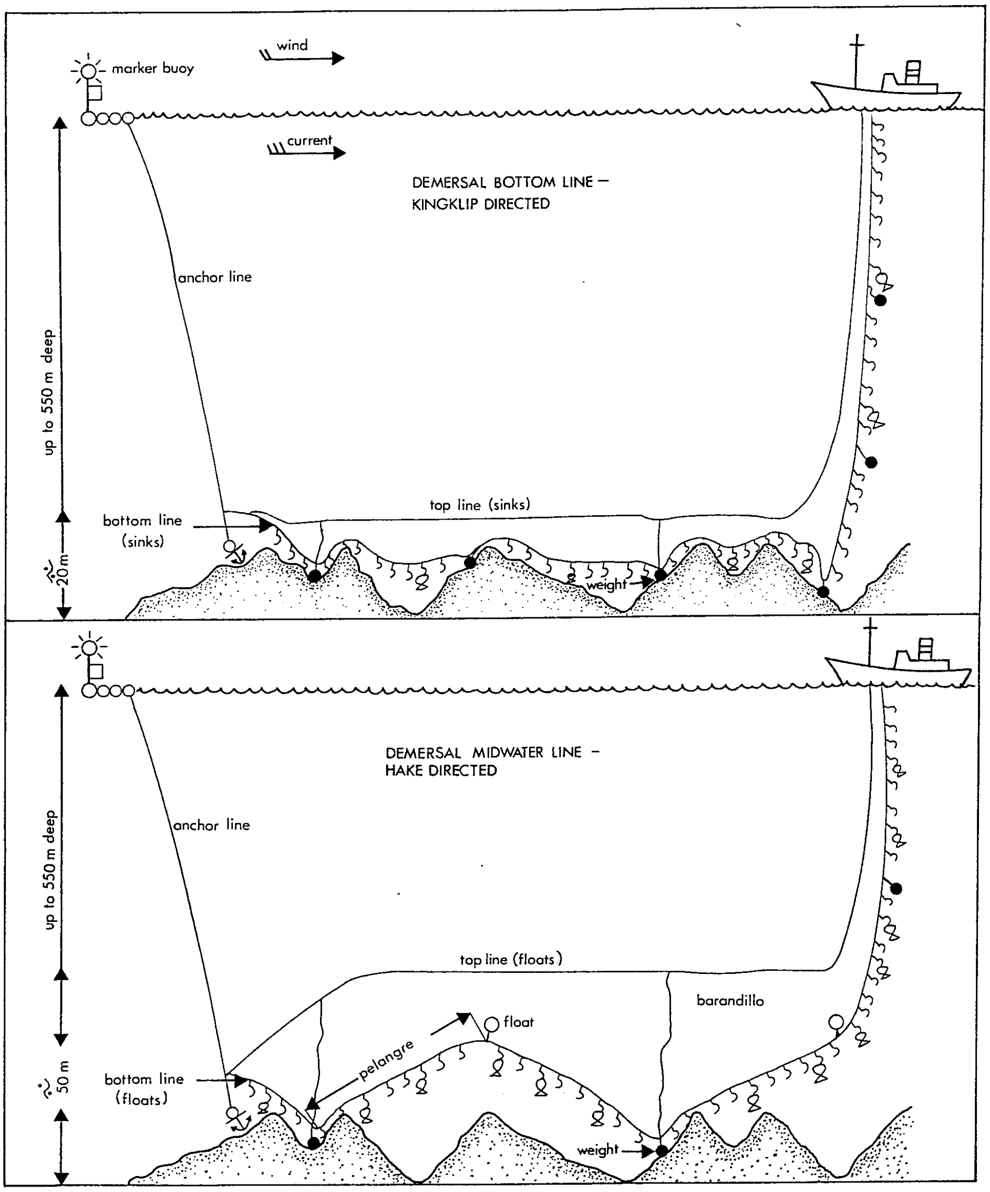

Figure 4.24: Typical configuration of demersal (bottom-set) hake long-line gear used in South African waters.

Hake-directed demersal long-line sector

Currently 64 hake-directed vessels are operational within the South African fishery, most of which are based at the harbours of Cape Town and Hout Bay. Operations are *ad hoc* and intermittent, subject to market demand. Of the total hake TAC of 144 671 tons set for 2012, the catch taken by the long-line fleet amounted to 8 399 tons (approximately 6%) or 9 257 tons including all other non-hake species landed.

Demersal long-lining is expected to occur in similar areas used by the hake-directed trawling, i.e. along the shelf edge from 300 m to a water depth of 1 000 m with lines usually set parallel to bathymetric contours. Figures 4.25 to 4.26 show the hake-directed demersal long-line effort and catch between 2000 and 2012 in relation to the area of interest, respectively. Over the period 2000 to 2012, an average of 30.7 million hooks were set and 8 791 tons of hake were landed per year. Over the period 2008 to 2012, the fishery set an average of 28.9 million hooks and landed 8 368 tons of hake per year.

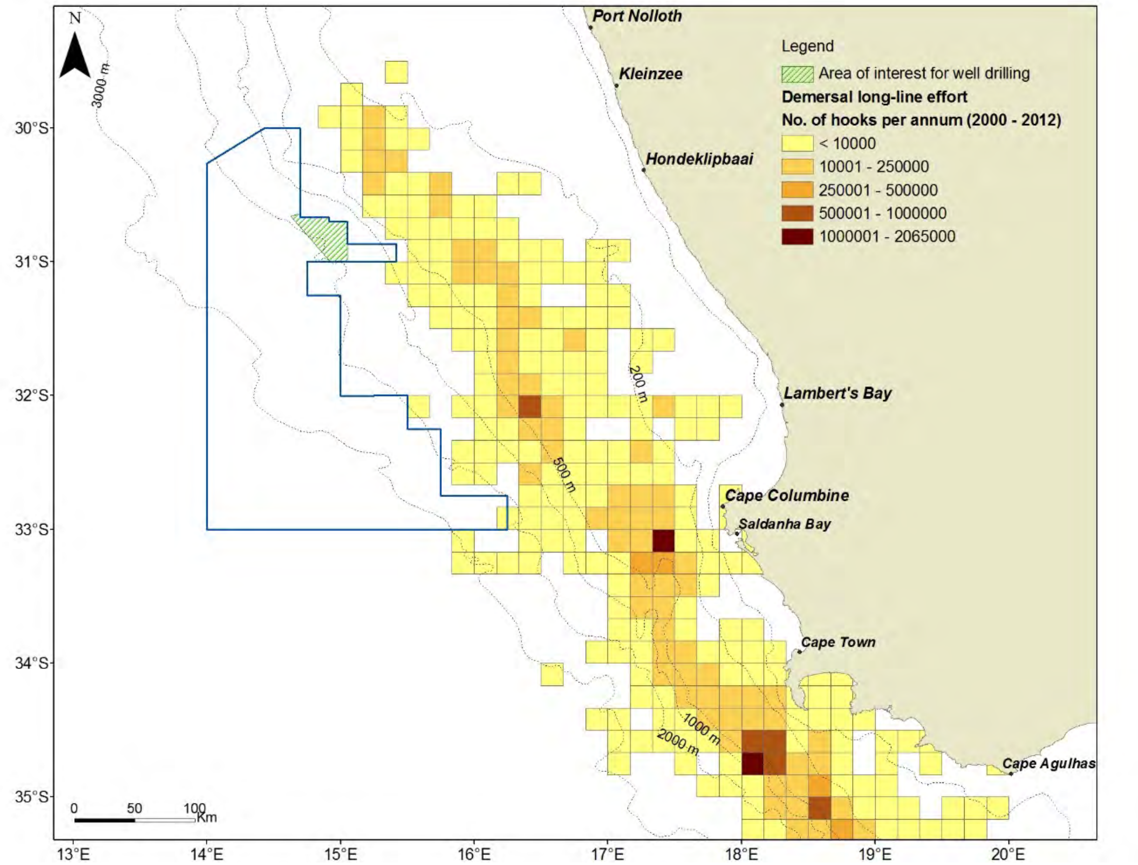

Figure 4.25: The proposed area of interest in relation to hake-directed demersal long-line effort (2000 - 2012).

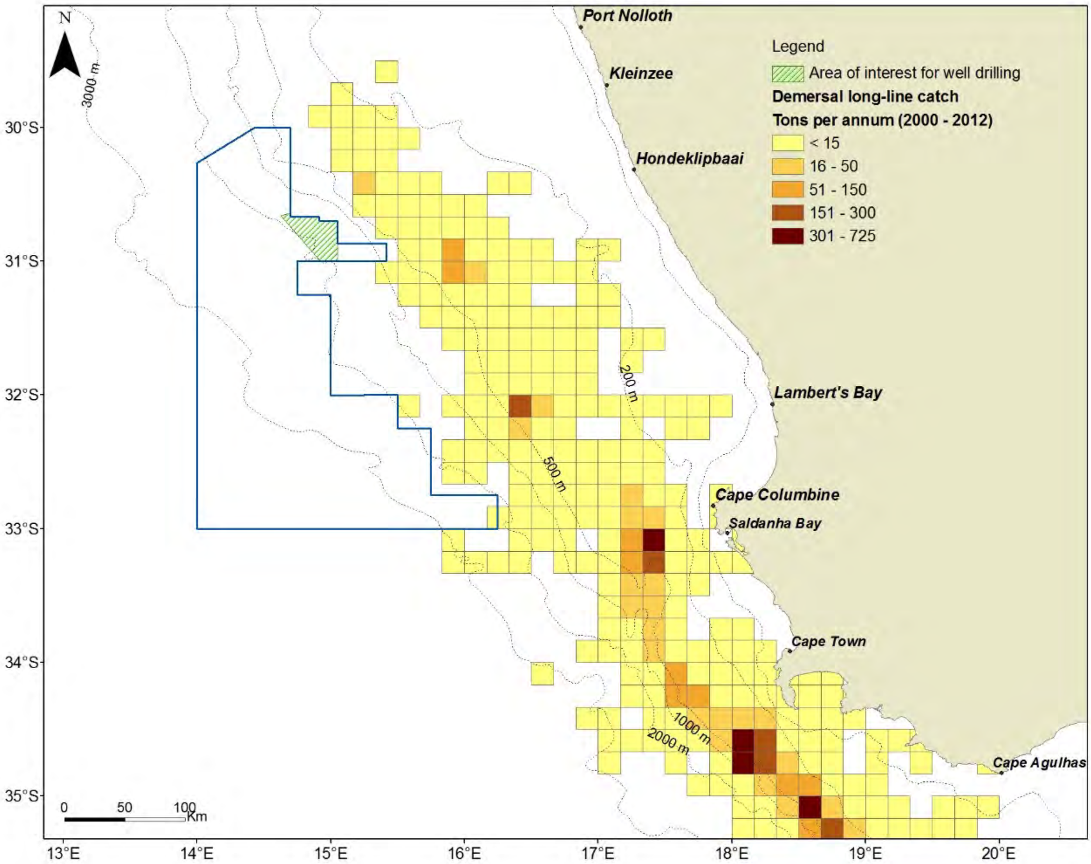

Figure 4.26: The proposed area of interest in relation to hake-directed demersal long-line catch (2000 - 2012).

<u>Shark-directed demersal long-line sector</u>

The demersal shark fishery targets soupfin shark, smooth-hound shark, spiny dogfish, St Joseph shark, *Charcharhinus* spp., rays and skates. Other species which are not targeted but may be landed include cape gurnards, jacopever and smooth hammerhead shark. Catches are landed at the harbours of Cape Town, Hout Bay, Mossel Bay, Plettenberg Bay, Cape St Francis, Saldanha Bay, St Helena Bay, Gansbaai and Port Elizabeth and currently six permit holders have been issued with long-term rights to operate within the fishery.

The fishery operates in coastal waters, predominantly inshore of the 150 m isobath. Figures 4.27 to 4.28 show the shark-directed demersal long-line effort and catch between 2007 and 2012 in relation to the area of interest, respectively. During the period 2007 to 2012, 430 500 hooks were set and 175 tons landed annually. Spatial records of effort and catch show the closest fishing effort located approximately 200 nm to the south-east of the proposed area of interest.

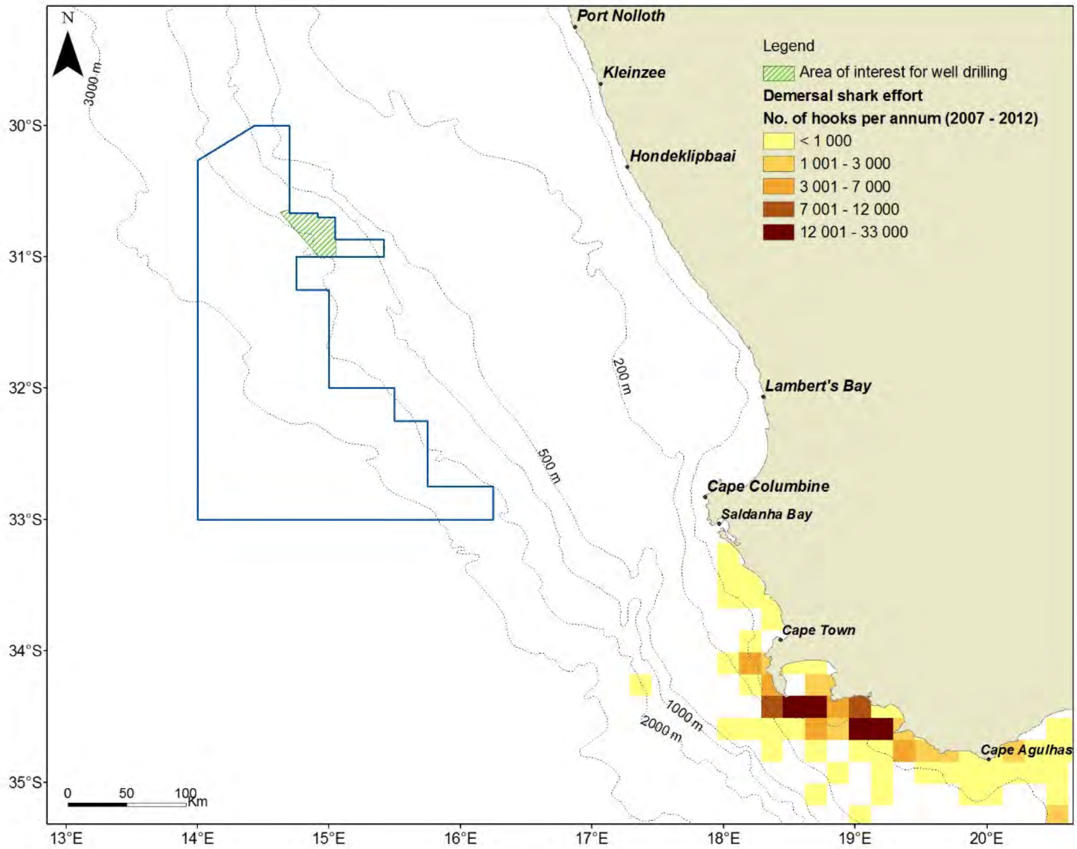

Figure 4.27: The proposed area of interest in relation to recent shark-directed demersal long-line effort (2007 - 2012).

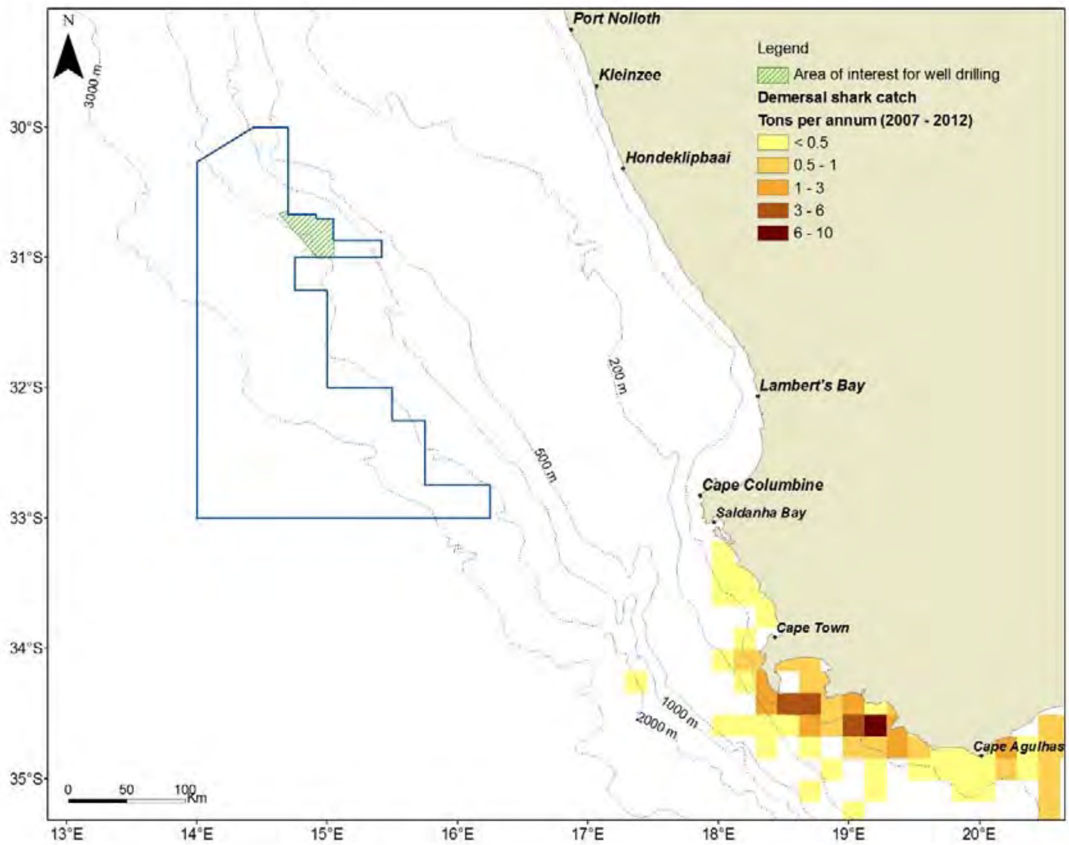

Figure 4.28: The proposed area of interest in relation to recent shark-directed demersal long-line catch (2000 - 2012).

(d) Pelagic long-line

The large pelagic long-line fishery operates year-round, extensively within the South African EEZ targeting primarily tuna and swordfish. Due to the highly migratory nature of these species, stocks straddle the EEZ of a number of countries and international waters. As such they are managed as a “shared resource” amongst various countries. There are currently 30 commercial large pelagic fishing rights issued for South African waters and there are 31 vessels active in the fishery.

Pelagic long-line vessels set a drifting mainline, which can be up to 100 km in length. The mainline is kept near the surface or at a certain depth (20 m below) by means of buoys connected via “buoy-lines”, which are spaced approximately 500 m apart along the length of the mainline (see Figure 4.29). Hooks are attached to the mainline via 20 m long trace lines, which are clipped to the mainline at intervals of approximately 50 m. There can be up to 3 500 hooks per line. A single main line consists of twisted rope (6 to 8 mm diameter) or a thick nylon monofilament (5 to 7.5 mm diameter). Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Each end of the line is marked by a Dahn Buoy and Radar reflector, which marks its position for later retrieval by the fishing vessel. A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. During hauling a vessel’s manoeuvrability is severely restricted and, in the event of an emergency, the line may be dropped to be hauled in at a later stage.

The fishery operates extensively from the continental shelf break into deeper waters, year-round. Pelagic long-line vessels are primarily concentrated seawards of the 500 m depth contour where the continental slope is steepest and can be expected within the area of interest.

Figures 4.30 to 4.31 show the large pelagic long-line effort and catch between 2000 and 2012 in relation to the area of interest, respectively. During the period 2000 to 2012, the national catch and effort recorded within the large pelagic fishery amounted to an average of 3 018 tons and 3.49 million hooks set per year. Approximately 2.1% of the total catch and 1.8% of the total number of hooks set were recorded in the area of interest. During the period 2008 to 2012, the national catch and effort recorded within the large pelagic fishery amounted to an average of 3 047 tons and 4.84 million hooks set per year. Approximately 1.1% of the total catch and 0.9% of the total number of hooks set were recorded in the area of interest. These figures represent the combined catch and effort of both the domestic and foreign-flagged vessels.

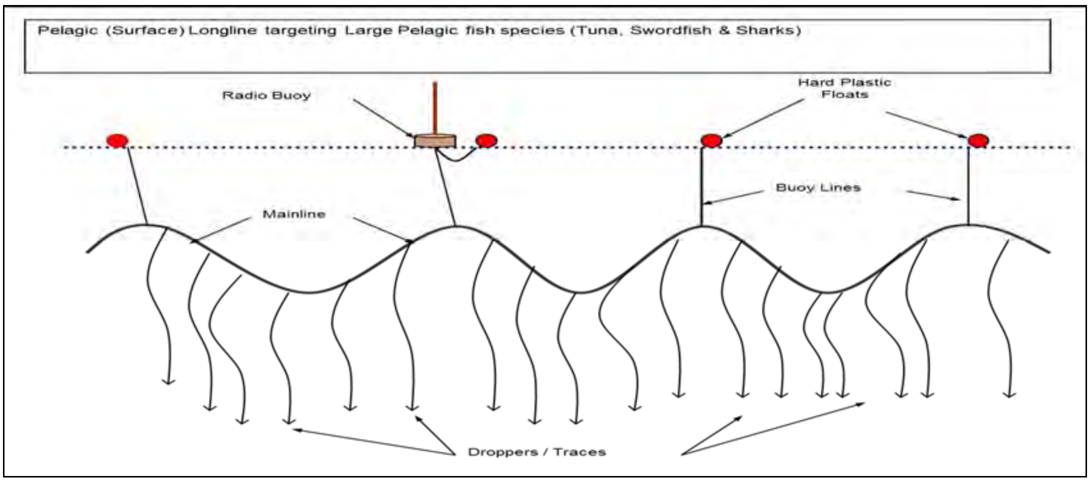

Figure 4.29: Typical pelagic long-line configuration targeting tuna, swordfish and shark species.

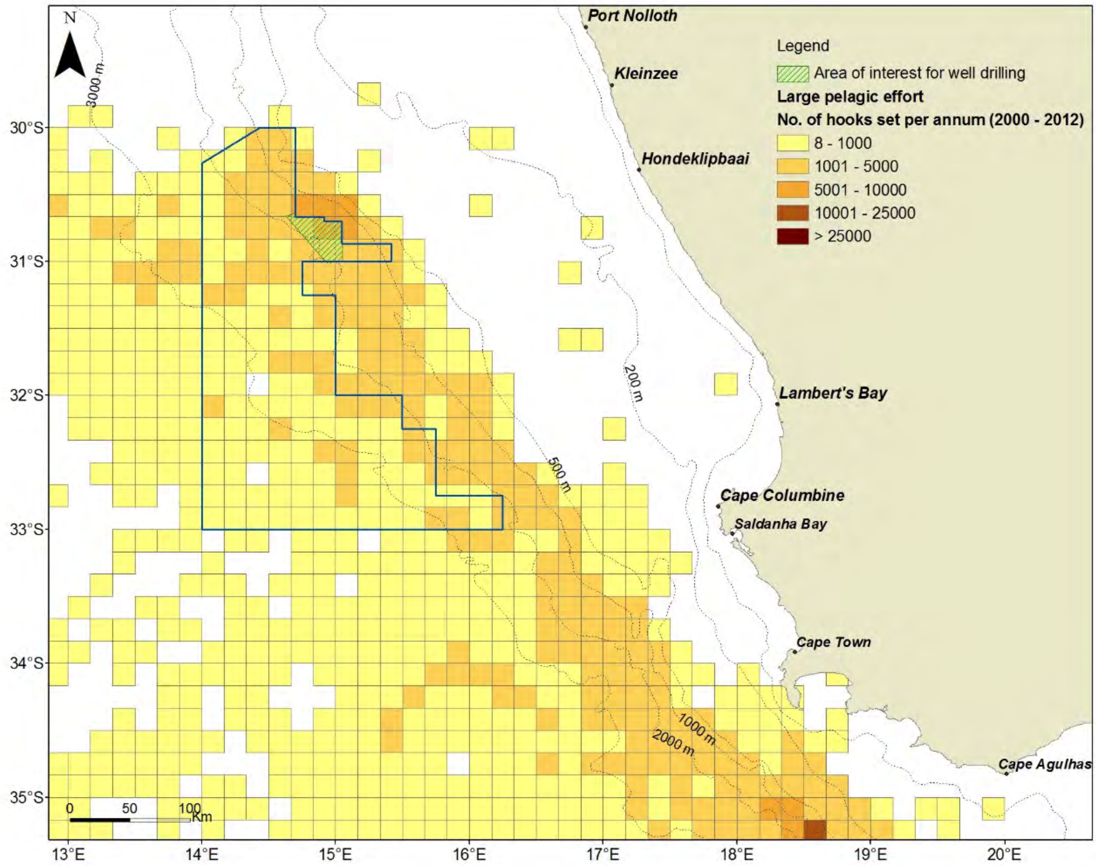

Figure 4.30: The proposed area of interest in relation to large pelagic long-line effort (2000 - 2012).

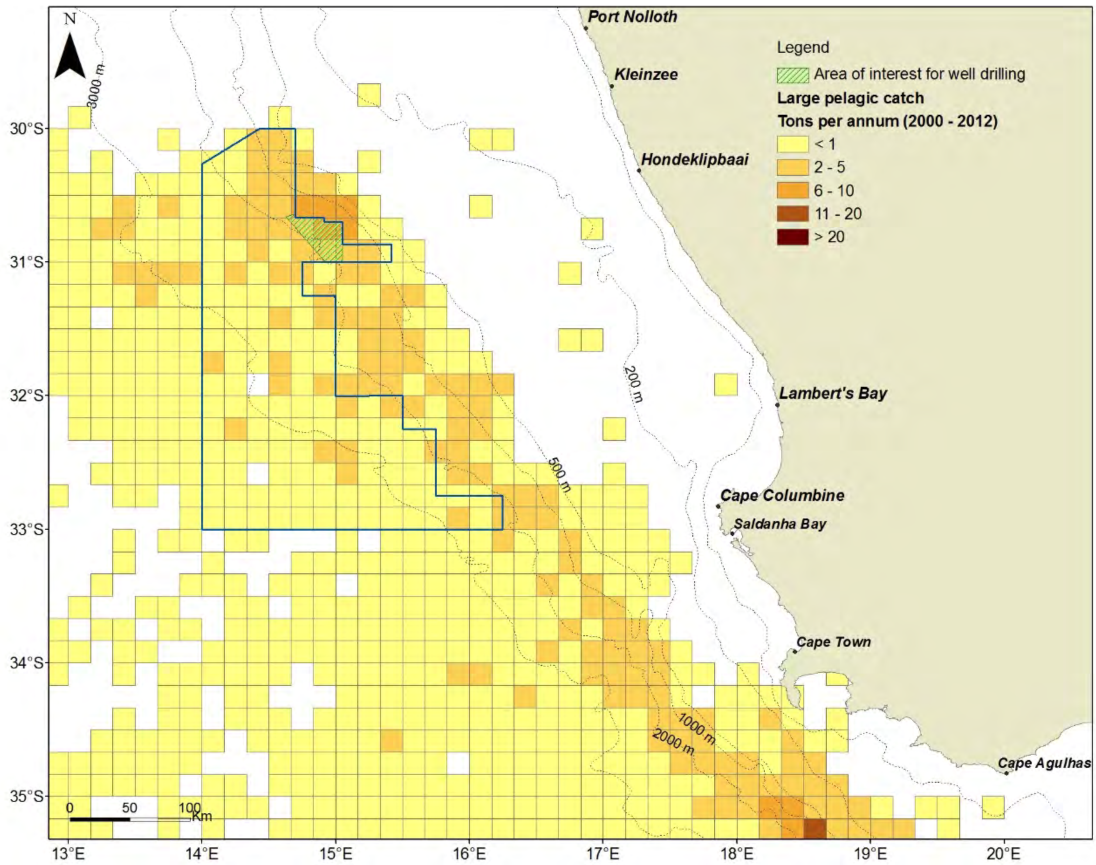

Figure 4.31: The proposed area of interest in relation to large pelagic long-line catch (2000 - 2012).

(e) Tuna pole

The tuna pole fishery is based on migratory species of tuna, predominantly Atlantic longfin tuna stock and a very small amount of skipjack tuna, yellowfin tuna and bigeye tuna. The South African fleet consists of approximately 128 pole-and-line vessels, which are based at the ports of Cape Town, Hout Bay and Saldanha Bay. The fishery is seasonal with vessel activity mostly between December and May and peak catches in February and March. The 2014 TAC for the South African tuna pole fishery (albacore) will be set at 4 400 tons.

Vessels drift whilst attracting and catching shoals of pelagic tunas. Sonars and echo sounders are used to locate schools of tuna. Once a school is located, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface. Live bait is then used to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the 2 to 3 m poles are fitted with a short length of fishing line leading to a hook. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (see Figure 4.32). Vessels are relatively small (less than 25 m in length) and store catch on ice, thus staying at sea for short periods (approximately five days).

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

Fishing activity occurs along the entire West Coast beyond the 200 m bathymetric contour. Activity would be expected to occur along the shelf break with favoured fishing grounds including areas north of Cape Columbine and between 60 km and 120 km offshore from Saldanha Bay. Figures 4.33 to 4.34 show the tuna pole effort and catch between 2003 and 2012 in relation to the area of interest, respectively. The total catch landed and effort expended by the tuna pole sector over the period 2003 to 2012 was 4 110 tons (all species) and 5 723 fishing events per annum. The total catch landed and effort expended by the tuna pole sector over the period 2008 to 2012 was 4 221 tons (all species) and 4 707 fishing events per annum. There have been no records of historical or recent fishing effort by tuna pole sector within the Orange Basin Deep Water Licence Area and the closest recorded fishing position is situated 60 nm inshore (due East) of the proposed area of interest of interest.

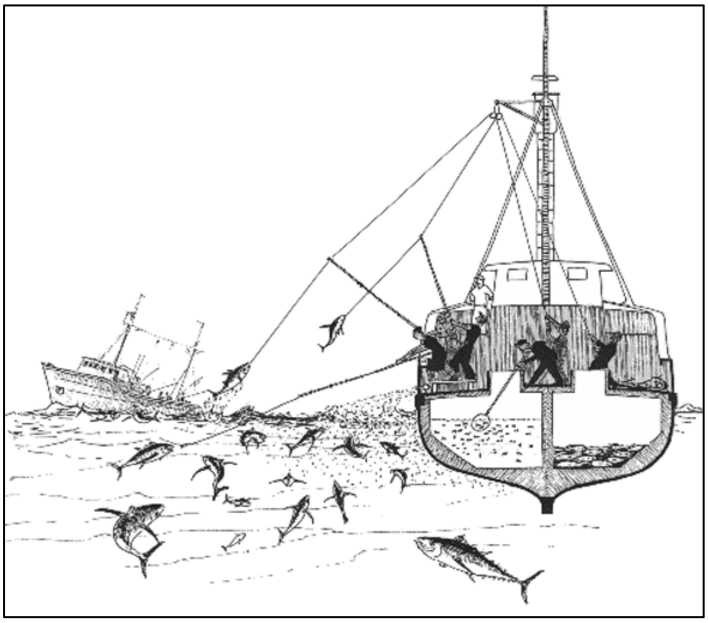

Figure 4.32: Schematic diagram of pole and line operation (www.fao.org/fishery).

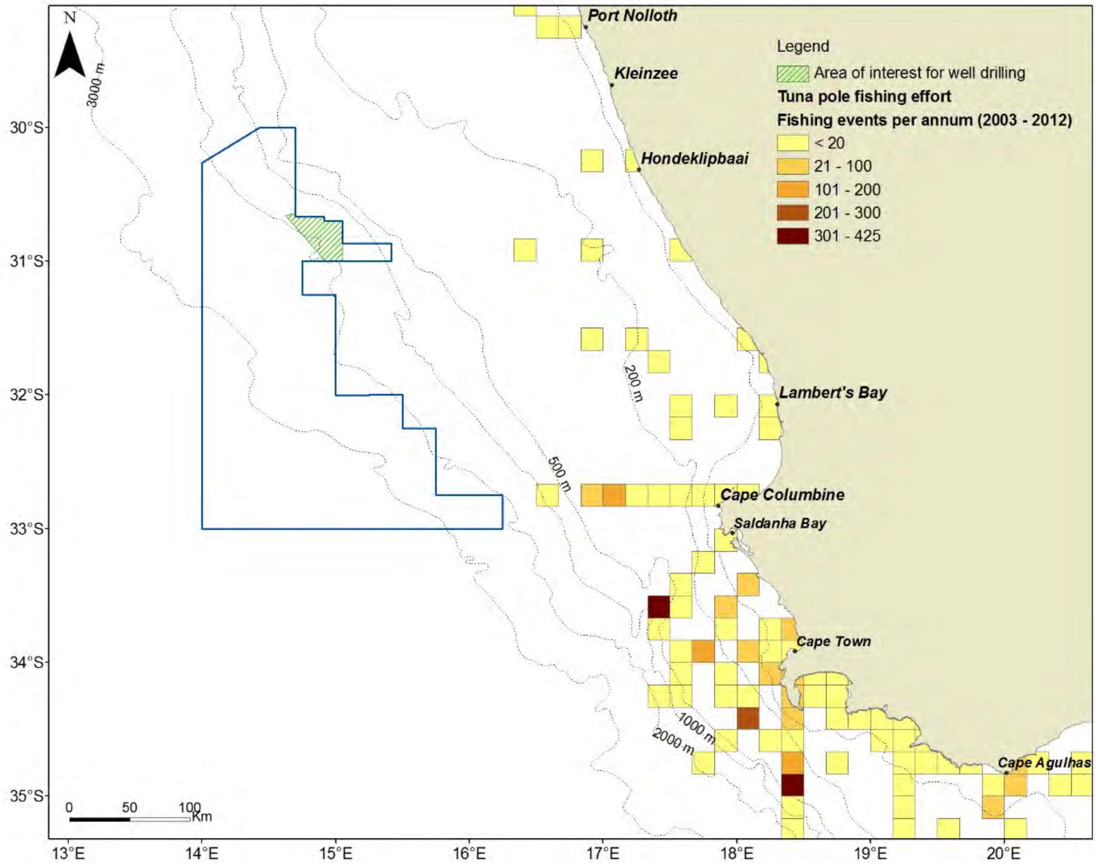

Figure 4.33: The proposed area of interest in relation to tuna pole effort (2003 - 2012).

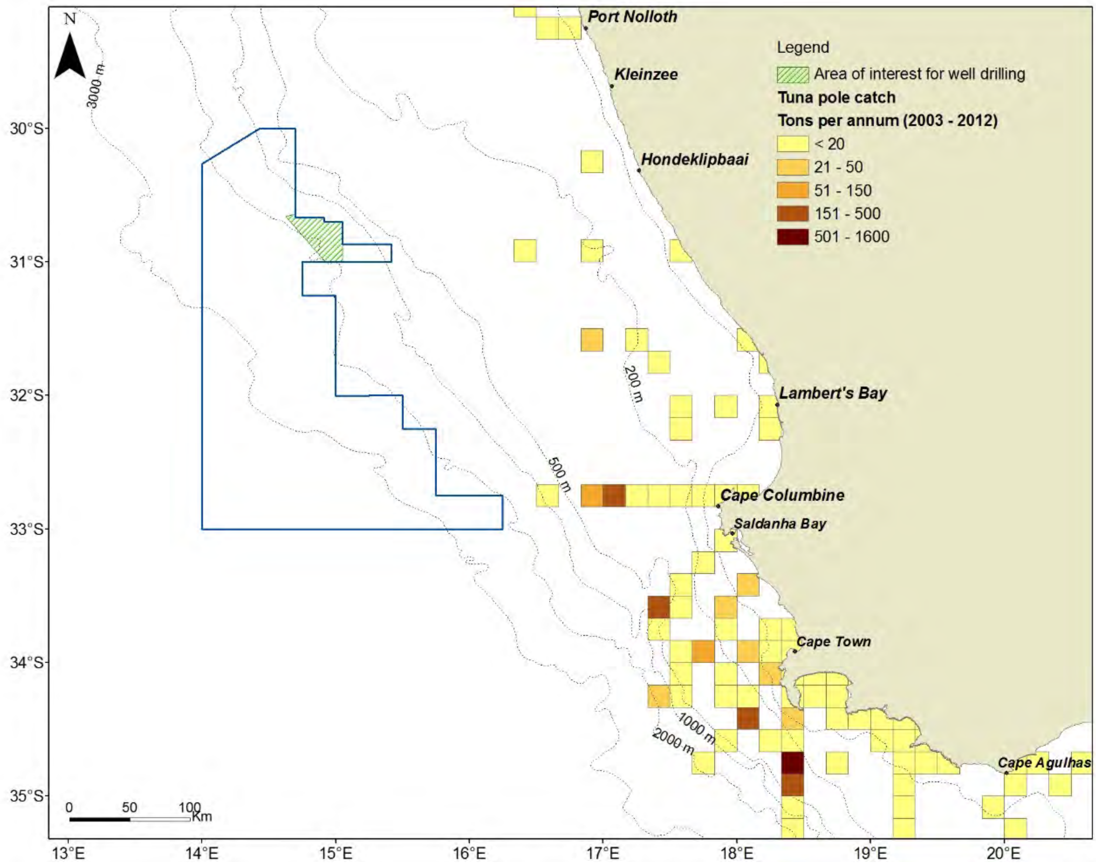

Figure 4.34: The proposed area of interest in relation to tuna pole catch (2003 - 2012).

(f) Traditional line-fish

This fishery includes commercial, subsistence and recreational sectors. The South African commercial line fishery is the country's third most important fishery in terms of total tons landed and economic value. The bulk of the fishery catch is made up of approximately 35 species. Different assemblages of species are targeted according to the region in which they are being fished and include tuna species, sparidae, serranidae, caragidae, scombridae and sciaenidae. In South Africa 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, which operates on the continental shelf mostly up to a depth of 200 m from the Namibian border on the West Coast to the Kei River in the Eastern Cape. Up to 3 000 boats are involved in the fishery on the national level, 450 of which are involved in the commercial fishery.

Fishing vessels generally range up to a maximum of 40 nm offshore, although fishing at the outer limit of this range is sporadic. Figure 4.35 shows the traditional line-fish catch between 2000 and 2012 in relation to the area of interest. Over the period 2000 to 2012, the fishery reported an annual catch of 13 082 tons. Over the five-year period from 2008 to 2012, annual catches for the sector are lower at 8 551 tons. There are records of catch within the proposed area of interest.

Line fishing techniques consist of hook and line deployments (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.

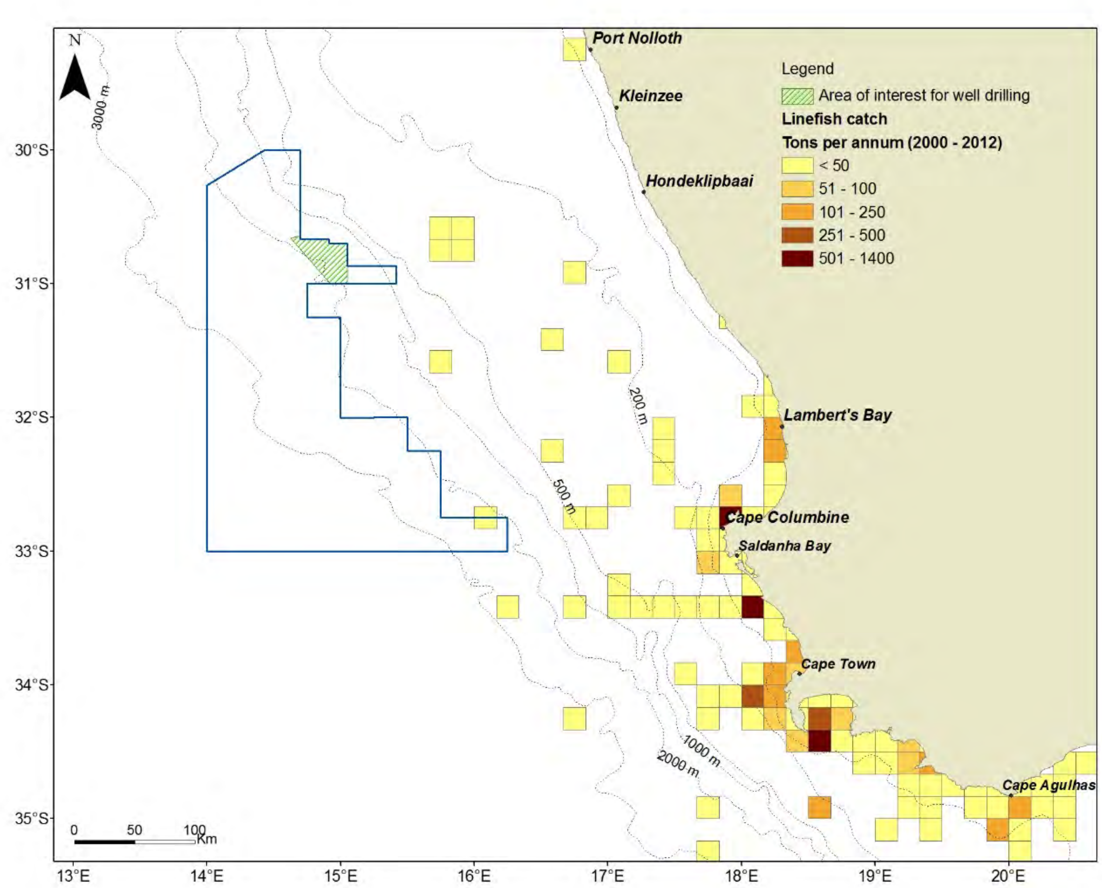

Figure 4.35: The proposed area of interest in relation to traditional line-fish catch (2000 - 2012).

(g) West Coast rock lobster

The West Coast rock lobster occurs inside the 200 m depth contour along the West Coast from Namibia to East London on the East Coast of South Africa. In South Africa the fishery is divided into the offshore fishery and the near-shore fishery, both directed inshore of the 100 m bathymetric contour. The offshore sector operates in a water depth range of 30 m to 100 m whilst the inshore fishery is restricted by the type of gear used to waters shallower than 30 m in depth.

Fishing grounds are divided into Zones stretching from the Orange River mouth to east of Cape Hangklip in the South-Eastern Cape. Effort is seasonal with boats operating from the shore and coastal harbours. Catch is managed using a TAC, 80% and 20% of which is allocated to the offshore and inshore fisheries respectively. A total national landing of approximately 1 879 tons (whole weight) was recorded for 2012. Figure 4.36 shows the West Coast rock lobster catch between 1969 and 2012 in the various management zones in relation to the area of interest. Catches of rock lobster have declined systematically due to heavy fishing pressure and are currently estimated to be at only 3% of their pristine state. The proposed area of interest lies approximately 125 nm (230 km) west of the fishing grounds.

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

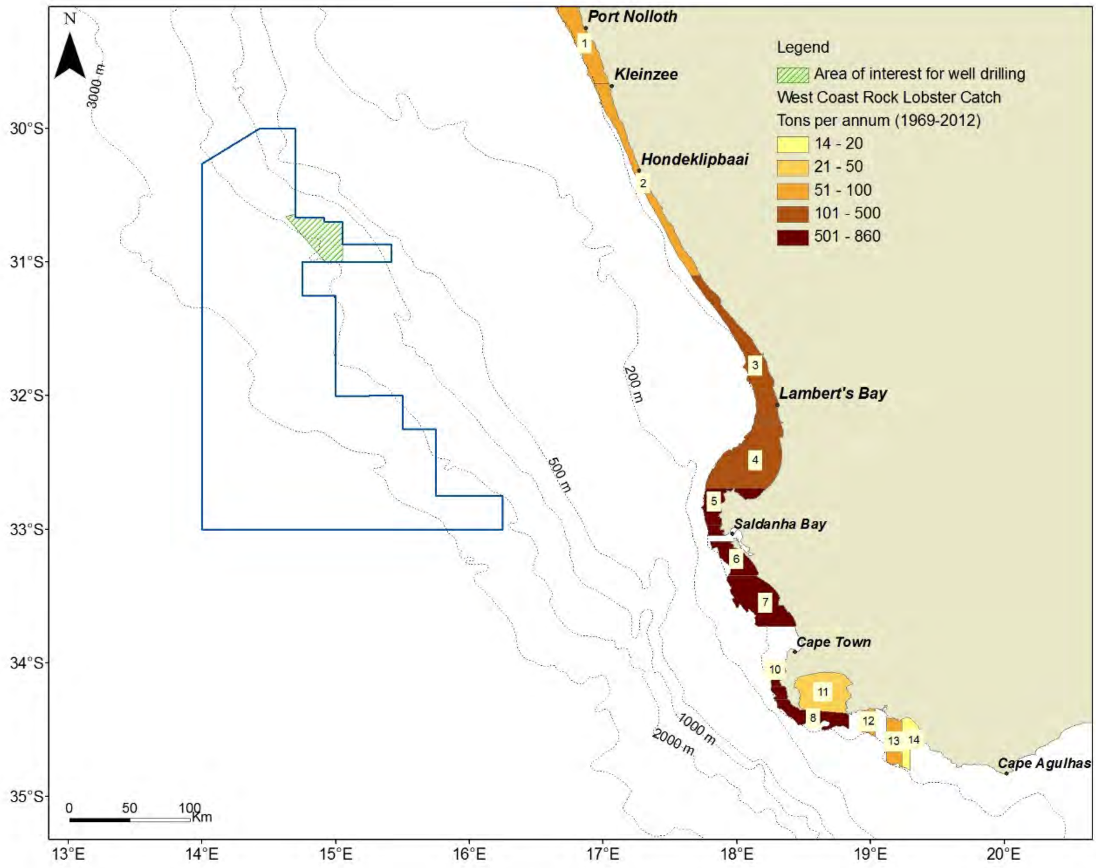

Figure 4.36: The proposed area of interest in relation to West Coast Rock Lobster catch (1969 - 2012).

(g) Fisheries research

Surveys of demersal fish resources are carried out in January (West Coast survey) and May (South Coast survey) each year by DAFF in order to set the annual TACs for demersal fisheries. Stratified, bottom trawls are conducted to assess the biomass, abundance and distribution of hake, horse mackerel, squid and other demersal trawl species on the shelf and upper slope of the South African coast. The gear configuration is similar to that of commercial demersal trawlers, however, nets are towed for a shorter duration of generally 30 minutes per tow. Trawl positions are randomly selected to cover specific depth strata that range from the coast to the 1 000 m bathymetric contour (see Figure 4.37), thus inshore of the proposed area of interest. Approximately 120 trawls are conducted during each survey over a period of approximately one month.

The biomass of small pelagic species is also assessed bi-annually by an acoustic survey. The first of these surveys is timed to commence mid-May and runs until mid-June while the second starts in mid-October and runs until mid-December. During these surveys the survey vessel travels pre-determined transects (perpendicular to bathymetric contours) running offshore from the coastline to approximately the 200 m bathymetric contour (thus inshore of the proposed area of interest). The survey is designed to cover an extensive area from the Orange River on the West Coast to Port Alfred on the East Coast.

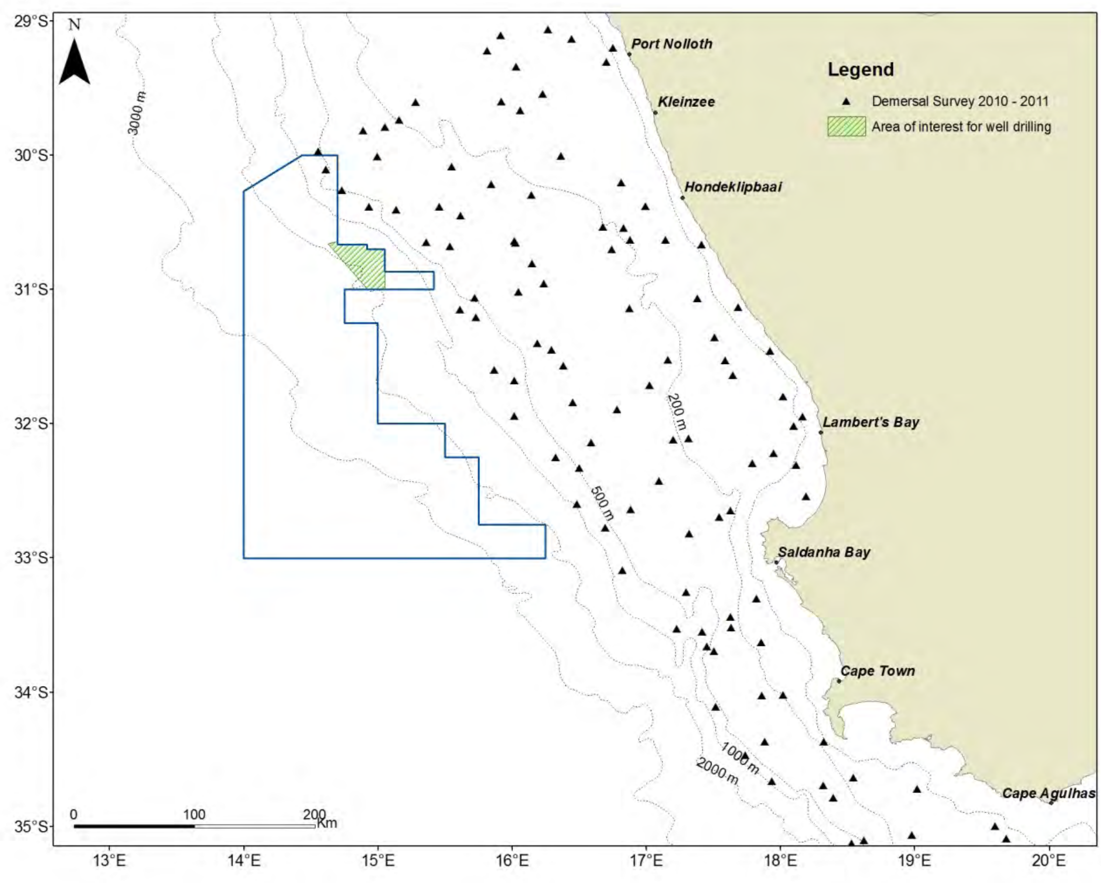

Figure 4.37: The proposed area of interest in relation to the spatial distribution of research trawls conducted between 2010 and 2011.

4.1.4.2 Shipping transport

The majority of shipping traffic is located on the outer edge of the continental shelf with traffic inshore of the continental shelf along the West Coast largely comprising fishing and mining vessels, especially between Kleinzee and Oranjemund. Figures 4.38 and 4.39 show that the majority of the shipping traffic en route to Cape Town would pass though the licence area and possibility though the area of interest.

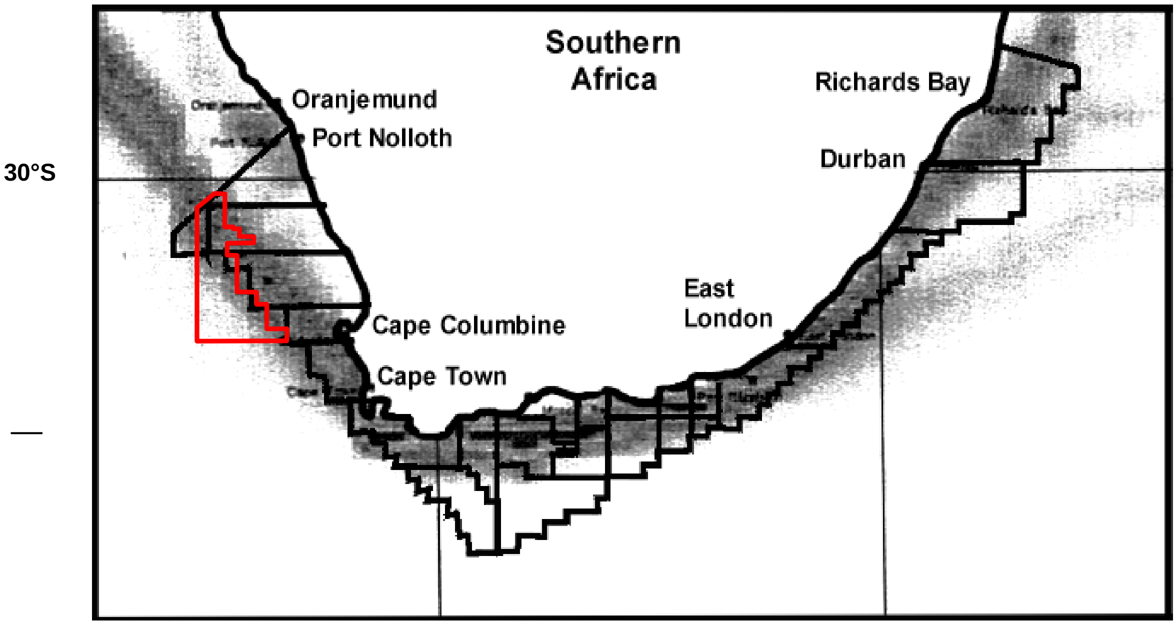

Figure 4.38: The major shipping routes along the west coast of South Africa showing petroleum license blocks (Data from the South African Centre for Oceanography). Approximate location of the licence area is also shown.

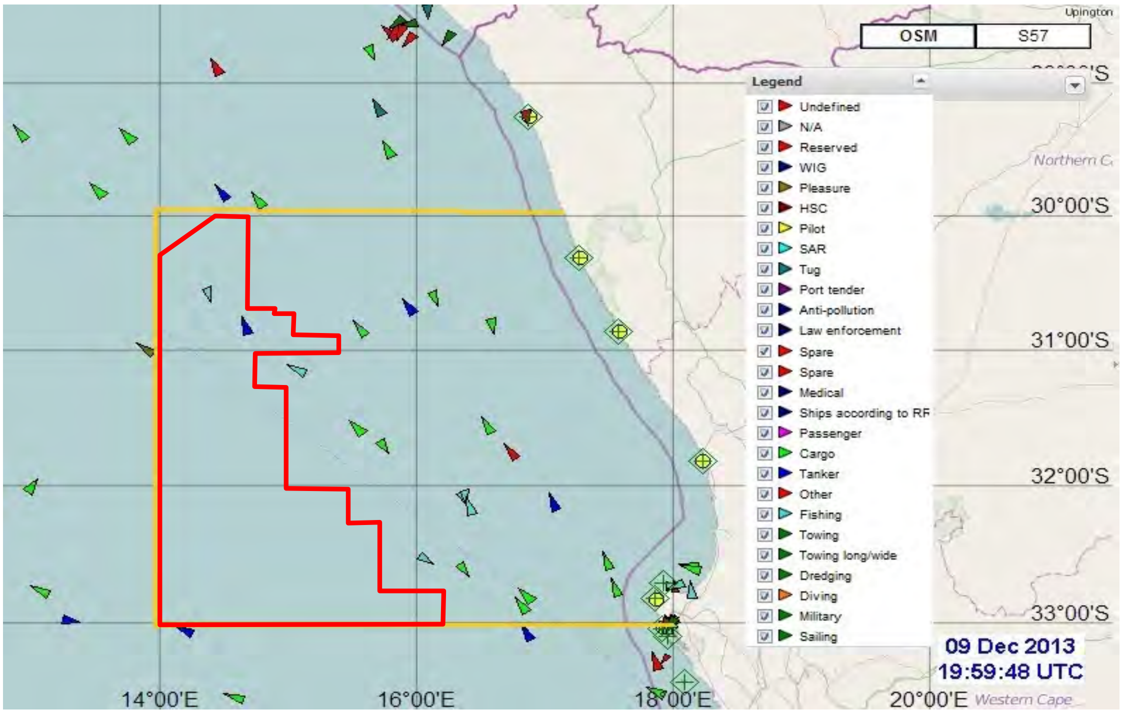

Figure 4.39: A typical representation (instantaneous) of the vessel type and numbers passing through the study area on a daily basis (after SAMSA, Capt Karl Otto, December 2013). Approximate location of the licence area is also shown.

4.1.4.3 Oil and Gas exploration and production

Exploration for oil and gas is currently undertaken in a number of licence blocks off the West, South and East coasts of South Africa (see Figure 4.40).

There is no current development or production from the South African West Coast offshore. The Ibhubesi Gas Field (Block 2A) and Kudu Gas Field (off southern Namibia) have been identified for development.

4.1.4.4 Diamond prospecting and mining

Marine diamonds are mined along the West Coast from just south of Lamberts Bay to the Orange River mouth. Twenty diamond mining concessions have been established along the West Coast with each concession divided into four zones from the coat seaward (a, b, c & d). There are no diamond mining concessions within the licence area (see Figure 4.41).

The majority of concessions worked at present are those closer inshore (water depths are mostly less than 150 m). No deep-water diamond mining is currently underway in the South African offshore concession areas, since mining activities ceased in Mining Licence 3 (ML3) (currently referred to as MPT25/2011) in 2010. De Beers Marine has applied to the Department of Mineral Resources for closure of this mining licence. International Mining and Dredging SA (Pty) Ltd (as part of a mining agreement with Alexkor) is currently undertaking sampling activities in concessions 1B and 1C. Belton Park Trading 127 (Pty) Ltd, a company of the International Mining and Dredging Holding Limited group, has a prospecting right (diamonds) for concessions 2C, 3C, 4C and 5C, which overlap with ML3.

In Namibian waters, diamond mining by De Beers Marine Namibia is currently operational in the Atlantic 1 Mining Licence Area, approximately 250 km to the north-northeast of the proposed area of interest.

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

4.1.4.5 Prospecting and mining of other minerals

(a) Heavy minerals

Heavy mineral sands containing, amongst other minerals, zircon, ilmenite, garnet and rutile may be found offshore of the West Coast. Tronox’s Namakwa Sands is currently exploiting heavy minerals from onshore deposits near Brand-se-Baai (approximately 385 km north of Cape Town). In October 2009, De Beers Marine secured a Prospecting Right for platinum group metals, gold and sapphires in the ML3 area (see Figure 4.42).

In addition, De Beers Consolidated Mines secured prospecting rights (including heavy minerals, platinum group metals, gold and sapphire) for three areas inshore of the 200 m bathymetric contour, and thus inshore of the licence area (see Figure 4.42). De Beers Marine is the operator of this prospecting right.

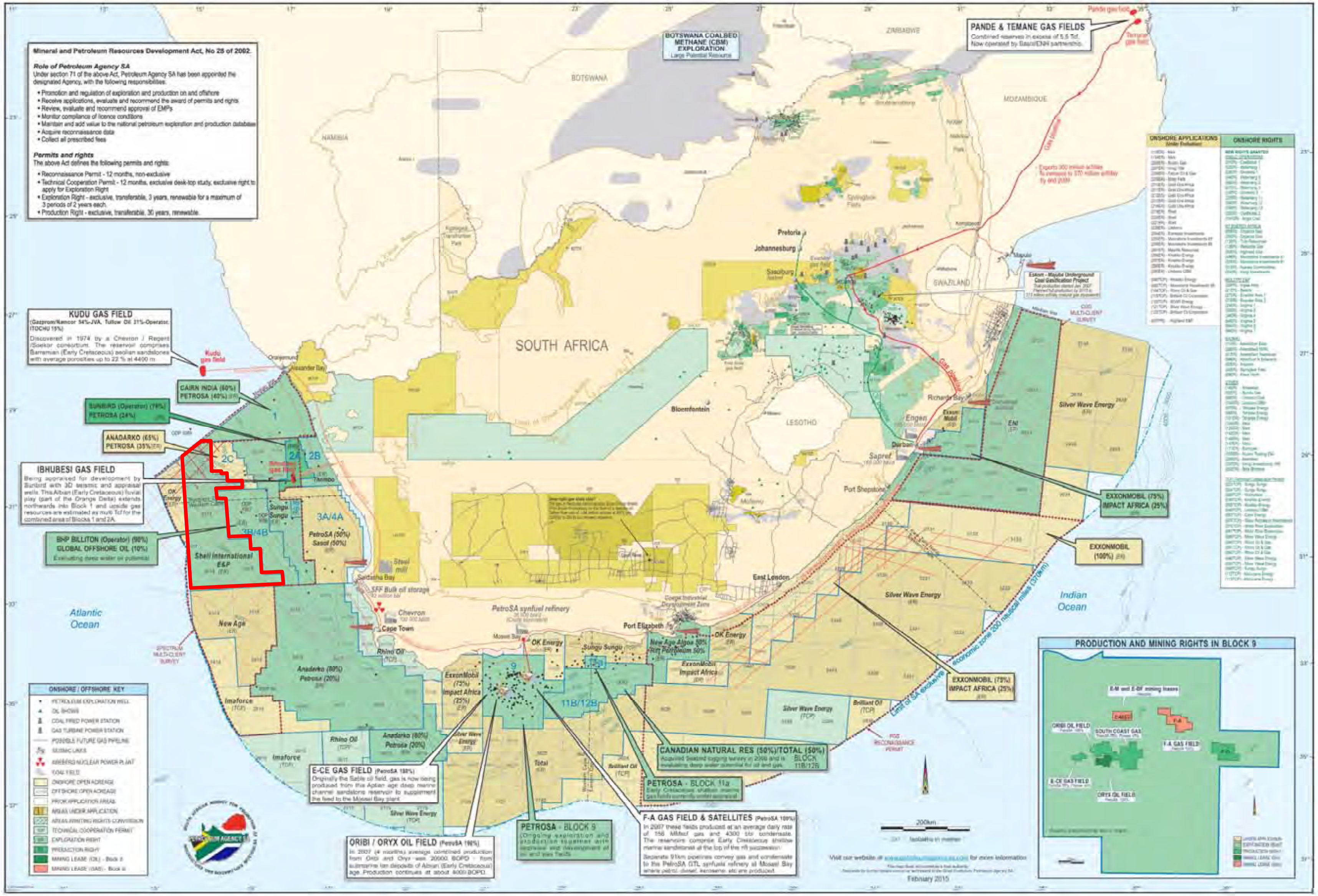

Figure 4.40: **Petroleum licence blocks off the West, South and East coasts of South Africa (after PASA, February 2015). The Orange Basin Deep Water Licence Area is highlighted in red.**

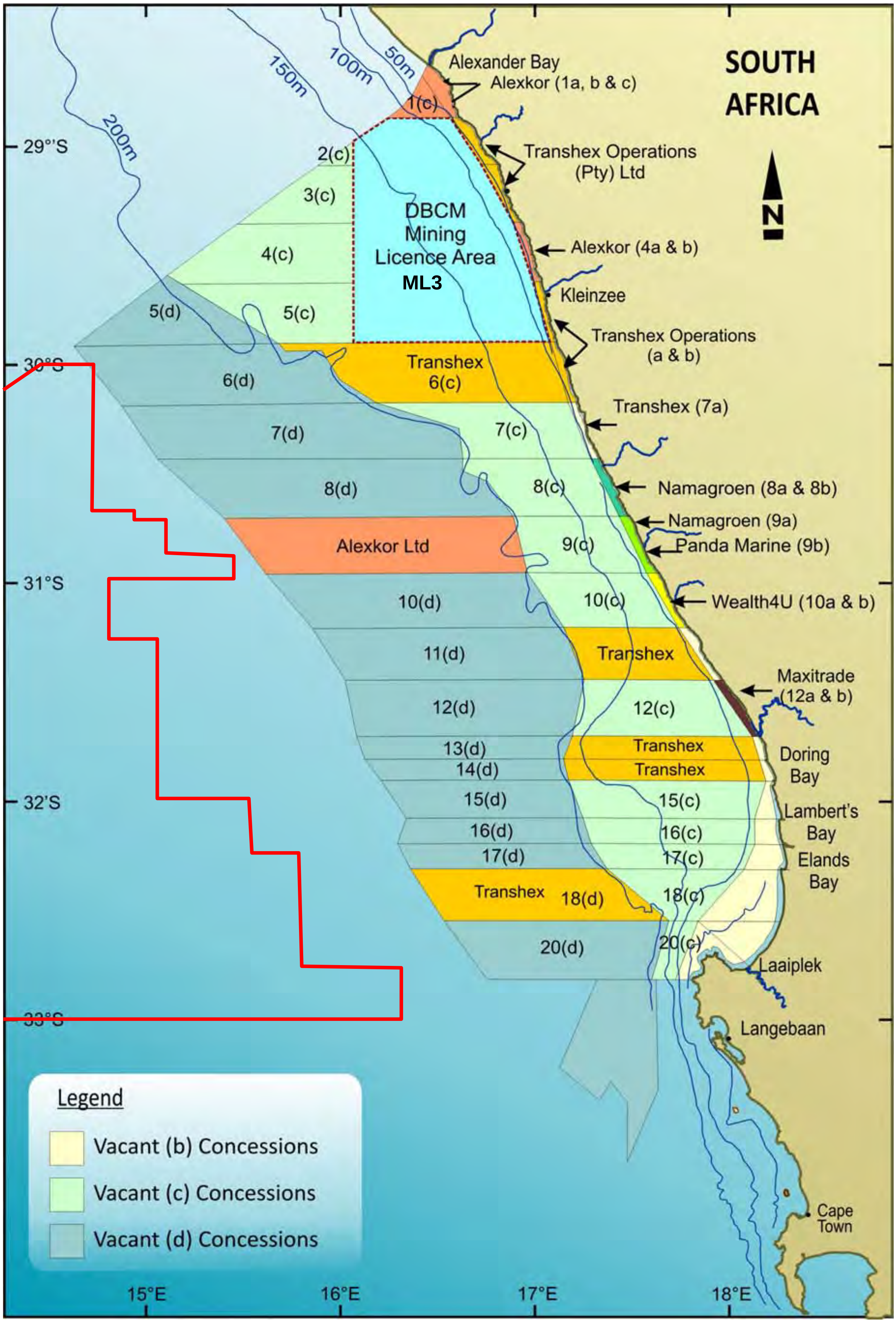

Figure 4.41: **South African Diamond Rights Holders off the West Coast (compiled by De Beers, 2011). Approximate location of the licence area is also indicated.**

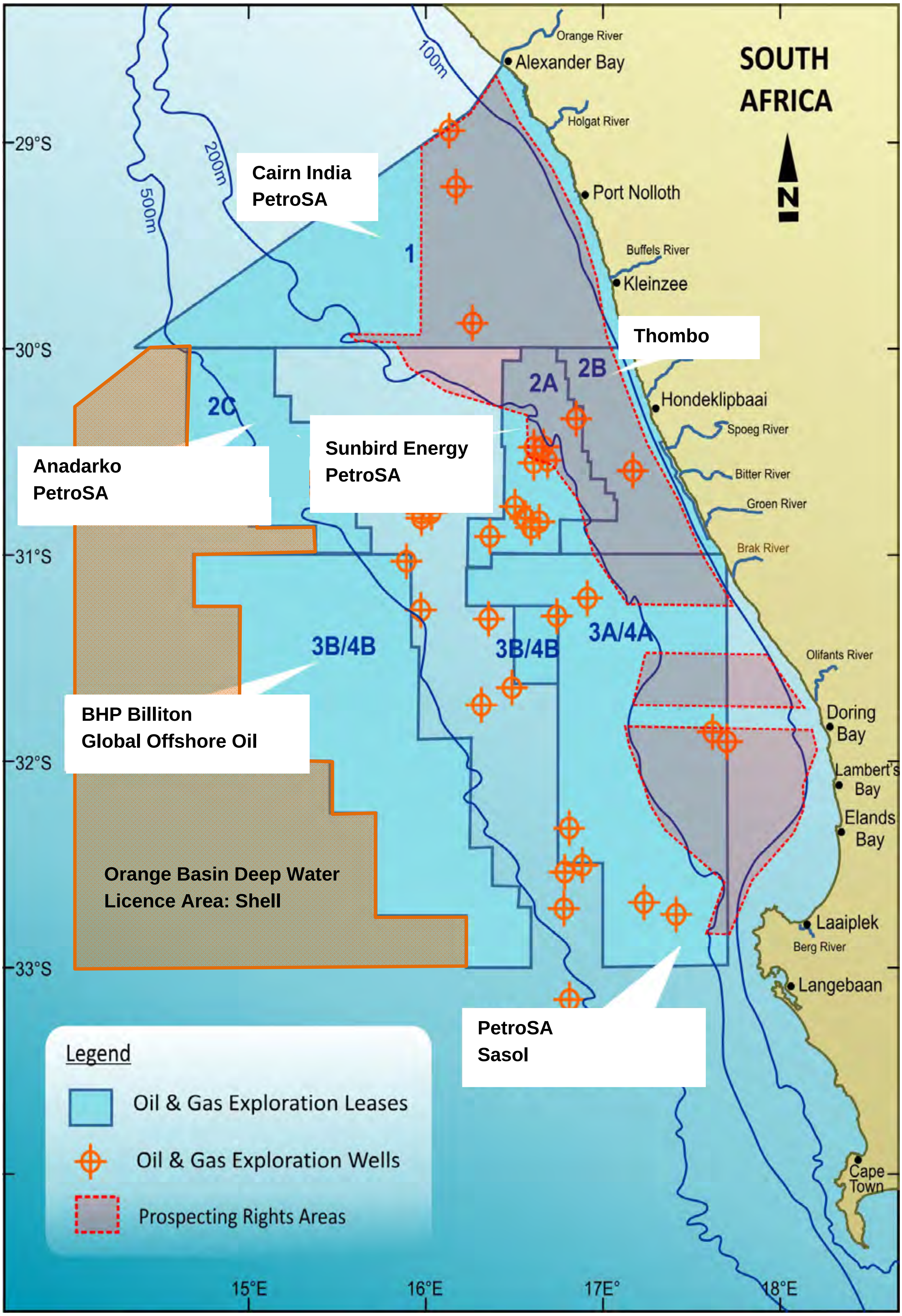

Figure 4.42: De Beers Marine's prospecting rights area in relation to Petroleum Licence Blocks off the West Coast of South Africa (adapted from De Beers, 2012).

(b) Glauconite and phosphate

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

A number of prospecting areas for glauconite and phosphorite / phosphate are located off the West Coast (see Figure 4.43), one of which is partially located within the proposed area of interest (i.e. Prospecting area 251). Green Flash Trading received their prospecting rights for Areas 251 and 257 in 2012/2013. The prospecting rights for Agrimin1, Agrimin2 and SOM1 have expired (Jan Briers, DMR *pers. comm*., December 2013).

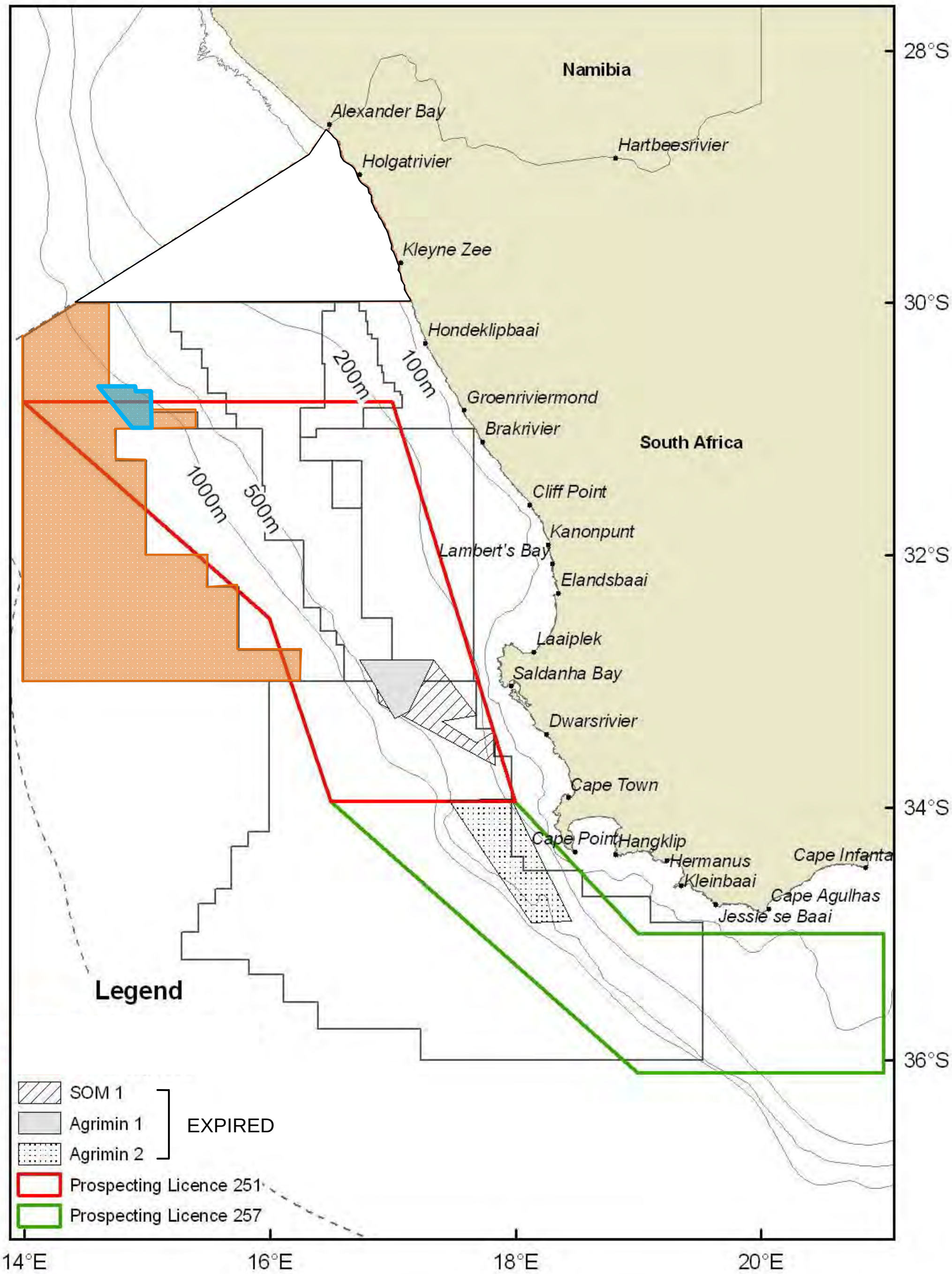

Figure 4.43: Location of the licence area and proposed area of interest in relation to glauconite and phosphorite / phosphate prospecting areas.

(c) 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) off the West Coast (see Figure 4.44). The nickel, copper and cobalt contents of the nodules fall below the current mining economic cut-off grade of 2% over most of the area, but the possibility exists for mineral grade nodules in the areas north of 33°S in the Cape Basin and off northern Namaqualand.

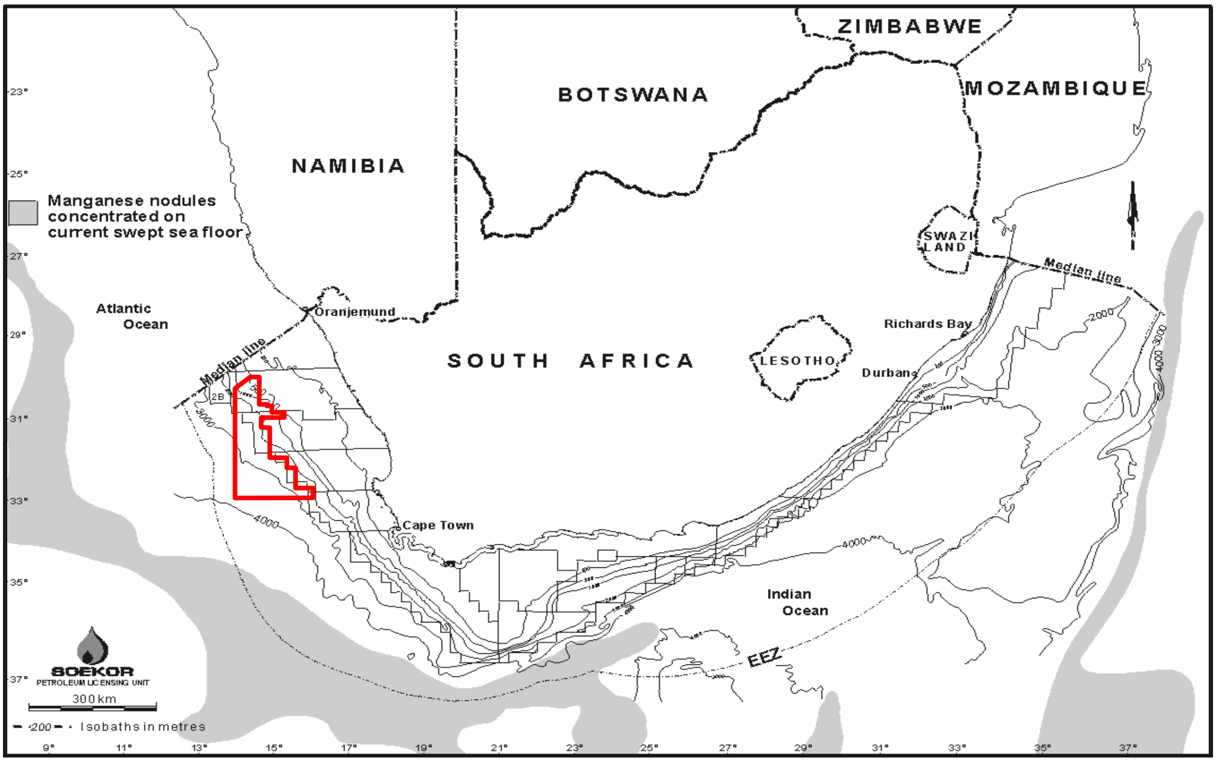

Figure 4.44: Schematic of location of manganese nodules off Southern Africa, showing petroleum licence blocks (Modified from Rogers 1995). Approximate location of the licence area is also shown.

4.1.4.6 Other

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 and charts from the South African Navy or Hydrographic Office provides detailed information on the location of different underwater hazards along the West Coast.

(a) Undersea cables

There are a number of submarine telecommunications cable systems across the Atlantic and the Indian Ocean (see Figure 4.45), including *inter alia*:

- South Atlantic Telecommunications cable No.3 / West African Submarine Cable / South Africa Far East (SAT3/WASC/SAFE): This cable system is divided into two sub-systems, SAT3/WASC in the Atlantic Ocean and SAFE in the Indian Ocean. The SAT3/WASC sub-system connects Portugal (Sesimbra) with South Africa (Melkbosstrand). From Melkbosstrand the SAT-3/WASC sub-system is extended via the SAFE sub-system to Malaysia (Penang) and has intermediate landing points at

Mtunzini South Africa, Saint Paul Reunion, Bale Jacot Mauritius and Cochin India (www.safe-sat3.co.za).

- Eastern Africa Submarine Cable System (EASSy): This is a high bandwidth fibre optic cable system, which connects countries of eastern Africa to the rest of the world. EASSy runs from Mtunzini (off the East Coast) in South Africa to Port Sudan in Sudan, with landing points in nine countries, and connected to at least ten landlocked countries.
- West Africa Cable System (WACS): WACS is 14 530 km in length, linking South Africa (Yzerfontein) and the United Kingdom (London). It has 14 landing points, 12 along the western coast of Africa (including Cape Verde and Canary Islands) and 2 in Europe (Portugal and England) completed on land by a cable termination station in London.
- African Coast to Europe (ACE): The ACE submarine communications cable is a 17 000 km cable system along the West Coast of Africa between France and South Africa (Yzerfontein).

There is an exclusion zone applicable to the telecommunication cables 1 nm (approximately 1.9 km) each side of the cable in which no anchoring is permitted. None of the submarine cables are located within the proposed area of interest (see Figure 4.46).

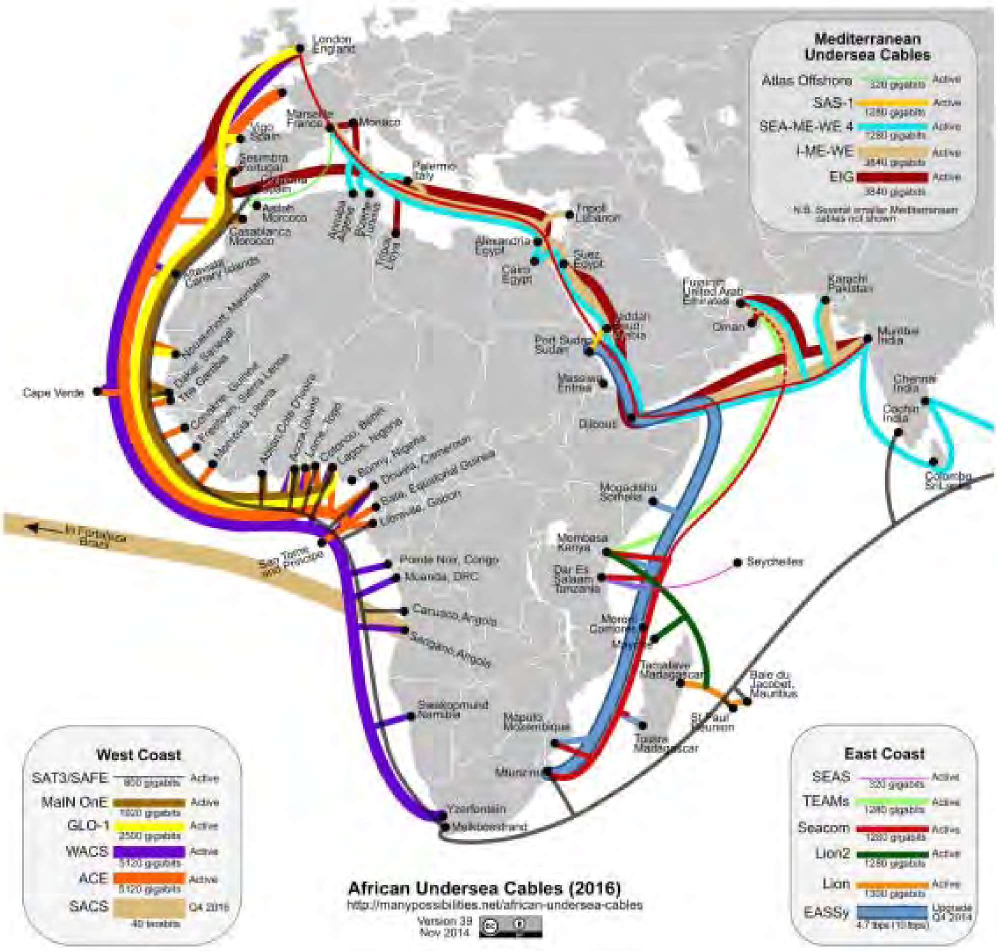

Figure 4.45: Configuration of the current African undersea cable systems, November 2014 (From http://www.manypossibilities.net).

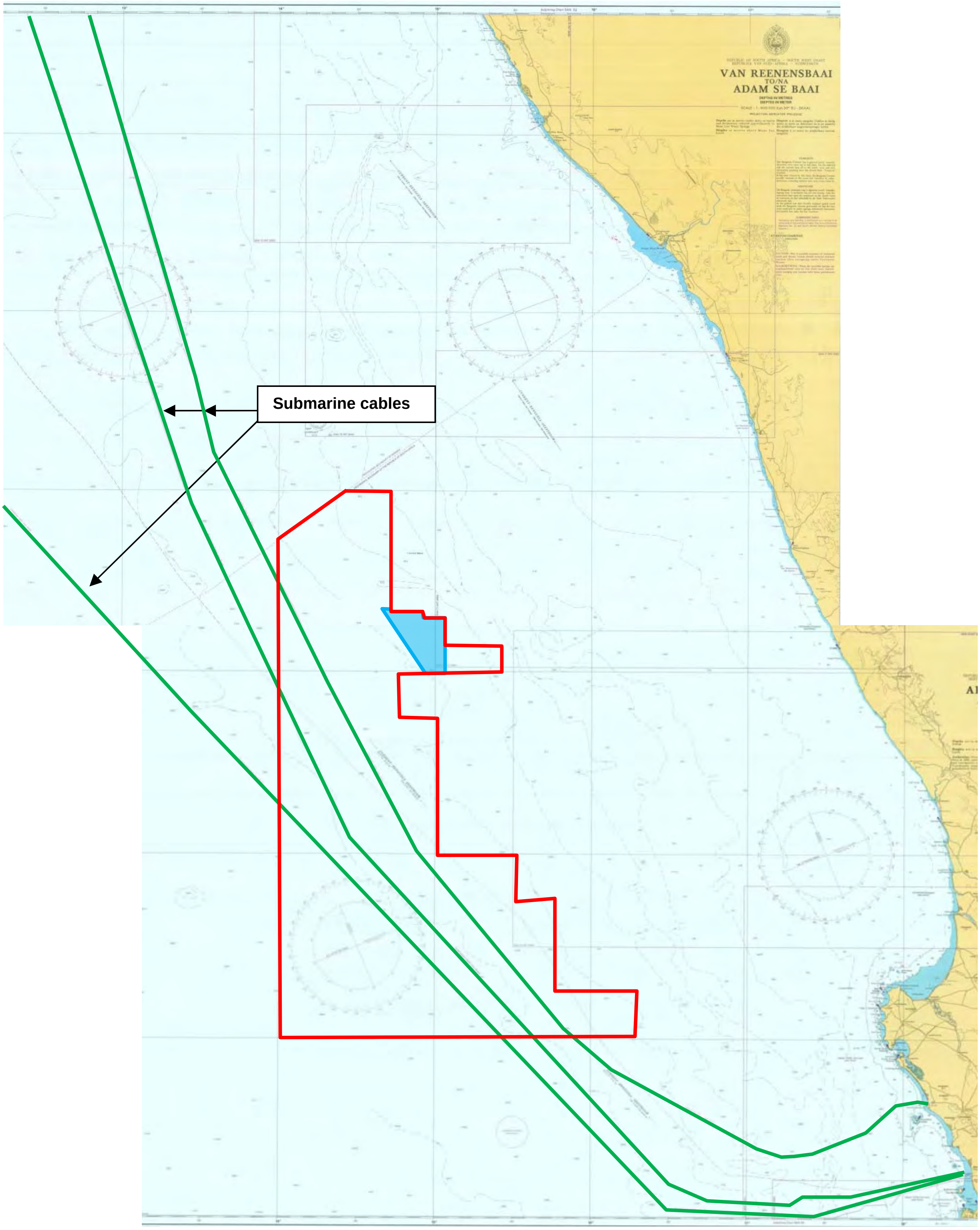

Figure 4.46: Location of the proposed area of interest in relation to submarine cables (Adapted from SAN Charts SAN54 and SAN55).

(b) Marine archaeological sites

Over 2 000 shipwrecks are present along the South African coastline. In terms of Section 2 and 35 of the National Heritage Resources Act (No. 25 of 1999), any wreck, being any vessel, aircraft or any part thereof, older than 60 years lying in South Africa’s territorial waters or maritime cultural zone is protected.

All known shipwrecks off the coast of South Africa occur in waters shallower than 100 m within 50 km of the coast. No wrecks are known in the proposed area of interest.

(c) Ammunition dump sites

Ammunition and explosive dumpsites off the South-West Coast are presented on SAN Chart 56. Such sites are located well to the south of the area of interest.

(d) Offshore conservation areas

Marine protected areas (MPAs) offering protection of the Namaqua biozones (sub-photic, deep-photic, shallow-photic, intertidal and supratidal zones) are absent northwards from Cape Columbine (Emanuel *et al*. 1992, Lombard *et al*. 2004). This has resulted in substantial portions of the coastal and shelf-edge marine biodiversity in the area being assigned a threat status of ‘critically endangered’, ‘endangered’ or ‘vulnerable’ (Lombard *et al*. 2004; Sink *et al*. 2011) (see Figure 4.9). Using biodiversity data mapped for the 2004 and 2011 National Biodiversity Assessments a systematic biodiversity plan has been developed for the West Coast (Majiedt *et al*. 2013) with the objective of identifying both coastal and offshore priority areas for MPA expansion. To this end, nine focus areas have been identified for protection on the West Coast between Cape Agulhas and the South African – Namibian border (see Figure 4.17). The closest proposed offshore protection areas to the proposed area of interest are “Namibian Border” (25 km north), “Childs Bank” (75 km east) and “Benguela Hard Ground” (175 km south-east). It should be noted that Shell is participating in Operation Phakisa and is in ongoing consultation with SANBI on the implications of their proposed Orange Basin MPAs. At the moment this matter is still under discussion and no agreement has been reached between the parties.

Nearshore conservation areas and MPAs are addressed in Section 4.2.3.4.

4.2 NEARSHORE REGION AND SHORELINE

4.2.1 INTRODUCTION

The National Biodiversity Spatial Assessment (NBSA) (Lombard and Strauss 2004) study analysed available data on rocky shores, mixed shores, sandy beaches, pebble beaches and boulder beaches and identified areas of high value / irreplaceability (see Figure 4.47). Three totally irreplaceable habitats have been identified on the West Coast.

Two coastal habitat types that dominate the Namaqua bioregion are rocky shores (approximately 53% of the coastline) and sandy shores (about 37%). Mixed shores make up a further 9%. Pebble or boulder beaches are very rare in the Namaqua bioregion, making up less than 1% of the coastline (Lombard & Strauss 2004).

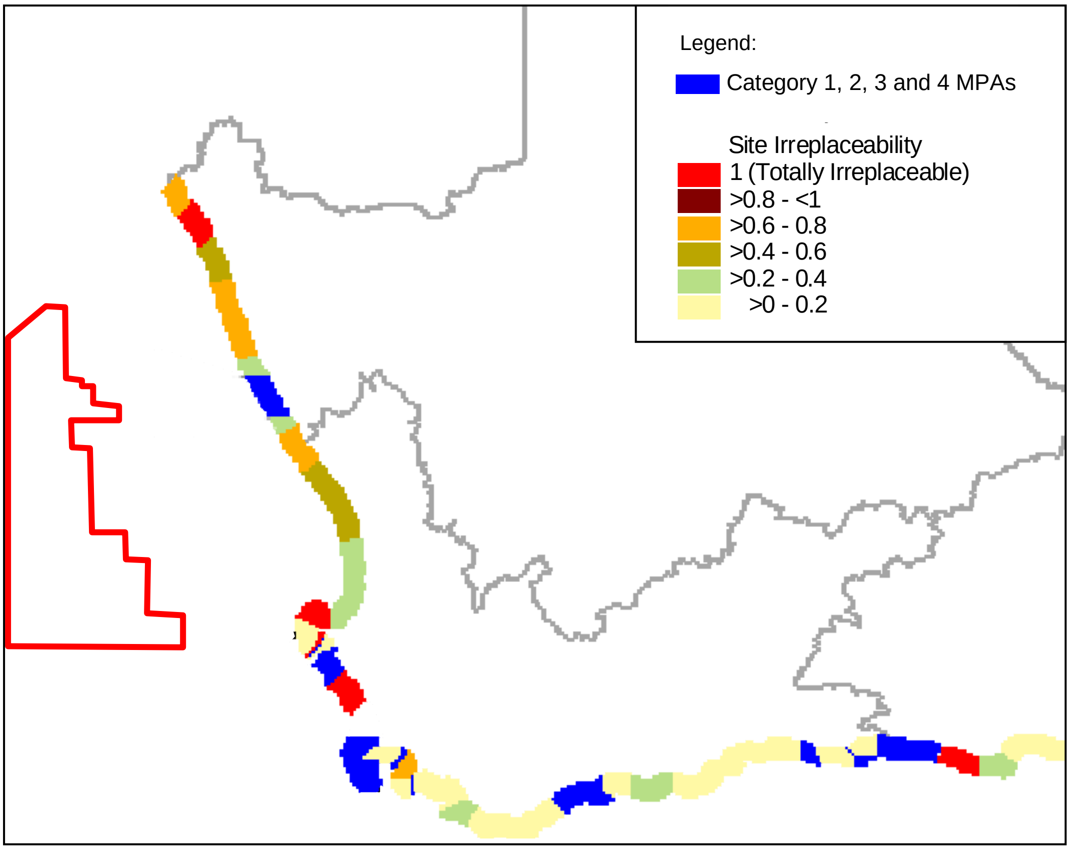

Figure 4.47: Irreplaceability analyses for intertidal habitats, in 50 km strips around South Africa, per bioregion (adapted from Lombard and Strauss 2004). The approximately location of the licence block is also shown.

4.2.2 OCEANOGRAPHY

This section briefly describes the oceanography of the coastal region of the West Coast of South Africa, which comprises rocky shores, sandy shores and kelp beds.

4.2.2.1 Rocky shores

Approximately 53% of the West Coast (west of Cape Agulhas) is rocky shore. Over 80% of this rocky shore comprises exposed rocky headlands, the balance being wave cut platforms (Jackson and Lipschitz 1984). The biota of the rocky shores of the study area is classified as cool temperate and forms one of the four main biogeographic provinces of southern Africa. Rocky shore faunal diversity is low although biomass may be high (Branch and Griffiths 1988), while floral diversity and biomass are high (Bolton 1986).

The fauna of rocky shores of the West Coast show distinct up/down-shore zonation into five zones including:

1. The *littorina zone* (also known as the supralittoral or splash zone) extends from the highest reaches of spring high tide to the normal high tide level. This area is dry much of the time, but is sprayed with salt water during high tides. It is only flooded during storms and extremely high tides. It is so named because of the dominance of small periwinkles of the genus *Littorina*. On the west coast the dominant periwinkle is *Littorina africana*. The red algae *Porphyra capensis* is the only notable floral representative of this zone.
2. The *upper balanoid zone* (also known as the upper-eulittoral, high tide or high intertidal zone) is flooded only during high tides. This zone is usually dominated by large numbers of barnacles.

However, although barnacles such as *Tetraclita serrata* and *Chthamalus dentatus* are present in the Namaqualand bioregion, the limpet *Patella granularis* (and to some extent *P. granatina*) is by far the most common animal species. The green alga called "sea lettuce" (*Ulva* spp.) is the most common floral representative found in this zone.

3. The *lower balanoid zone* (also known as the mid-eulittoral zone) is flooded twice a day. It is the first zone in which algae is well represented (Branch & Griffiths 1988). The red algae *Gigartina radula, Gigartina stiriata, Aeodes orbitosa* and *Champia lumbricalis* as well as the brown alga *Splachnidium rugosum* occur in this zone, whilst the limpet *P. granatina* is the most common faunal species. The tubeworm *Gunnarea capensis* may form distinctive colonies in this zone along the southern parts of the Namaqua bioregion.
4. The *cochlear / argenvillei zone* (also known as the lower-eulittoral zone) is covered and uncovered twice a day with salt water from the tides. Along the Namaqualand coast, the zone is dominated by very dense aggregations of the limpet *P. cochlear* in the south and *P. argenvillei* in the north. Depending on the local conditions, the black mussel, *Choromytilus meridionalis* is also present, and can completely displace the limpets along rocky shores exposed to strong wave action. The Mediterranean mussel (*Mytilus galloprovincialis*) appears to be displacing the black mussel along the Namaqualand coast, in turn. The definitive flora in this zone is coralline encrusting algae.
5. The *intertidal zone* can be divided into the sublittoral fringe, infratidal zone and sublittoral zone. In the study area the region stretching from the low tide level to, and including, the kelp beds is considered to be the sublittoral zone. Along the central Namaqualand coast this zone is dominated by the Mediterranean mussels, rock lobsters, sea urchins and various red algae.

A number of predatory species are associated with the fauna found along the rocky shores of the central parts of the Namaqualand coast. These include the whelks such as *Natica tecta*, *Nucella cinulata* and *N. dubia*; the starfish (*Marthasterias glacialis)*; tidal pool fish such as the klipvis (*Clinus superciliosus)*; the common octopus (*Octopus vulgaris)* and seabirds, primarily the African oyster catcher (*Haemaptopus moquini)*. The African oyster catcher is listed in the South African Red Data Book as "Near-threatened". Scavengers such as the shore crab (*Cyclograpsus puncatus)* and the kelp gull (*Larus dominicanus)* are also common along these shores.

4.2.2.2 Sandy shores

Approximately 37% of the West Coast comprises sandy beaches. Apart from the larger bays such as St Helena Bay, the sandy shores within the study area are exposed to strong wave action.

There has been little work on sandy beach ecology between Walvis Bay and St Helena Bay (Branch and Griffiths 1988). The invertebrate fauna is cool temperate and relatively consistent throughout the region (Field and Griffiths 1988). Sandy beaches have no stable substrate for plant attachment and consequently have little or no primary production. Major nutrient input into Benguela beaches arise from beach cast kelp wrack and upwelling-related coastal phytoplankton in the nearshore region. Macrofaunal species are generally primary or secondary consumers and can be divided into four major trophic groups, including air breathing scavengers, aquatic particle feeders, aquatic scavengers and predators.

The South African sandy beach up/down-shore environment can be divided into a number of zones (Brown and MacLachlan 1990) (see Figure 4.48) including:

1. The *supralittoral zone* runs from the foredunes to the high water drift line. The sand remains mostly dry. The dominant force disturbing the substrate in this zone is the wind. The zone is populated by insects and air-breathing crustaceans.
2. The *littoral or intertidal zone* extends from the high tide drift line down to the low tide mark. This zone is flushed periodically by the changing tide, and the sand is generally damp. The dominant force in this zone comes from the swash. No macro-flora grows in this zone, especially on an exposed beach. Near the drift line, air-breathing crustaceans such as the pill bug isopod (*Tylos granulatus)* or the

beach hopper amphipod (*Talorchestia capensis)* are common, as well as some oligochaete worms, usually found under rotting beach cast seaweed. Further down the beach, isopods such as the right-angle beach louse (*Eurydice longicornis)* and the wide-foot beach louse (*Pontogeloides laticeps)* typify the mid-shore region. Also common to this region of the zone are polychaete worms such as *Scolelepis squamata.* While the white sand mussel (*Donex serra)* occurs in certain instances, it apparently is not found in the Port Nolloth region. In the lower reaches of the intertidal zone, including the sublittoral fringe, the common organisms are the surf mysid shrimp (*Gastrosaccus psammodytes*) and a ubiquitous gastropod scavenger, the finger ploughshell (*Bullia digitalis)*.

3. The *surf zone* starts below the low water level. In the surf zone the sand substrate is always saturated, and experiences strong wave action and currents. The sand bed is generally in a state of mobility in this zone. The macro-fauna found in this zone are much the same as that which occurs in the sublittoral fringe, with some species of amphipods present. Micro-flora in the form of diatoms can be an important component in this zone, migrating between the water column during the day and the sandy substrate at night. High densities of these diatoms can result in semi-stable formations of foam in the inner surf zone.
4. The *transition zone* occurs between the turbulence of the surf zone and the more stable outer turbulent zone. This is the region across which the wave break line will range, depending on the prevailing weather conditions.
5. The *outer turbulent zone* is typified by a return to stability after the turbulence of the surf zone. The currents are weak compared to the surf zone, and although the effects of wave surge are apparent, the sandy substrate is stable enough to be colonised by macro-fauna including amphipods and other small crustaceans, tube-building polychaetes such as *Nephys* spp., delicate cnidarians and anemones such as *Anthopleura michaelseni.*

The three-spot swimming crab (*Ovalipes trimaculatus)* is probably the only resident predator on the sandy shores along the West Coast. The rest of the organisms that predate on the intertidal macro-fauna originate from outside of the sandy beaches. Birds are the most important predators when the shores are exposed during low tides; fish are most important when the shores are submerged during high tides. On exposed beaches the migratory sanderlings (*Calidris alba)* and white-fronted plovers (*Charadrius marginatus)* are the most common bird species, but African black oystercatchers (*Haematopus moquini)*, kelp gulls (*Larus dominicanus)*, Hartlaubs gulls (*Larus hartlaubii)*, turnstones (*Arenaria interpres)* and curlew sandpipers also visit the sandy shores of the West Coast. The galjoen (*Dichristius capensis)* and white steenbras (*Lithognathus lithognathus)* are representatives of the predatory teleost fishes in the region, as is the blue stingray (*Dasyatis chrysonota)* for elasmobranch fishes. There have also been reports of the West Coast sole (*Austroglossus microlepis)* occurring in the sheltered embayment during periods of warmer water temperatures.

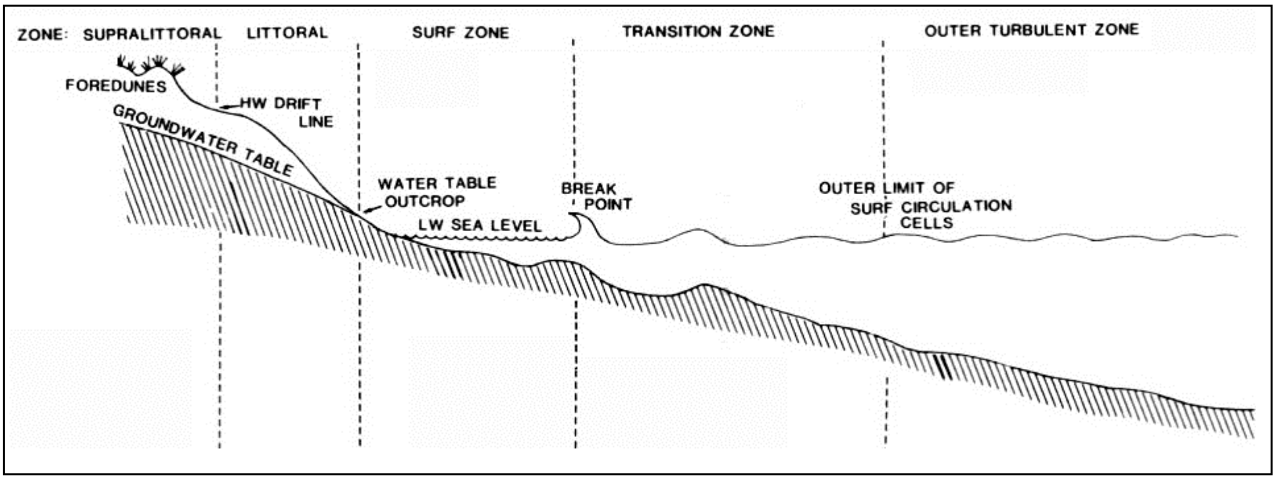

Figure 4.48: Generalised scheme of zonation on sandy shores (Modified from Brown & MacLachlan 1990).

4.2.2.3 Kelp beds

Kelp beds along the West Coast of South Africa are characterised by four species, *Ecklonia maxima* reaching up to 12 m in length, *Laminaria pallida* and *Laminaria schintzei* reaching 5 m in length and the smaller species *Macrocystis angustifolia*. These kelp beds occur in shallow waters and extend from the shore to as much as 3 km offshore. Because of the clearer waters around Cape Point, kelp extends out to the 30 m depth contour (Branch, 1981).

The shallow kelp beds are colonised by relatively few faunal species, with diversity increasing on their deeper, seaward fringes (Branch and Griffiths, 1988). The faunal species include grazers such as the sea urchin (*Parechinus angulosus)*, limpet (*Patella compressa)*, kelp louse (*Paridotea reticulate)* and amphipods; and filter feeders including mussels, sponges, ascidians and barnacles. Carnivorous species are also represented, including anemones, whelks, starfish, fish and crustaceans (including the most important predator in the ecosystem, the West Coast rock lobster).

4.2.3 ANTHROPOGENIC ACTIVITIES

4.2.3.1 Mariculture industries

The following mariculture facilities can be found along the West Coast of South Africa (O’Sullivan 1998; DAFF 2011):

- Alexkor Diamond Mines has an oyster (*Crassostrea gigax*) growout system in the seawater reservoirs employed by diamond processing plants south of Alexander Bay, while a similar facility for oysters, perlemoen (*Haliotis midae*) and the red seaweed *Gracilaria gracilis* can be found at Kleinzee;
- A permit has been granted for perlemoen ranching within a 100 km long 0 to 20 m deep zone north and south of Port Nolloth. Oysters are also grown at Port Nolloth;
- A perlemoen aquaculture operation at Hondeklip Bay;
- Abalone, oysters and finfish are grown in Jacobs Bay;
- Abalone, mussels, seaweed, oysters, clams and scallops are grown in Paternoster;
- Oysters and seaweed are grown in St Helena Bay; and
- Mussels and oysters are grown within Saldanha Bay.

4.2.3.2 Recreational utilisation

Coastal recreation along the West Coast may be either consumptive or non-consumptive.

Consumptive recreational uses involve people collecting material from the sea for their own use. Recreational anglers (Brouwer, Mann, Lamberth, Sauer and Erasmus 1997) and divers (Mann, Scott, Mann-Lang, Brouwer, Lamberth, Sauer and Erasmus 1997) target linefish from either a boat or the shore, while shore-based divers also target perlemoen and West Coast rock lobsters. Rock lobsters are also exploited recreationally from boats with the use of hoop nets. The majority of recreational exploitation of marine resources occurs from inshore waters, and is not substantial compared to activities along the South and East Coasts.

Non-consumptive recreational uses of the marine environment include watersports, nature watching and beach recreation. Recreational practices are mostly undertaken near coastal settlements, and are largely practised for their aesthetic value. Recreational sites are listed by Jackson and Lipshitz (1984).

Although few resource economic studies exist for South African marine recreational use, the value of recreational coastal use and tourism should not be underestimated.

4.2.3.3 Marine outfall/intake pipes

Thirty-four outfalls, of which the majority are sewerage outfalls, and 17 intakes are located along the West Coast of South Africa. An important pipeline intake/outfall is the Koeberg Nuclear Power Station (located approximately 435 km to the south-east of the proposed area of interest); a thermal outfall, discharging warmed cooling water into the cooler coastal waters rather than a chemical effluent. A 2 nm marine exclusion zone exists offshore of the nuclear power station.

4.2.3.4 Conservation Areas and Marine Protected Areas

A number of conservation areas and MPAs exist along the West Coast, none of which are located within the licence area (see Figure 4.49 and Table 4.6).

As described in Section 4.1.4.6(d), a systematic biodiversity plan has been developed for the West Coast (Majiedt *et al*. 2013) with the objective of identifying both coastal and offshore priority areas for MPA expansion (see Figure 4.17). The closest coastal priority areas to the area of interest include the proposed “Namaqua MPA” focus area (250 km east), “Rietpoort” focus area (275 km east-southeast), and the focus area “North of Kleinzee” (225 km north-east).

The Orange River Mouth wetland located approximately 250 km to the north-east of the proposed area of interest provides an important habitat for large numbers of a great diversity of wetland birds and is listed as a Global Important Bird Area (IBA) (ZA023/NA 019) (BirdLife International 2013). The area was designated a Ramsar site in June 1991, and processes are underway to declare a jointly-managed transboundary Ramsar reserve. Further IBAs in the general project area include the Olifants River Estuary (ZA078), Verlorenvlei (ZA082), the Lower Berg River wetlands (ZA083) and the West Coast National Park and Saldanha Bay Islands (ZA 084).

There are also various conservation areas in southern Namibia (see Figure 4.50). The Sperrgebiet, which covers an area of approximately 26 000 km^2 between the Orange River in the south and latitude 26° in the north, extends inland from the coast for 100 km. The Sperrgebiet was proclaimed in 1908 to prevent public access to the rich surface diamond deposits occurring in the area. However, as diamond mining has remained confined to the narrow coastal strip and along the banks of the Orange River, most the area has effectively been preserved as a pristine wilderness. Although large parts of the Sperrgebiet have now reverted to unproclaimed State land, most of the area is not yet formally managed as a conservation area. The southern boundary of the Sperrgebiet is located at Oranjemund approximately 250 km north-east of the proposed area of interest.

The proposed Namibian Islands’ MPA (9 555 km^2), which comprises a coastal strip extending from Chamais Bay (27º57’S) in the south to Hollamsbird Island (24º38’S) in the north, has an average width of 30 km and includes 16 specified offshore islands, islets and rocks (Currie *et al.* 2008). The southern boundary of the proposed MPA is located approximately 300 km north of the project area of interest (see Figure 4.50). The purpose of the proposed MPA is to protect sensitive ecosystems and breeding and foraging areas for seabirds and marine mammals, as well as protecting important spawning and nursery grounds for fish and other marine resources (such as rock lobster). The proposed MPA includes a rock-lobster sanctuary constituting 478 km^2 between Chameis Bay and Prince of Wales Bay and a linefish sanctuary. The offshore islands, whose combined surface area amounts to only 2.35 km^2, have been given priority conservation and highest protection status as they serve as vital breeding grounds for a variety of seabirds that breed in Namibia, most of which are listed Red Data species in Namibia (Currie *et al.* 2009). Of particular importance are the African Penguin, Bank Cormorant and Cape Gannet, which are listed as Endangered and Near Threatened.

Table 4.6: List of marine conservation areas along the West Coast of South Africa.

Bioregion	Marine Protected Area	Protection	Location
Namaqualand	McDougall's Bay Rock Lobster Sanctuary: 2.5 km of coastline, 3 km south of Port Nolloth	No rock lobsters may be caught.	29°14' S 16°52' E
	Robeiland / Kleinzee Seal Colony Robeiland: 15 km north of Kleinzee	Island reserve for seabirds and seals, no access	29°33' S 16°59' E
	Elephant Rocks (Olifant's River Mouth)	Island reserve for seabirds and seals, no access	31°38' S 18°07' E
	Penguin / Bird Island (Lambert's Bay)	Island reserve for seabirds and seals, no access	32°05' S 18°18' E
	Rocherpan Marine Reserve: Adjacent to the Rocherpan Nature Reserve extending 500 m seaward, 2.75 km of coastline (in process of being registered as a declared reserve)	Exploitation limited to shore-based angling.	32°35'-37' S 18°07' E
	St Helena Bay Rock Lobster Sanctuary From Shelly Bay Point to Stompneus Point, extending three nautical miles seaward of the high-water mark; From Stompneus Point to SHBE/DR beacon, extending six nautical miles seaward of the high-water mark	No rock lobster may be caught	32°43' S 18°00'-07' E
South-Western Cape	Paternoster Rocks – Egg and Seal Island: Between Great Paternoster Point & Cape Columbine	Island reserve for seabirds and seals, no access.	32°44' S 17°51' E
	Jacob's Reef: Jacob's Baai	Island reserve for seabirds and seals, no access	32°57' S 17°51' E
	Malgas Island, Jutten Island and Marcus Island Marine Protected Areas: Saldanha Bay	No person permitted on the islands and no fishing allowed along the shores. Marcus Island is a 'no-take' MPA	33°02' S to 33°05' S
	West Coast National Park: Langebaan Lagoon north of a line drawn from beacon LB3 at Oesterwal to beacon LB4 at Preekstoel, south of Kraal Bay. Jutten, Malgas, Marcus and Schaapen. Langebaan Lagoon MPA Saldanha Bay	Only angling and bait collection are permitted Ramsar Site since 1988 and zoned MPA. Zone A: harvesting allowed; Zone B: no extractive removal; Zone C: no entry. No rock lobster fishing between North Head and South Head, No net, netting or long-line may be used.	33°02' S to 33°12' S
	Sixteen Mile Beach (including Vondeling Island): Plankies to Rooipan se Klippe (near Yzerfontein).	No fishing from the shore	33°08' S to 33°19' S

Bioregion	Marine Protected Area	Protection	Location
	Within 12 nm seaward of the high water mark between Melkbos Punt and “Die Josie” at Chapmans Peak	No fishing, collecting or disturbing of rock lobsters	33°44’S to 34°05’S
	Within 12 nm seaward of the high water mark between Klein Slangkop Point and Slangkop Point Lighthouse	No fishing, collecting or disturbing of rock lobsters by commercial permit holder	34°07’36S to 34°09’S
	Table Mountain National Park MPA	Fishing allowed in the majority of the MPA, subject Department of Agriculture, Fisheries and Forestry permits, regulations and seasons. Six "no-take" zones where no fishing or extractive activities are allowed.	33°54’S to 34°23’S

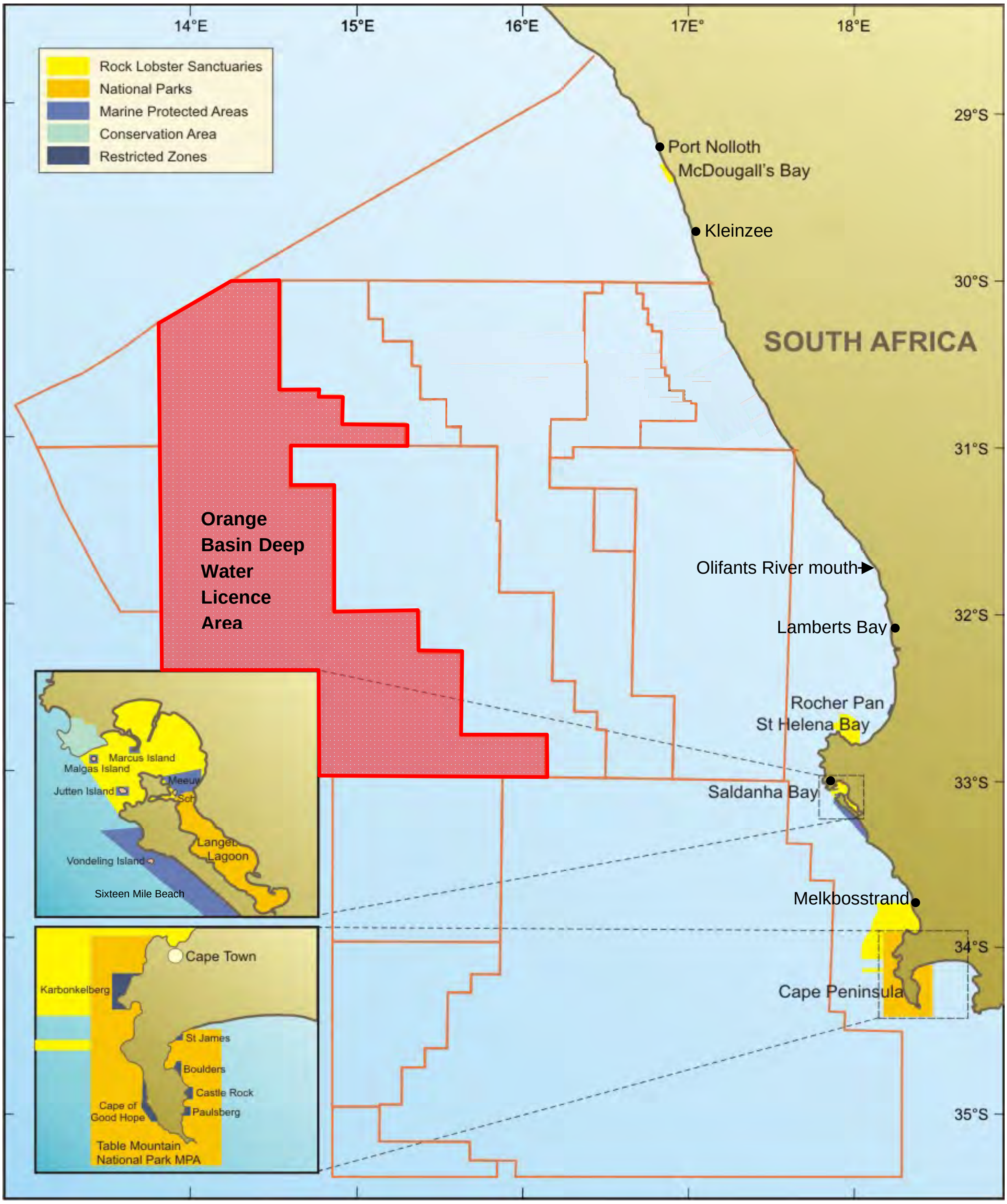

Figure 4.49: The Orange Basin Deep Water Licence Area in relation to reserves and Marine Protected Areas on the West Coast.

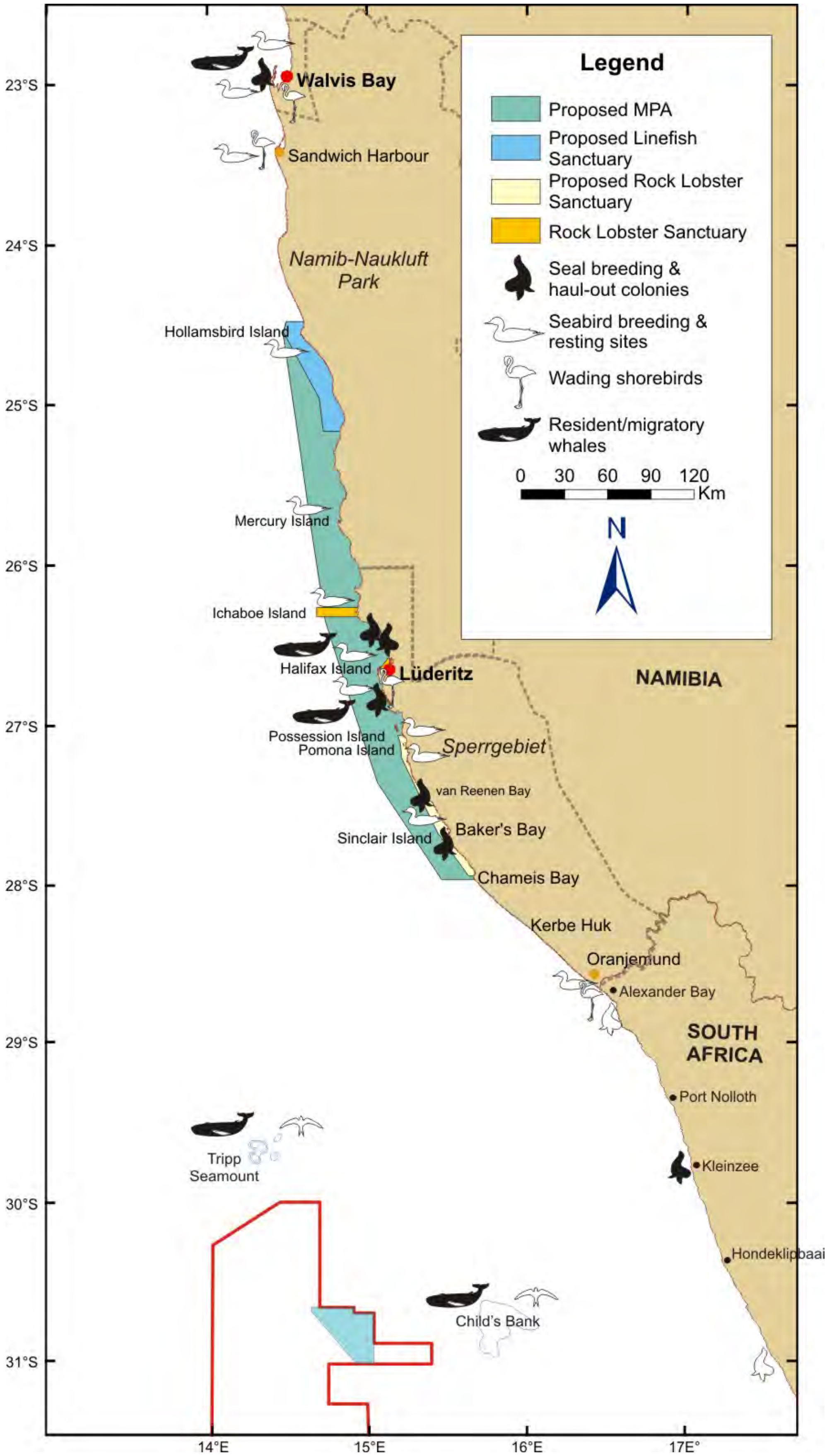

Figure 4.50: Project - environment interaction points in southern and central Namibia illustrating conservation and marine protected areas, seal colonies and seabird breeding areas in the coastal region in relation to the licence area and proposed area of interest.