Appendix B1

MARINE SPECIALIST REPORT
Marine aquaculture development zones for fin fish cage culture in the Eastern Cape:
Description of the affected environment and existing marine users

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Executive Summary

An Environmental Impact Assessment (EIA) for the development of two marine aquaculture development zones (ADZs) specific for fin fish cage farming in the sea off the Eastern Cape Province is being undertaken on behalf of the the Directorate Sustainable Aquaculture Management: Aquaculture Animal Health and Environmental Interactions within the Department of Agriculture, Forestry and Fisheries- DAFF. This description of the affected environment report constitutes a section of the EIA. The DAFF mariculture policy aims to promote growth in the industry, as it envisions benefits of skills-based job creation in poor coastal communities and increased seafood production to compensate for dwindling catches of wild stocks. This report describes the current state of knowledge of the physical oceanography, marine ecology and affected users of the region.

The proposed ADZs in the Eastern Cape Province were identified during a SEA of the entire South African coastline using systematic-based spatial analyses that considered defined criteria work shopped *a-priori* with industry stakeholders (Hutchings *et al*. 2012). The analysis yielded several potential sites in the Eastern Cape for caged fin fish aquaculture. Monitoring commenced at two of these sites in 2012, however, during the Scoping Phase objections were raised with regards to the locations of these sites due to shipping and safety concerns. Two other potential sites for the establishment of ADZs were therefore identified within Algoa Bay and are now the focus (Hutchings *et al*. 2012 & Clark 2012). These are Algoa 1 and Algoa 5.

Some of the potential impacts of fin fish caged aquaculture such as pollution, habitat alteration and user conflict can be mitigated by correct site selection as employed in the spatial analyses and are being verified with further *in situ* monitoring. Other potential impacts may be mitigated by astute animal husbandry and adaptive management strategies.

The potential ADZs situated in Algoa Bay, occur in an area where two large current systems (the Agulhas and Benguela) with different temperatures undergo mixing. In addition, periodic upwelling may occur near the rocky headlands of the bays during easterly winds that can cause sharp drops in temperature. Temperature and current dynamics are therefore complex and vary over small spatial scales within Algoa Bay. *In situ* monitoring of the physical oceanography of Algoa Bay was carried out over 11 months at the two initial most favourable ADZs (Algoa 2 & Algoa 3) using acoustic-Doppler current profilers (ADCPs), thermister strings and single beam echo-sounding for accurate bottom type characterisation and depth profiling. Data acquired from the monitoring of these two ADZs selected for *in situ* analyses and then halted for reasons explained above, are available and offer the best existing data at present to describe the conditions within Algoa Bay. These data are presented in addition to data recently gathered from the two currently preferred locations, Algoa 1 and Algoa 5, where monitoring is ongoing.

Preliminary results collected in Algoa 2 over an 11 month period suggest that upward movement of the thermocline is a potential concern, with rapid changes in temperatures of more than 7°C over a 12 hr

period detected as shallow as 13 m on occasions during summer, spring and autumn months. Less extreme decreases of up to 2.5 degrees in 12 hours were recorded at 9 m and 5 m water depth. On Algoa 1 and Algoa 5, data collected for the four month period between January and June 2013 showed similar temperature variability during the summer and autumn period, with increasing variation in temperature at greater depths. During 2013 monitoring at Algoa 1 and Algoa 5, vertical movement of the thermocline was common below 9 m and nearly reached the surface (5 m depth), where drops of ~ 4°C over a 12 hr period were recorded at both sites, at least once during the four months. Commercial scale fish cages will be ~15m deep and stock will certainly be exposed to some rapid temperature declines. Stock response to these temperature fluctuations and the impacts on potential maximum stocking density and fish health will be species specific and are not understood at this stage, but impacts are likely to be negative. At all three sites during winter, temperatures averaged approximately 17-18°C and were far more stable with little movement of the thermocline detected.

Wave climate at Algoa 2 was characterised by average significant wave heights of less than 2 m 95 % of the time and wave period was most commonly one wave every 12 seconds. However, the maximum significant wave height recorded reached 5 m with a wave period of 13 seconds, which is of concern as this exceeds the specifications for most common floating gravity fish cage designs (significant wave height < 3.5 m). Wave data collected thus far for Algoa 5 confirm that this site is more exposed (being further east and out of the lee of Cape Recife), with wave heights exceeding 2 m, 6.5% of the time and a maximum wave height of 3.4 m . Over the same season during 2012, significant waves heights recorded on Algoa 2 only exceeded 2 m for 1 % of the time. This indicates that Algoa 5 is the least suitable potential ADZ for the floating circular cage types most likely to be used in South Africa's pioneering sea cage industry. Wave data are not yet available for Algoa 1 (monitoring is ongoing), but this site is expected to have the lowest average and maximum significant wave heights due to its position in the lee of Cape Recife.

On average, during the period January – June 2013, currents on Algoa 1 flowed at a higher velocity than the other two monitored sites and in a predominately southerly direction i.e. out of the Bay and away from the popular bathing and surfing beaches, but towards identified dive sites and a squid fishing ground. Current velocities in the lower water column (deeper than 15m) at Algoa 1 exceeded 10 cm $.s^{-1}$ for 34 - 43% of the time. Currents shallower than 10 m exceeded 10 $cm.s^{-1}$ for more than 50% of the time and reached a maximum velocity of 62 $cm.s^{-1.}$ This suggests, in terms of current strengths conducive to the adequate dispersal of organic wastes from fish cages, that Algoa 1 is the most suitable of the three sites monitored. Ongoing monitoring during 2013 will confirm if this is the case throughout the year.

During 2012, on Algoa 2 (no longer under consideration), dominant currents moved mainly in south-westerly directions through the bottom and mid-water columns but increased in frequency to flow in the opposite direction (north-east) nearer the surface, for a similar amount of time. However, currents at all levels of the water column were also found to flow in all possible directions but with relatively low velocities. Maximum current velocities rarely exceeded 30 $cm.s^{-1}$ and are well below the maximum threshold of 150 $cm.S^{-1}$ that would make the area unsuitable for caged aquaculture. However, 70 % of the time current velocities did not exceed 10 $cm.s^{-1}$ considered necessary to adequately disperse wastes below cages.

On Algoa 5, near surface currents predominately flowed coast parallel, to the east or west for approximately equal amounts of time; deeper in the water column, currents flowed more to the west, although a significant east or SE component remained. Surface currents were somewhat stronger than those recorded on Algoa 2, but at depths below the cages (>15m) current velocities were low, and did not exceed 10 $cm.s^{-1}$ for 70-80 % of the time suggesting that excessive build up of organic waste below the cages would occur.

Bathymetry at the two preferred ADZs Algoa 1 and Algoa 5 has been found to be suitable in terms of depth which ranges between 21.3 – 39.7 m. No reef has been detected within the proposed footprint of Algoa 1 based on bottom topography and *in situ* grabs of sediments which revealed the presence of sand. However, a small area of reef was detected at the north-western most corner of Algoa 5 based on bathymetry and *in situ* analyses of bottom type. Remaining areas of Algoa 5 were sandy.

Current (ongoing) baseline *in situ* monitoring of the physical oceanographic conditions within Algoa 1 and Algoa 5 will reveal important information on whether the year round conditions are suitable for caged fin fish culture and will guide the industry on what species and infrastructure will be most appropriate. In addition, baseline samples of the sandy macrofaunal communities within the footprints of the two proposed ADZs have been collected, so that potential impacts can be detected and proactively managed and mitigated should the development go ahead.

Algoa Bay is known to support a high biodiversity of marine life, particularly reef-associated invertebrates and fish as well as several breeding colonies of endangered or vulnerable seabirds and a suite of cetaceans. For these reasons, a large portion of Algoa Bay has been identified for a future Marine Protected Area. The Algoa 5 site lies within the proposed controlled use zone of the Addo MPA. Several species of concern (e.g. African penguins, Cape Gannets) have been verified to occur within the footprints of the two proposed ADZs and the impacts of the proposed development on the marine biodiversity of Algoa Bay is being considered in the Assessment of Impacts component of this project.

Existing recreational and commercial users of marine waters in Algoa Bay are described, the degree of spatial overlap with the two potential ADZs is determined and any potential affects are identified. Recreational non- motorized personal water sports (swimming, surfing, kayaking, kite surfing etc) take place well inshore of the two proposed ADZs and spatial conflict is not anticipated. Potential changes in large shark distribution patterns and behavior caused by fish cages have been documented and the potential change in risk to personal water sport participants (particularly should Algoa 1 be developed for fin fish cage culture) is not quantified. It is recommended that existing shark movement studies currently underway within Algoa Bay be continued and expanded to include the potential ADZ sites so that any changes in residency and behavior should fish farms become operational, can be quantified in the future.

Yacht sailing within Algoa Bay would be slightly affected should either of the potential ADZs be developed in that fish cages would pose a navigational hazard within the popular sailing areas. Effective navigational markers as required by SAMSA should mitigate this affect. Recreational Scuba diving sites do not occur within the two proposed ADZs. However, at least five popular diving reefs are within 1km of Algoa 1 and potential changes in water quality caused by fish farms on Algoa 1 could adversely affect the water visibility, reef ecology and value of these reefs to SCUBA divers.

Fish cages on either ADZ would also pose a navigational hazard to recreational skiboat fishers, but actual spatial competition for fishing grounds is likely to be minor as there is little overlap between areas of high fishing activity and the proposed ADZs. Recreational (and commercial) line fishers would be more seriously affected should disease or genetic contamination from fish within farm cages cause population declines in wild stocks. These potential impacts are assessed in the Environmental Impact Report.

Four commercial fisheries that take place within Algoa Bay were identified as potentially affected by the development of either Algoa 1 or 5 and spatial catch and effort data were analyzed in relation to the two ADZs. The commercial line fishery and small pelagic purse seine fishery are only likely to be lightly affected by development of the two ADZs in terms of loss of fishing grounds, although for both these fisheries, potential impacts of finfish cage culture on the wild stock (disease introduction, genetic contamination) may affect these sectors. Algoa 1 and Algoa 5 are important grounds for both the squid fishery and shark longline fishery in Algoa Bay. Further potential losses of fishing area due to the proposed Addo Marine Protected Area makes these impacts potentially cumulative and ADZ proclamation is likely to be resisted by these two sectors. Mitigation by reducing the size of the proposed ADZs to exclude important fishing grounds (both are larger than the 200ha minimum identified in the SEA) may help mitigate this.

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Acronyms

ABYC	Algoa Bay Yacht Club
ADZ	Aquaculture Development Zone
ADCP	Acoustic Doppler Current Profiler
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
GIS	Geographical Information System
IBA	Important Birding Area
SADCO	South African Data Centre for Oceanography
SAMSA	South African Maritime Safety Authority
SANBI	South African National Biodiversity Institute
SANP	South African National Parks
SEA	Strategic Environmental Assessment

1 Introduction

The stated purpose of establishing Aquaculture Development Zones (ADZs), as presented by the Directorate Sustainable Aquaculture Management: Aquaculture Animal Health and Environmental Interactions, in the Department of Agriculture, Forestry and Fisheries (DAFF), is to encourage investor and consumer confidence in the marine aquaculture industry in South Africa, and also to create incentives for industry development, provide marine aquaculture services, manage risk associated with aquaculture, and provide skills development and employment for coastal communities. A Strategic Environmental Assessment (SEA) conducted by Anchor Environmental Consultants (2011) has identified several potential sites in the Eastern Cape. The DAFF has identified the Eastern Cape as a priority region for establishing ADZs in South Africa.

The two sites in Algoa Bay, referred to as Algoa 2 and Algoa 3 (previously called Port Elizabeth2 (Algoa 2) and Port Elizabeth3 (Algoa 3) in the SEA report), were the focus of the EIA. These potential ADZs were identified using a number of criteria workshopped with stakeholders from government and industry using a spatial GIS-based analysis and a post-hoc ranking system. *In situ* baseline assessments on the biology and oceanography at these two ADZs (Algoa 2 and Algoa 3) commenced in February 2012. However, during the Scoping Phase, concerns pertaining to safety and shipping were raised by Transnet regarding the proposed locations of the two ADZs (Clark 2012).

Algoa 1 was determined as the next-best option, in addition to Algoa 5 which, although not conceived in the original SEA, was an area that required relaxing the least amount of exclusionary criteria; in this case the criterion of proposed marine protected areas (MPAs) (see Clark 2012). *In situ* monitoring instrumentation was therefore retrieved from Algoa 2 and Algoa 3 and redeployed at Algoa 1 and Algoa 5 in February 2013.

Monitoring and analyses currently underway include identifying and quantifying the benthic macrofaunal communities, while oceanography will focus on quantifying depth and bottom type, wave and current dynamics as well as temperature measurements. The *in situ* oceanographic data will be used to verify if the proposed ADZs delineated in the desktop-based SEA are suitable for fin fish cage culture. Biological data will be utilised for monitoring purposes should the development (i.e. ADZs) be authorised.

This report provides a description of the affected environment in terms of the marine ecology and physical oceanography of the study area and presents results from *in situ* monitoring gathered to date. In addition, it provides a description of the affected user groups and how they could be affected by the proposed ADZs

2 Physical oceanography

The waters off the Eastern Cape coast are warm temperate in nature with average sea surface temperatures approximating 17-22°C (Figure 1) (Goschen and Schumann, 1988; Schumann *et al.* 2005). The south-flowing Agulhas Current is the dominant oceanic-scale feature and typically flows along the coast at approximately $1 m.s^{-1}$ on average (Grundlingh and Lutjeharms, 1979; Ross, 1988). However, several hundred kilometres to the north east of Port Elizabeth near East London, the current begins to move away from the shore as the continental shelf begins to widen (see Figure 1) (Dingle *et al.* 1987). This generally results in the inshore waters being markedly cooler, by a few degrees compared with the Agulhas Current water further offshore (Goschen and Schumann, 1988).

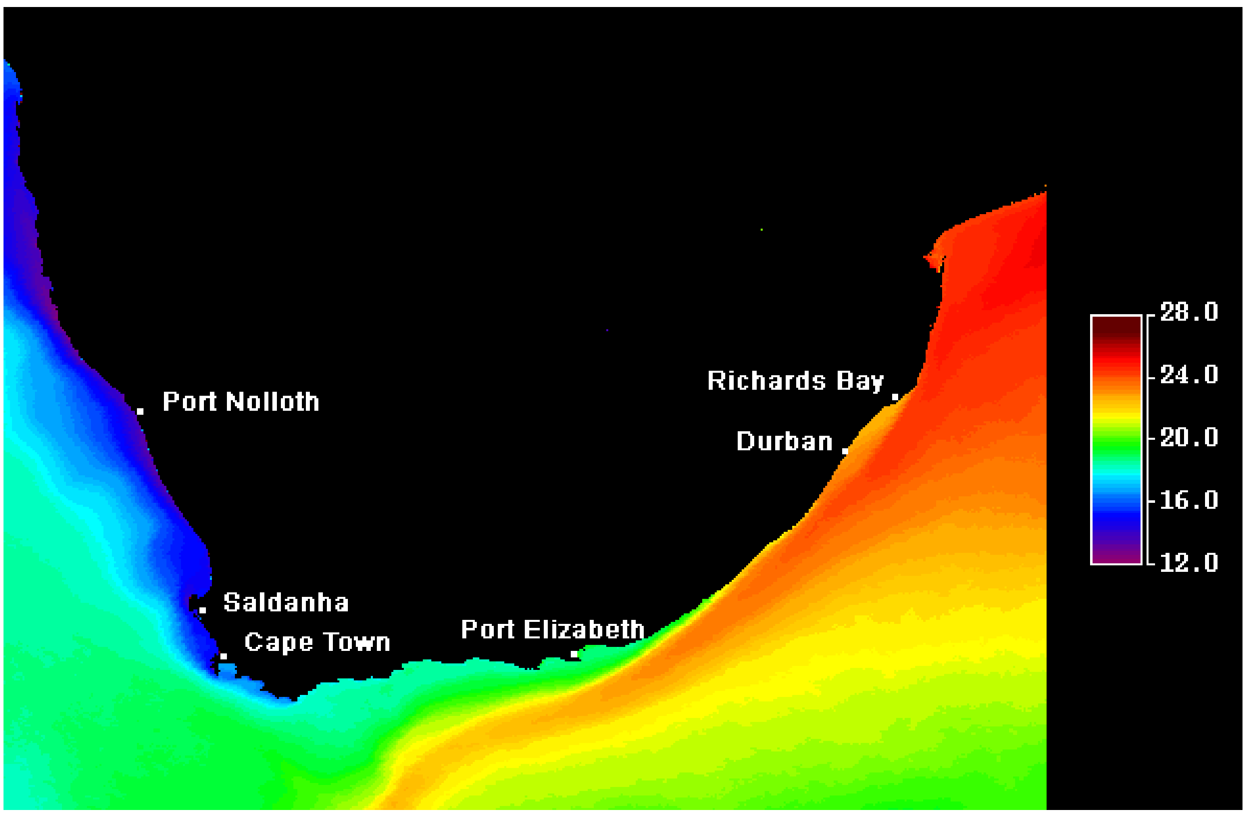


Figure 1. Average sea surface temperature (°C) showing the warm-water Agulhas Current moving south westerly along the coast (AquaMODIS 4km-resolution, nine-year time composite image).

The movement offshore of the Agulhas current in the vicinity of East London however creates shear edge features such as eddies which may circulate warm water inshore near Port Elizabeth periodically (Stone, 1988). Water temperature as a result of the Agulhas shear edge features can therefore vary over short temporal scales along the Eastern Cape Coast, particularly in the vicinity of St Francis and Port Elizabeth.

Another source of temperature variability and a characteristic of the Eastern Cape coast are upwelling events (Beckley, 1983; Schumann 1999, Schumann *et al.* 1988; Churchill, 1995; Goschen & Schumann, 1995). This phenomenon is caused by wind driven currents particularly during easterly winds (Churchill, 1995). Upwelling cells are prominent adjacent to many of the rocky headlands, particularly off Cape Recife and Cape Padrone and may move into Algoa Bay (Schumann *et al*. 1982; Beckley, 1983; Churchill, 1995; Goschen and Schumann, 1995; Goschen *et al.* 2012). Although not as frequent or as severe as those upwelling events on the west coast, wind-driven upwelling has been responsible for fish kills, and water as cold as 6°C has been recorded in the area (Ross, 1988). As the upwelling events are generally relatively weak and short lived the proliferation of harmful algal blooms does not occur.

Temperature, salinity, nutrients and ocean current dynamics have been studied in Algoa Bay by Goschen and Schumann (1988, 2011) and Schumann *et al.* (2007). The Agulhas Current plays an intermittent role in determining the current and temperature structure in Algoa Bay, while prevailing winds are important on the wider shelf areas as one moves inshore (Goschen and Schumann 2011). Current speeds of less than 10 $cm.s^{-1}$ have been measured most frequently within the bay (Roberts, 1990; Schumann *et al.* 2007), although currents exceeding 20 $cm.s^{-1}$ are not uncommon (Schumann *et al.* 2007; Goschen *et al*. 2012). However, currents in the bay are known to be highly variable in both direction and magnitude and show considerable variation depending on where in the bay they are measured (see Harris, 1978; Goschen and Schumann, 1988; Roberts, 1990; Schumann *et al.* 2005). Figure 2 is of current roses at Bird Island recorded over 7 months showing currents moving in mainly south-west and north-easterly directions at velocities of less than 15 $cm.s^{-1}$ for most of the time (Goschen *et al.* 2012). During 10% of this seven-month period, the south-west-flowing surface currents at Bird Island exceeded 70 $cm.s^{-1}$ and sometimes reached 110 $cm.s^{-1}$. Bottom currents, however, reached a maximum of 55 $cm.s^{-1}$ due to friction with the seafloor.

Two types of water masses have been documented to move into Algoa Bay, namely warm Agulhas Current water and cold upwelled water originating from upwelling at Cape Recife and Cape Padrone (Goschen et al. 2012). Warm water from the Agulhas Current is associated with occasional large meanders shorewards as the current moves southward. On the other hand, cold upwelled water originating from Cape Recife during relatively short-lived easterly winds, particularly during summer, is known to move into the bay when the wind switches to a westerly direction shortly after upwelling has occurred (Schumann *et al.* 1982; Goschen and Schumann, 1995). Upwelling also occurs off Cape Padrone and cool waters can move into Algoa Bay causing rapid temperature decreases (Goschen *et* al. 2012). Upwelling occurs along this stretch of coast because the orientation is such that the easterly wind has an offshore component, which combined with Ekman transport and the steep and prominent bathymetry, readily draws cold bottom water to the surface within the inertial period of 21 h (for this latitude) (Roberts, 2005). Upwelled water moving into the bay has been known to cause sharp changes in temperature by approximately 8°C within a 24 hour period (Goschen and Schumann, 1995).

Yearly-average minimum temperatures are found in winter of 14-15°C and maximum average temperatures in summer of 20-22°C (Beckley, 1983 & 1988; Schumann *et al*. 2005). Temperature variation in Algoa Bay is high and typically ranges between 11°C in winter and 27°C in summer (Beckley, 1983, 1988). A strong thermocline is evident in summer in water deeper than 15 m characterised by fairly intense gradients of up to 3°C.m^{-1}, whereas in winter conditions are homogenous (Schumann *et al.* 2005).

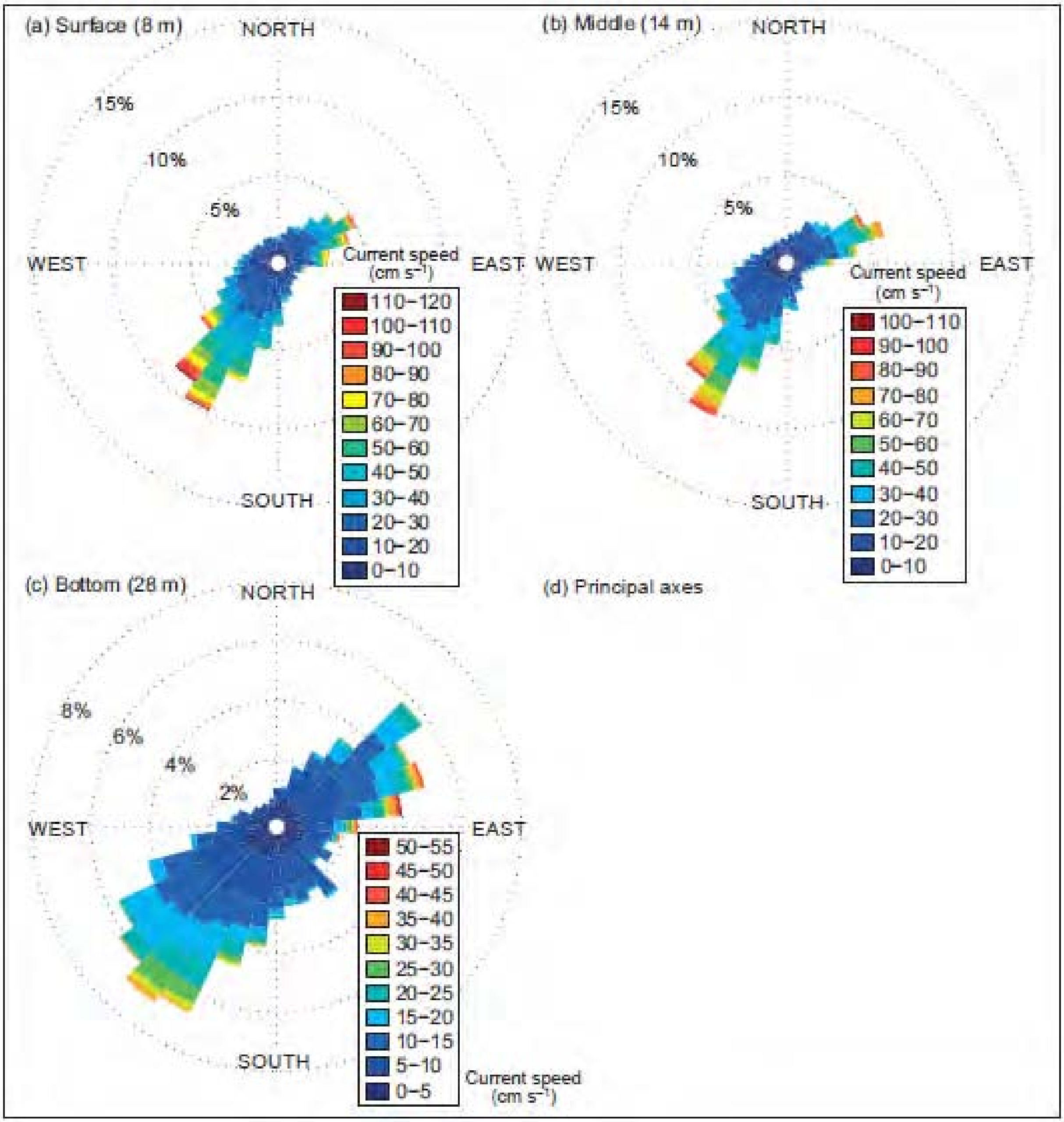


Figure 2. Current roses from Bird Island at (a) near surface (8m), (b) mid-depth (14m) and (c) the bottom (28m) showing the direction currents are flowing to, over a seven-month period between November 2008 and May 2009 (Goschen *et al*. 2012).

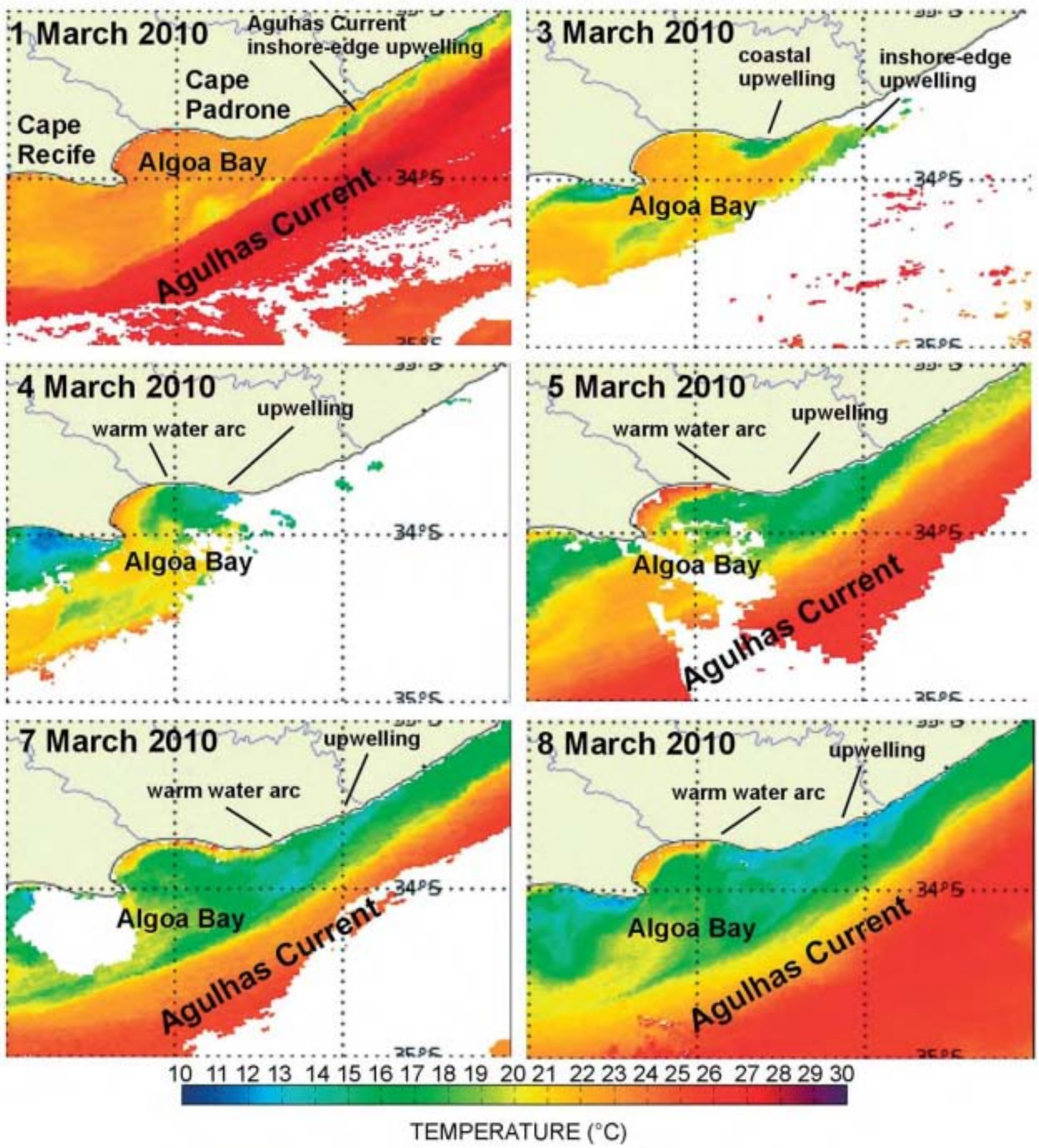


Figure 3. **Satellite imagery of sea surface temperature between 1 and 8 March 2010 showing an upwelling event. Cool water first emerges at Woody Cape/ Cape Padrone and expands into Algoa Bay.**

Salinity remains relatively constant within Algoa Bay and close to natural oceanic water for the region of 35.2 ‰ (Schumann et al 1988). However, close to the mouth of the Swartkops River and at the New Brighton Pier outfall, salinity as low as 34.7 ‰ has been measured, although it remains only in the top 5 m of water and does not penetrate deeper (Schumann *et al.* 2005).

Wave climate is predominantly from the south west with swells of less than 2 m being most common and occurring approximately 80% of the time (Ashby *et al.* 1973; MacLachlan, 1983) (see **Error! Reference source not found.**). However, an important percentage of waves in excess of 3 m emanate from the south west generated by storms in the vast reaches of the Southern Ocean. Fortunately, most of Algoa Bay is protected from these swells by the rocky headland at Cape Recife despite some degree of refraction (Ross, 1988; Goschen and Schumann, 2011). Nevertheless, maximum wave heights of 6 m have been recorded along the surf zone of Algoa Bay by MacLachlan (1983), possibly from easterly swell, and Council for Scientific and Industrial Research (CSIR, 1987) buoy-data have recorded wave heights of between 0.5-5.0 m (87% of waves between 1-3 m) in summer and between 1.0-6.5 m in winter approaching the Bay at Cape Recife.

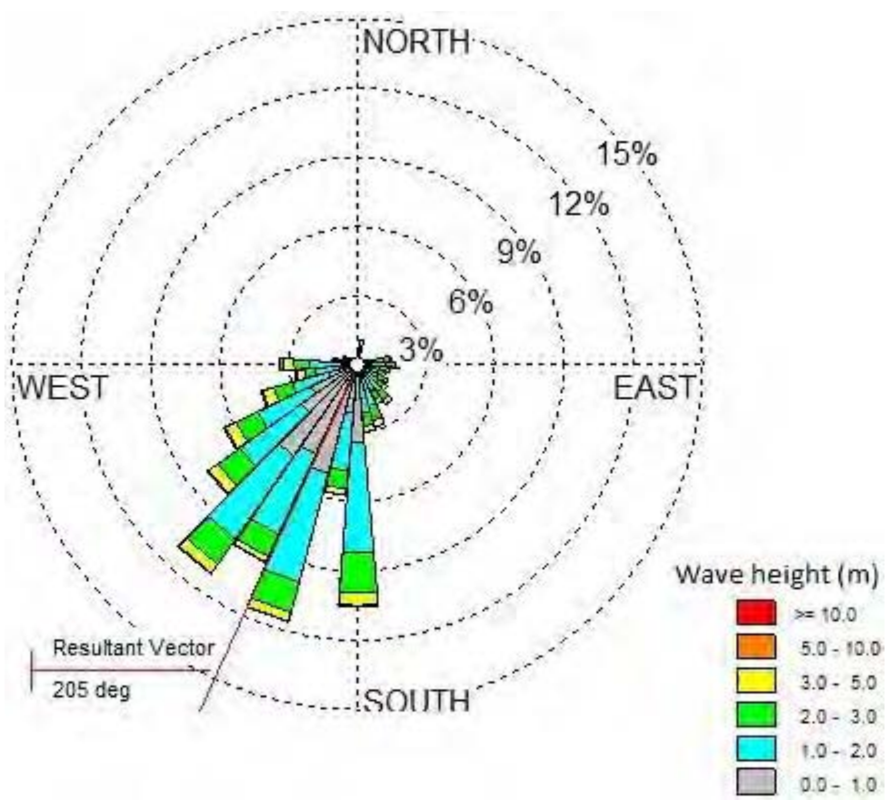


Figure 4. Wave rose showing the direction from, proportion and magnitude of waves experienced offshore of the St Francis-Algoa Bay region. Data from SADCO Voluntary Observing Ships for a 30-year period.

3 Marine ecology

3.1 Regional biogeography

Algoa Bay falls within the warm temperate Agulhas Bioregion or ecoregion, one of four inshore bioregions spanning the coast of South Africa (Emanuel *et al*. 1992; Bustamante and Branch, 1996; Turpie *et al*. 2000; Branch *et al.* 2010). This bioregion extends from the Mbashe River in the Eastern Cape west to Cape Point. It is an important area of mixing where warm Agulhas Current water mixes with cool Benguela Current water. The shelf margin also extends considerably further offshore relative to the east and west of this bioregion (Emery and Uchupi, 1975). At a finer scale, the area encompassing Algoa Bay is considered the Agulhas Inner Shelf Ecozone (Sink *et al*. 2011) (Figure 5). These characteristics of the coast play an important role in providing habitat for many organisms and contribute to the maintenance of important fisheries (see Wallace *et al*. 1984). The wide oceanic shelf provides and an array of habitats and the temperature mixing also plays a large role in accounting for high levels of biodiversity and endemicity, including the highest number of endemic fish species along the South African coast (Turpie *et al*. 2000; Lombard *et al.* 2004, Sink et al 2011).

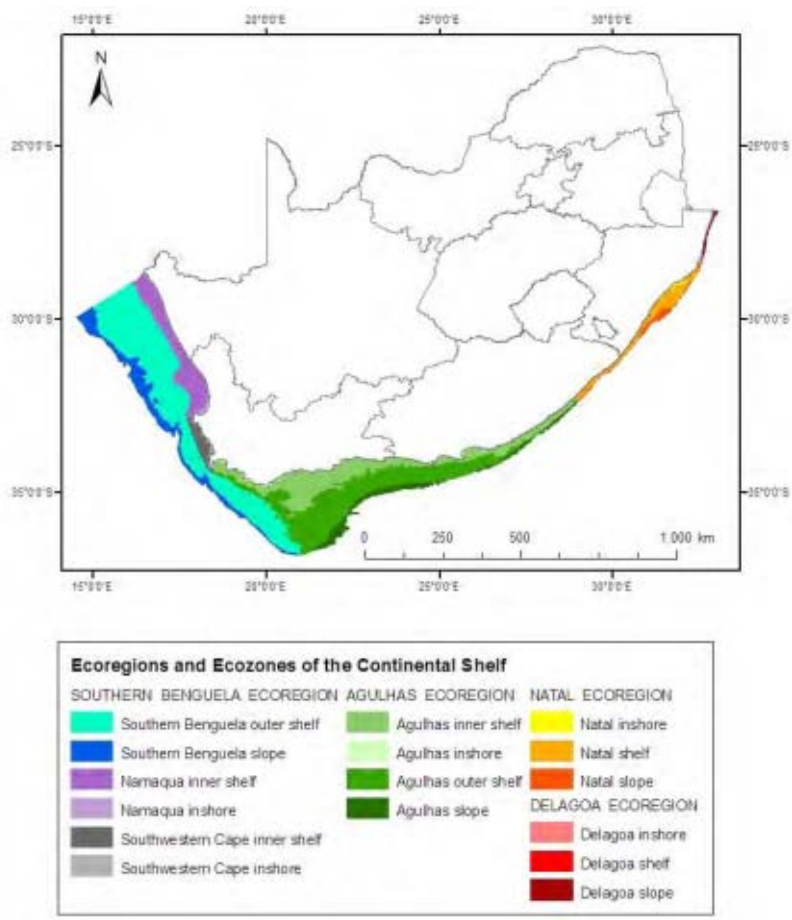


Figure 5. Inshore and offshore bioregions in South Africa as defined by Sink et al. (2011).

3.2 Rocky intertidal shores

Zonation patterns of marine organisms on rocky shores result from the variation in environmental variables across the shore (e.g. the amount of time each zone is exposed to the air), which in turn influences the organisms which inhabit each section of the shore (Branch 1981, Beckley 1988). Species that are more tolerant to desiccation (drying out) are found near the high-water mark, while those that cannot stand long periods of water recession are found near the low-water mark. Five distinct zones are typically found on rocky shores South Africa's coast, most of which are present on the Eastern Cape Coastline. These zones (moving in a landward direction) are named the Infratidal zone, the Cochlear zone, the Lower Balanoid zone, the Upper Balanoid zone and the Littorina zone.

On intertidal reefs, red algae dominate particularly *Plocamium corallorhiza*, *P. Cornutum, Pterosiphonia cloiophylla, Hypnea spicifera, Chondrococcus hornemannii*, *Gigartina paxillata*, *Laurencia flexuosa* and articulated corallines *Amphiroa bowerbankii, A. ephedraea*, *Arthrocardia duthiae, Cheilosporum cultratum, Corallina* sp*.* and *Jania* sp. (Seagrief, 1988; Lubke & Seagrief 1998). Brown algae are also an important component, particularly species of *Dictyota* and *Dictyopteris, Zonaria subarticulata, Ecklonia biruncinata* and *Lyengaria stellata.* Green algae such as *Caulerpa filiformis, C. racemosa, Bryopsis* spp. and *Codium* spp. play a subordinate role to intertidal community composition (Seagrief, 1988).

Grazers and filter feeders are the most prolific fauna. In the Littorina zone, species of the very abundant periwinkle *Nodilittorina* spp. are the dominant animal (Wooldridge & Coetzee 1998). The balanoid zone is dominated by three species of barnacle (*Cthalamus dentatus*, *Tetraclita serrata* & *Octomeris angulosa*), three species of topshell (*Oxystele sinensis*, *O. tigrina* & *O. variegate*), beds of brown mussel *Perna perna,* limpets (especially *Helcion pectunculus*, *H. pruinosus*, *Patella granularis*, *P. oculus* and *P. longicosta*) and false limpets (*Siphonaria capensis*, *S. oculus*, *S. aspera* & *S. concinna*). Predatory whelks (*Burnupena cincta* & *B. lagenaria*, *Thais capensis*, *T. castanea*, *Nucella dubia* & *N. Squamosa*), echinoderms (particularly *Patiriella exigue*, *Henricia ornata, Patiria granifera, Parechinus angulosa*) and various sea anemones (*Pseudactinia flagellifer*, *Actinia equine* & *Anthothoe stimpsoni*) are also common, especially in rock pools. Lower down the shore, the Cochlear zone is characterised by a dominance of the limpet *Patella cochlear*, however this zone may be absent on very sheltered shores (Beckley 1988). Below the Cochlear zone, and the beginning of the subtidal zone, the red bait ascidian *Pyura stoloinfera* is usually dominant (Beckley, 1988).

Fish are also diverse and include clinids (especially *Clinus cottoides* & *C. superciliosus*), the gobies (*Caffrogobius caffer*), juvenile sparids, particularly Blacktail *Diplodus sargus capensis* and fransmadam *Boobsoidea inornata*as well as mullet which all utilize the intertidal rock pools and prey on invertebrates and algae found on the rocky shore.

Some species of bird also utilise intertidal rocky shores as important foraging areas in the region; in particular, the near threatened Cape cormorant and black oystercatcher, pied kingfisher, Kelp and Grey-headed gulls, as well as swift and common tern.

3.3 Sandy shores

A description of typical marine communities found in the sandy beach and surf zone habitat types that occur off the Eastern Cape coasts as described in the literature is provided below.

Intertidal sandy beaches are very dynamic environments. The faunal community composition is largely dependent on the interaction of wave energy, beach slope and sand particle size (beach morphodynamics). Three morphodynamic beach types are described: dissipative, reflective and intermediate beaches (McLachlan *et al* 1993). Dissipative beaches are wide and flat with fine sands and high wave energy. Waves start to break far from the shore in a series of spilling breakers that 'dissipate' their energy along a broad surf zone. This generates slow swashes with long periods, resulting in less turbulent conditions on the gently sloping beach face. These beaches usually harbour the richest intertidal faunal communities. Reflective beaches have low wave energy, and are coarse grained (>500 µm sand) which have narrow and steep intertidal beach faces. The relative absence of a surf-zone causes the waves to break directly on the shore causing a high turnover of sand. The result is depauperate faunal communities. Intermediate beach conditions exist between these extremes and have a very variable species composition (McLachlan *et al.* 1993; Jaramillo *et al.* 1995; Soares 2003). This variability is mainly attributable to the amount and quality of food available.

Beaches typically comprise three functional zones, namely the surf zone, the beach (intertidal and backshore zones) and the dunes. They are continually changing; strong waves scour and erode beaches while gentle waves deposit sand. Sand is typically deposited with offshore winds, and eroded with onshore winds. Sand erosion will also increase during the high seas and stormy weather that is relatively common along the Eastern Cape coast. Relatively few species occur on sandy beaches due to their unstable and harsh nature, but those that do occur are hardy, and well adapted to life in these environments (Branch 1981). Animals living here are, however, offered some degree of protection by being able to burrow into the layers of sand to escape desiccation, overheating and strong waves (Branch 1981).

Sandy beaches have no hard substratum onto which animals and plants can attach. Organisms living here rely on seaweeds deposited sporadically on the beach and organic rich froth, or spume, which provides a more consistent source of nutrients (Branch 1981). Five groups of organisms are typically found on sandy beaches: aquatic scavengers, aquatic particle feeders, air breathing scavengers, meiofauna (smaller than 1 mm in size), and higher predators (Branch 1981).

Aquatic scavengers feed on dead or dying animals that wash up on the beach and their activity is largely regulated by tides. This group includes species such as *Bullia* (the plough snail), that emerge from the sand as the tide rises and are deposited in the same area in which the wave drops the debris and decaying matter. Later they follow the tide down the shore as it recedes to avoid be eaten by terrestrial predators. Three species of plough shells occur on Eastern Cape beaches, *Bullia rhodostoma, B. digitalis* and *B. pura* (Beckley 1988, Wooldridge and Coetzee 1998). Other important aquatic scavengers in the region include the three spotted swimming crab *Ovalipe punctatus* and the subtropical mole crab *Emerita austroafricana* (Beckley 1988). Several species of burrowing polychaete worms that are either scavengers or carnivores are also found intertidally on sandy beaches. These include *Nephytys capensis*, *Lumbrinereis tetraura, Glycera convolute* and *Arabella irricolor* (Beckley 1988, Wooldridge and Coetzee 1998).

The dominant aquatic filter feeders on Eastern Cape beaches are the sand mussels *Donax serra* and *D sordidus*, that occur mostly buried on the low and mid-shore and feed on small organic particles they suck in through siphons that protrude above the sand. *D. sordidus* migrates up and down the beach with each tidal cycle, whilst *D. serra* remains in the midshore (Beckley 1988). A small crustacean, the surf mysid *Gastrosaccus psammodytes*, is also very abundant on sandy beaches in the area (Beckely 1988, Wooldridge and Coetzee 1998). This species burrows in the sand during the day and emerges into the water column at night (Branch et al 1010). Mysids are an important component in the diet of many surfzone fish.

Air breathing scavengers live high on the shore and feed on kelp and other seaweeds that have been washed up, as well as dead and decaying animal matter. These species complete their life cycles out of water, emerge from the sand during low tide when there is less risk of being washed away, and are almost strictly nocturnal to avoid desiccation and predation. The dominant species in this group are amphipods (e.g. *Talorchestia capensis* and *Talorchestia quadrispinosa)* and isopods (e.g. *Tylos capensis*, *Euridice longicornis* and *Pontogeloides latipes*). These species are important for the breakdown of sea weeds, and are also a major food source for shore birds and fish that feed on sandy beaches. Another high shore scavenger is the ghost crab *Ocypode ryderi,* that is found on some Eastern Cape beaches, predominately during the summer months. Both ghost crabs and mole crabs are rare south of East London (Wooldridge and Coetzee 1998).

Meiofauna (organisms < 1mm in size) are by far the most abundant of the animals found on sandy beaches, as their small size enables them to live between sand grains. The two most common groups are nematode worms and harpacticoid copepods (Wooldridge and Coetzee 1998).

Vertebrate predators that feed on sandy beach organisms include mainly birds such as Kelp and Grey-headed gulls, White fronted plovers, Swift, Common and the near-threatened Caspian tern, as well as Sanderlings in the summer (Craig 1998). Fish such as galjoen and white steenbras also swim over submerged beaches at high tide and feed on small crabs and the like (Branch 1981). Elf, leervis, sand shark, white seacatfish and white steenbras are some of the characteristic species which favour the sandy surfzone. Sandy beaches are also important for the filtering and decomposition of organic matter in sea water. As water percolates down through the sand the organic particles are trapped and decomposed by bacteria, which in turn release nitrates and phosphates that are returned to the sea. Continual flow of water through the sand maintains oxygen levels and aids bacterial decomposition, and thus sandy beaches act as water purifiers (Branch 1981).

3.4 Estuaries

Three rivers drain via estuaries into Algoa Bay, these are the Swartkops, Coega (Ngqura) and Sundays. The Swartkops and Sundays estuaries are both considered to have Critically Endangered threat status (van Niekerk & Turpie 2011). Many species of fish rely heavily on them as nursery areas (Marais & Baird 1980; Marais 1981; Beckley 1984). Of particular relevance to the proposed ADZs are the important populations of overexploited, Dusky kob *Argyrosumus japonicus* and spotted grunter *Pomadasys commersonnii* that frequent these estuaries and the broader Algoa Bay region (Marais 1981; Marais & Baird 1980; Smale & Buxton 1998; Griffiths 1996). Acoustic tracking of dusky kob reveals high natal estuary fidelity, but quite extensive bay wide movement by adults. A limited number of turbid estuaries (including the Sundays) appear to be critically important primary nurseries for this species and coastal bays appear to be more important than open coastal areas (Paul Cowley, SAIAB personal communication).

Dusky kob is a potential culture species and large scale escapes from an ADZ could have serious disease and or genetic impacts on native populations. Native populations have compromised resilience against these impacts due to their reduced numbers resulting from overexploitation. The same is true for other potential culture species with overexploited native populations in Algoa Bay such as the silver kob (*A. inodorus)* and white steenbras (*Lithognathus lithonathus*).

3.5 Subtidal habitats

Relative to sandy habitats, reefs are scarce in Algoa Bay (Figure 6). On shallow subtidal reefs (<10 m), algae, grazers and filter feeders are the most prolific fauna. Dominant algae consist mainly of red foliose species, especially *Plocamium* spp. The ascidian *Pyura stolonifera* is also abundant (Beckley, 1988). Cape oysters, particularly in areas prone to periodic sanding are prevalent. Perlemoen *Haliotus midae* are an important species occurring on shallow subtidal reefs, particularly on algae dominated reefs. The large predatory whelk *Charonia lampas pustulata* is also frequently encountered, particularly on deeper reefs.

Deeper reefs below 10 m are characterised by exceptionally high levels of diversity and dominated by many species of filter feeders, particularly colonial ascidians, sponges, sea fans, soft corals, hydroides and bryozoans (Wooldridge & Coetzee 1998) (Figure 7). Sponges and ascidians are especially diverse on subtidal reefs in the region and are particularly poorly studied. Sea fans (*Leptogorgia palma*, *Eunicella albicans*, *E. papillosa & E. tricoronata*) are common in the area as is the purple soft coral *Alcyonium fauri*. Bryozoans become more abundant with depth due to their fragile structure as do feather stars, two species of which, namely *Comanthus wahlbergi* and *Tropiometra carinata* occur in the area.

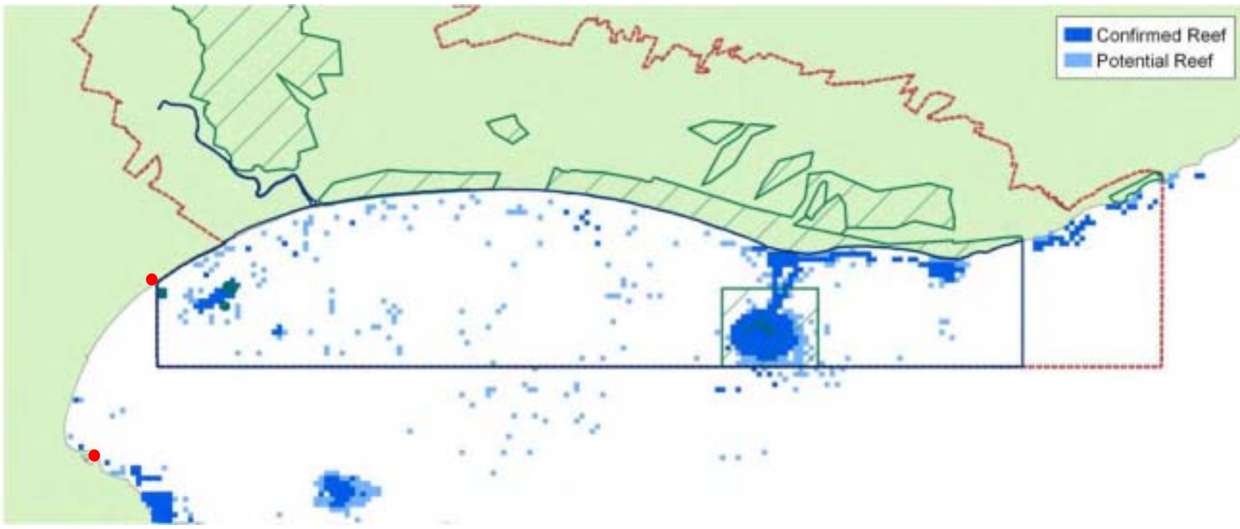


Figure 6. **Reefs areas within the Algoa Bay. The area to the left of the dotted red line is included in the proposed sanctuary zone of the Addo MPA. Red dots indicate the positions of the Ports of Port Elizabeth (left) and Ngqura (right), respectively. (Source: A. Oostehuizen, SANParks).**

Characteristic fishes on these deeper reefs include Panga *Pterogymnus laniarius*, Piggy grunter *Pomadasys olivaceum*, Santer *Cheimerius nufar*, Fransmadam, Carpenter *Argyrozoma argyrozona*, Fransmadam *Boopsoidea* inornata, Roman *Chrysoblephus laticeps*, Dageraad *Chrysoblephus cristiceps,* Yellowbelly rockcod *Epinephelus marginatus*, Steentjie *Spondyliosoma emarginatum* and white musselcracker *Sparadon durbanensis* (Smale & Buxton 1998; Chalmers 2012).

On soft bottom habitats, subtidal trawl and dredge surveys conducted from Mossel Bay to Cape Padrone have recorded high diversities of polychaetes (56 species of bristleworms), gastropods (53 species of snails) , ophiuroids (9 species of brittlestar) and mysids (4 species of shrimps) (Wallace *et al*. 1984).

Wallace *et al*. (1984) also sampled the inshore ichthyofauna using otter-nets, blanket nets, try nets, scoop-nets and dredges in an effort to gain an understanding of the fish community composition and their dependence on estuaries and inshore areas as nursery grounds.

Table 1 summarizes those species comprising the catch (according to their relative frequencies) in the vicinity of the Swartkops River. Table 2 list those species comprising the catch off the Sundays River mouth in the vicinity of Algoa 5. Wallace *et al.* (1984) conducted the same survey in St Francis Bay and these catches are summarised in Table 3.

Species composition among the three areas is relatively similar, as one would expect, although there are some differences in the rank contribution of species to the overall catch, probably due to local scale determinants.

Inshore fish larvae sampled at depths of 5 and 15 m inshore of Algoa 5 and further eastwards near Woody Cape revealed the presence of 78 species (Pattrick & Strydom 2008). The larvae of 10 fish families dominated these samples. The Gobiidae was the dominant family and made up half (49%) of the contribution to the total catch. The Cynoglossidae, Engraulidae and Clupeidae each contributed 8%, the Sparidae 7% to the total catch. The Blenniidae and Soleidae contributed 5% and 4%, respectively. Sciaenidae contributed 3% to the catch while the Tripterygiidae and Kyphosidae contributed 2% and 1%, respectively.

Figure 7. A typical subtidal reef found in the Algoa Bay area of the Agulhas Bioregion.

Table 1. Proportion that each species (%) caught in inshore trawls contributes according to the frequency of that species relative to that of the total catch in the vicinity of the proposed ADZs offshore of the Swartkops River mouth.

Species name	Common name	Habitat	Percentage of catch
Dasyatis pastinacus	Blue stingray	Benthic on sand or mud, prefers surf zone but found down to 110m	0.43
Myliobatus aquila	Eagle ray	Shallow water to 95m	0.82
Squalus megalops	Spiny dogfish	Shore down to 500m, usually close to bottom, juveniles pelagic over continental shelf	1.37
Argyrosomus inodorus	Silver kob	Important nursery areas are sandy and muddy substrata of the nearshore, sandy reef edges and estuaries	13.91
Cynoglossus capensis	Sand tonguefish	Sandy or silty bottom, from 10m to well below 100m	1.65
Galeichthys feliceps	White sea-catfish	Sheltered reefs or muddy bottom down to 100m	31.25
Merluccius capensis	shallow water hake	In water between 50-400m deep. Closer to surface at night	1.04
Pagellus natalensis	Red tjor tjor	Deep water species brought closer inshore by upwelled water over sandy bottoms	6.74
Pomadasys olivaceum	Piggy grunter	Juvenies and adults in coastal waters. Often over offshore reefs and soft substrate banks	24.42
Pomatomus saltatrix	Shad	Predatory pver sandy bottoms and reef edges	12.07
Trachurus trachurus	Maasbanker	Pelagic, surface to 400m	2.83

Table 2. Proportion that each species (%) caught in inshore trawls contributes according to the frequency of that species relative to that of the total catch offshore of the Sundays River mouth in the vicinity of Algoa 5.

Species name	Common name	Habitat	Percentage of catch
Dasyatis pastinacus	Blue stingray	Benthic on sand or mud, prefers surf zone but found down to 110m	0.75
Myliobatus aquila	Eagle ray	Shallow water to 95m	0.6
Narke capensis	One-fin electric ray	No data	0.49
Raja miraletus	Twin-eye skate	shallow water down to 50m	0.44
Squalus megalops	Spiny dogfish	Shore down to 500m, usually close to bottom, juveniles pelagic over continental shelf	1.25
Argyrosomus inodorus	Silver kob	Important nursery areas are sandy and muddy substrata of the nearshore, sandy reef edges and estuaries	26.64
Engraulis encrasicolus	Anchovy	Coastal pelagic down to 400m	11.27
Galeichthys feliceps	White sea-catfish	Sheltered reefs or muddy bottom down to 100m	14.56
Pomadasys olivaceum	Piggy grunter	Juvenies and adults in coastal waters. Often over offshore reefs and soft substrate banks	20.85
Pomatomus saltatrix	Shad	Predatory pver sandy bottoms and reef edges	4.75
Trachurus trachurus	Maasbanker	Pelagic, surface to 400m	5.53
Umbrina canariensis	Baardman	Benthic, 40-100m, feed over soft substrata	1.95

Table 3. Proportion that each species (%) caught in inshore trawls contributes according to the frequency of that species relative to that of the total catch in St Francis Bay.

Species name	Common name	Habitat	Percentage of catch
Myliobatus aquila	Eagle ray	Shallow water to 95m	0.9
Squalus megalops	Spiny dogfish	Shore down to 500m, usually close to bottom, juveniles pelagic over continental shelf	1.65
Argyrosomus inodorus	Silver kob	Important nursery areas are sandy and muddy substrata of the nearshore, sandy reef edges and estuaries	4.13
Galeichthys feliceps	White sea-catfish	Sheltered reefs or muddy bottom down to 100m	16.45
Merluccius capensis	shallow water hake	In water between 50-400m deep. Closer to surface at night	6.38
Pomadasys olivaceum	Piggy grunter	Juvenies and adults in coastal waters. Often over offshore reefs and soft substrate banks	30.08
Pagellus natalensis	Red tjor tjor	Deep water species brought closer inshore by upwelled water over sandy bottoms	6.65
Pterogymnus laniarius	Panga	Adults over rocky reefs 20-230m deep	5.75
Pomatomus saltatrix	Shad	Predatory over sandy bottoms and reef edges	17.31
Trachurus trachurus	Maasbanker	Pelagic, surface to 400m	5.75

3.6 Offshore pelagic region & islands

The pilchard *Sardinops ocellatus*, anchovy *Engraulis encrasicolus* east coast roundherring *Etrumeus teres* and saury *Scomberesox saurus* are probably the most abundant pelagic species in the region of Algoa Bay and the pilchard, anchovy and round herring in particular are both prolific schooling species occurring in huge shoals (Smale & Buxton 1998; van der Elst 1993). They provide a very important food source for many other pelagic species (Batchelor & Ross 1984; Randall & Randall 1986; van der Elst 1993). These include other predatory pelagic fish, especially yellowtail, skipjack tuna, yellowfin tuna, leervis, horse mackerel, bronze whaler, dusky sharks and hammerhead sharks (Smale 1986; Smale 1991; Heemstra & Heemstra 2004).

The small pelagic fish also support important birds and marine mammals. For example more than 90 % of the numerical dietary composition of the Cape gannet (listed as Vulnerable) off Bird Island consisted of three species of small pelagic, mainly Pilchard *Sardinops ocellata*, Anchovy *Engraulis capensis* and Saury *Scomberesox saurus* (Batchelor & Ross 1984; Klages *et al.* 1992) and the diet of Jackass penguins *Spheniscus demersus* from St Croix Island comprised 19 species of fish (Randall & Randall 1986). Pelagic shoaling fish being the dominant prey items, specifically anchovy, pilchard and round herring, in that order (Randall & Randall 1986).

Satellite tracking shows that large areas of the bay are utilised by penguins for foraging. It appears that the majority of foraging effort takes place outside of Algoa 1 and Algoa 5 in areas further offshore (Figure 8). However, these data were collected for a short period of two months in 2008 and again in 2009 and therefore have limited utility in assessing whether or not the proposed ADZs are utilised extensively for foraging or not. In reality, penguins will follow their prey, and the very nature of their small pelagic fish prey means that where penguins feed within Algoa Bay is likely to be highly variable and governed by the movements of these fish.

The islands of Algoa Bay are home to many endangered, vulnerable and near-threatened birds including breeding colonies of African penguins (Crawford *et al.* 1990; Barnes 1998), Cape gannet (Crawford, 1997b; Barnes, 1998), African black oystercatchers (Martin, 1997), Roseate tern (Randall *et al.* 1991; Crawford, 1997a), Cape Cormorant (Cooper *et al.* 1982) and winter visiting Antarctic terns (Williams, 1997). The African penguin colony at St Croix Island is the largest in the world (Pichegru *et al*. 2010). In addition, Algoa Bay is the eastern most distribution of the Cape fur seal and breeding takes place on Black Rocks (Mills and Hes, 1997).

Two groups of three islands each, support these colonies of birds and seals (Figure 9). One island group comprises the large St Croix Island with smaller stacks of Jahleel and Brenton Rocks. St Croix Island lies 4 km from the coast and is situated between the Coega and Sundays river mouths. This rocky 12 ha island rises to 58m and has very little vegetation. The second island group consists of Bird, Seal and Stag Islands, and lies near Cape Padrone, 7km from the coastal Woody Cape Nature Reserve. Bird Island (19 ha) is the largest of the Algoa Bay islands and is relatively flat rising by only 9 m. Seal Island is much smaller (0.6ha) lying 360 m north of Bird Island, and Stag Island is even smaller (0.1ha), lying 320 m north-west of Bird Island (Bird Life International, 2012).

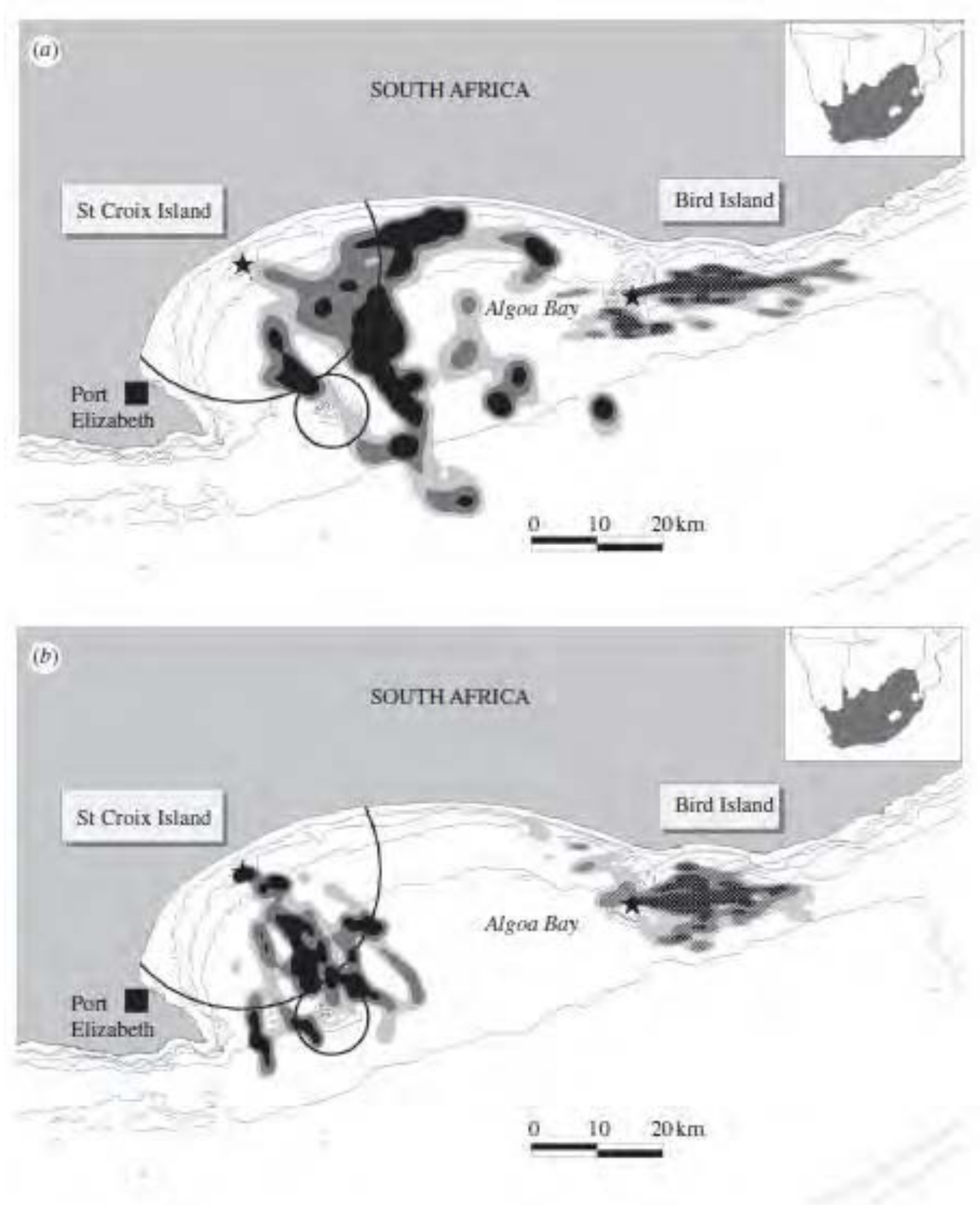


Figure 8. Foraging areas (density of feeding dives) of African penguins breeding on St Croix Island and Bird Island (stars), (a) before (2008) and (b) after (2009) closure to the purse-seine fishing within 20 km of St Croix Island (circled). Foraging range (feeding dives): black, 50%; dark grey, 50-75%; and light grey, 75-90% (Pichegru *et al*. 2010).

Figure 9. Demarcated island habitats in the proposed Addo MPA. The area to the left of the dotted red line is included in the proposed sanctuary zone of the Addo MPA. Red dots indicate the positions of the Ports of Port Elizabeth (left) and Ngqura (right), respectively. (Source: A. Oostehuizen, SAParks).

Much of the island group is covered by sparse growth of mixed vegetation dominated by the fleshy herbs that form patches of thicket that provide cover for some seabirds. The Algoa Bay Islands are of considerable importance as they are the only islands along a 1,777 km stretch of coastline between Cape Agulhas and Inhaca Island in Mozambique (see Barnes, 1998; Bird Life International, 2012). All islands are protected areas and components of them are located within Important Birding Areas (IBAs) (Barnes 1998; Bird Life International, 2012a).

In addition to the important colonies of seabirds and seals, six species of cetaceans are regularly seen in Algoa Bay; these include southern right whales (*Eubalaena australis*), humpback whales (*Megaptera novaeangliae*), Bryde's whales (*Balaenoptera brydei*), Indian Ocean bottlenose dolphins (*Tursiops aduncus*), Indo-Pacific humpback dolphins (*Sousa chinensis*), and longbeaked common dolphins (*Delphinus capensis*) (Saayman *et al*. 1972; Karczmarski *et al*. 2000; Reisinger & Karczmarski 2009 Melly 2011). The zoogeography of these species has been the focus of a recent comprehensive study that analysed distribution patterns collected from over a year's worth of boat-based observations in relation to various physical and behavioural variables e.g. distance from shore, bottom depth and type, season, sea state, foraging, travelling, resting etc (Melly 2011). This study identified key habitats for each species and highlighted the importance of Algoa Bay as a breeding and nursery area for southern right whales and as a potentially important nursery area and migration route for humpback whales. The distribution patterns of the other four cetacean species were thought to be linked primarily to prey distributions. A key habitat area for southern right whales, humpback dolphins and bottlenose dolphins was identified between PE Port and Cape Recife adjacent to, but mostly inshore of the proposed Algoa 1 ADZ (humpback dolphins in particular inhabit very shallow coastal waters, an average of 6.6m, and most of the Algoa 1 ADZ is deeper than 25m). A long coastal strip from just east of the Sundays River estuary mouth to Woody Cape was identified as a key habitat for southern right and humpback whales and bottlenose dolphins. This area also lies inshore and to the east of the proposed Algoa 5 ADZ, although humpback whales (along with Brydes whales and common dolphins) were associated with deeper water i.e. a more offshore group whose distributions may more frequently overlap with the proposed ADZs.

The diversity of organisms, many of which are endemic, endangered or use Algoa Bay as an important breeding area has led to the establishment of the no-take Bird Island Marine Protected Area (MPA) and the no-take Sardinia Bay MPA located approximately 16 km to the west of Algoa Bay. In addition, the proposed Addo-Elephant Park MPA, if proclaimed would cover an area of 137 773 ha from Cape Padrone to Coega Harbour and encompass all islands within Algoa Bay as well as the proposed ADZ area Algoa 5.

4 Biodiversity importance and conservation status

Due to the high diversity of habitats, marine organisms and seabirds in Algoa Bay, several of which are of conservation concern, significant biodiversity importance is attributed to many areas in the bay (Chalmers 2012) (Figure 10). The St Croix Reserve and Bird Island Marine Protected Area (MPA) off Woody Cape make a significant contribution to biodiversity conservation, particularly for birds and offshore island habitat (Barnes 1998; Chalmers 2012). However, large areas with high biodiversity conservation importance are afforded no protection. The National Protected Areas Expansion Plan (SANBI 2009) proposed an MPA in Algoa Bay, which would adjoin the Greater Addo Elephant National Park (GAENP) and considerably improve biodiversity conservation. The proposed Addo Elephant National Park MPA would be the first in South Africa to incorporate a bay environment, exposed rocky headlands and offshore islands. Detailed research and planning for the proposed MPA began in 2006, and has culminated in the current proposed zonal boundaries for the MPA (Figure 11).

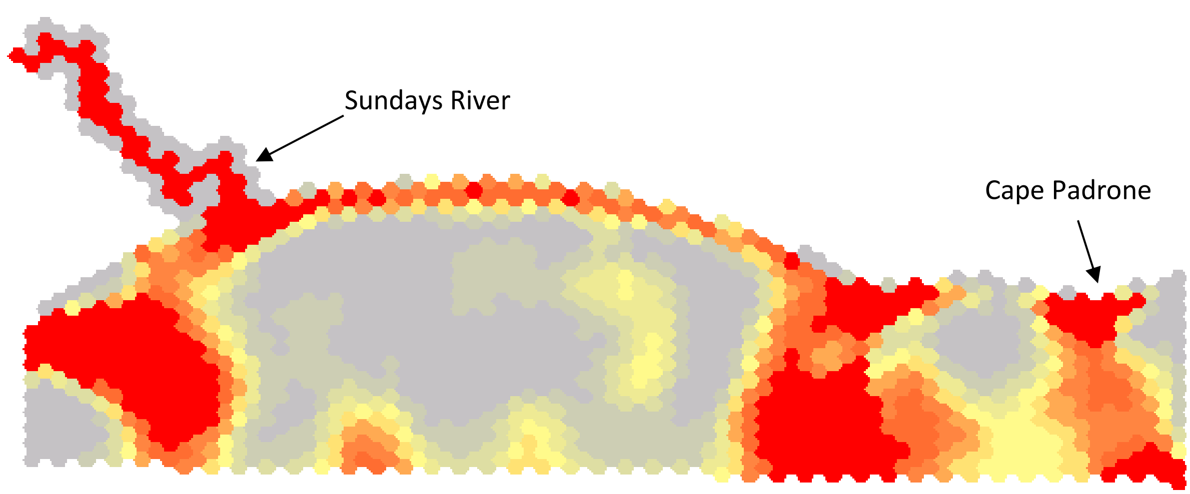


Figure 10. Areas of high biodiversity importance in the area of the proposed Addo Elephant MPA. (Source: A. Oostehuizen, SAParks).

The proposed boundaries of the Addo MPA do not conflict with the potential Algoa 1 ADZ. However, the possible Algoa 5 ADZ, which was not identified as a potential inshore ADZ in the original Strategic Environmental Assessment (SEA) would lie within the boundaries of the proposed Addo MPA (see Hutchings *et al*. 2012; Clark 2012). Note that one of the criteria included in the SEA process was the exclusion of all sites within existing or proposed MPAs being in keeping with a principle adopted at the MPA Managers Forum in 2010 by all conservation institutions present (Chadwick 2010; Hutchings *et al*. 2012). Institutions represented at this meeting including DEA, DAFF, SANParks, Cape Nature, Eastern Cape Parks Board, South African National Biodiversity Institute, University of Cape Town, Rhodes University, and WWF-SA. Subsequent discussions between DAFF, DEA, SANParks and Anchor have further clarified this position. SANParks have confirmed that they do not support mariculture in MPAs as per the principle adopted at the MPA Managers Forum in 2010 (Ane Oosthuizen pers. comm.). They have indicated further that the proposed Greater Addo MPA will be zoned into control use and restricted zones as indicated in Figure 11. The “Restricted” zones correspond with those areas identified as biodiversity hotspots, or containing habitats or features (processes) with high conservation importance identified through a systematic conservation planning exercise undertaken for the area (Figure 10; Oosthuizen *et al*. 2011). In terms of the proposed structure of the MPA these areas would correspond with sanctuary or no-take zone within the MPA where no fishing will be permitted. The remaining portions of the MPA are proposed as controlled use zones where fishing will be permitted in future in accordance with national regulations.

If established, the Algoa 5 ADZ would lie within the Controlled zone of the proposed MPA. However, SANParks remains opposed to the idea of allowing aquaculture to take part in any part of the MPA and have indicated that they would “most likely excise these areas from the MPA”. The option of placing an ADZ within the proposed controlled use areas of the Addo MPA remains the only option besides Algoa 1 that would not violate the remaining criteria (both logistical and environmental) included in the original SEA (see Clark 2012).

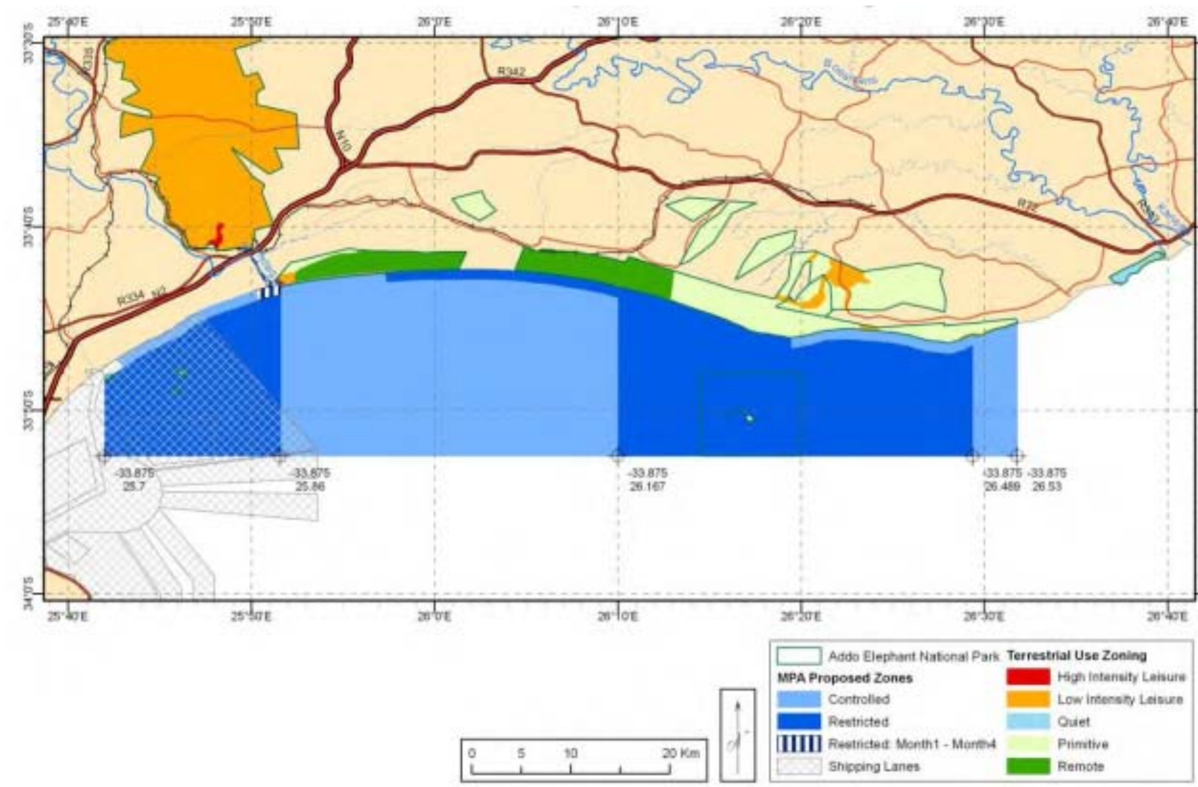


Figure 11. Proposed Addo Elephant National Park MPA, showing the proposed zoning into restricted (no-take) and controlled use zones (Source: SANParks).

5 Site specific descriptions

5.1 Context of existing monitoring

In situ baseline surveys of the ecology and oceanography of Algoa Bay commenced in February 2012 in the footprints of Algoa 2 and Algoa 3. However, concerns about Algoa 2 and 3 were raised during the Scoping Phase regarding shipping and safety after deployment of monitoring equipment (Clark 2012). Algoa 2 and 3 therefore remain unsuitable, and monitoring at these sites has ceased. Monitoring equipment has now been redeployed within ADZs Algoa 1 and 5 as these appear to be the next-most suitable areas that violate the fewest conditions outlined in the Strategic Environmental Assessment (Hutchings et al. 2012; Clark 2012). Nevertheless, data from these previous surveys remains valid and the best indicators of physical oceanographic conditions available at present. The data presented here were collected over an 11 month period from Algoa 2, which lies approximately 8 km to the north of Algoa 1. Therefore, these data provide a reasonable proxy of the oceanographic conditions that are likely to be experienced at Algoa 1 in the interim. Algoa 5, however, is more than 18 km away from the monitoring instrumentation that was deployed at Algoa 2, and best available data for this potential ADZ is limited to the literature (see Goschen *et al*. 2012), although data on bathymetry and bottom type are now available and presented for both Algoa 1 and 5.

Nevertheless, all oceanographic monitoring and *in situ* surveys commenced on the 25th of January 2013 at Algoa 1 and Algoa 5 and will provide data comparable that presented here for Algoa 2.

Update, June 2013

The current, wave and temperature recording equipment moored on Algoa 1 and Algoa 5 was serviced in early June 2013. The data collected over the 4 month period (31 January 2013 - 11 June 2013) are presented below. These data are indicative of the conditions at the two proposed ADZ sites over the summer-early winter period. All equipment has been redeployed and monitoring will continue until January 2014 – providing a full years worth of information for these two sites.

5.2 *In situ* monitoring and survey methodology

Ecological analyses include baseline assessments of the macrobenthic community and any rare/unique habitats within the two potential ADZs. Should the development of the ADZs go ahead, these data will be used for future comparison and ecological monitoring to detect any potential changes in marine communities due to aquaculture. Benthic grab samples in the footprint of both the proposed ADZs have been collected. Biological samples have been preserved and taken back to the laboratory for identification by experts.

For estimation of total organic content, sediment samples were oven dried at 40^{o}C for 48 hrs. The dry soil samples were placed on crucibles, weighed to the nearest 0.01g and placed in a muffle furnace at 600°C for 6 h, allowed to cool to room temperature in a dessicator, then weighed again. The difference in weight for before and after is assumed to be equal to the organic content of the sample.

Sediment particle size was analysed by dry sieving each sample through graded sieves (2000*u*m, 1000*u*m, 850*u*m, 710*u*m, 500*u*m, 425*u*m, 300*u*m, 212*u*m, 150*u*m and 62*u*m) on a mechanical shaker for ten minutes. The weight of each fraction on each sieve was recorded to the nearest 0.1 g. Data were analyzed using the program Gradistat Version 6 (Blott 2008).

Oceanographic variables being measured include current and temperature profiles, wave climate, depth and bottom type. Acoustic-Doppler current profilers (ADCPs) have been redeployed in each of the two latest preferred sites (Algoa 1 and 5) to quantify the wave climate (wave height and period) and currents at various depths in the water column (Figure 12 and Figure 13). Current data presented below are from the deployment at Algoa 2 over the period February – December 2012, and the deployments at Algoa 1 and Algoa 5 for the period 31 January 2013 - 11 June 2013. On advice from SonTek technical support, the current data were cleaned to exclude all cases where the noise to signal ratio for any of the instrument's three beams dropped below a value of 3. Data from cells near the water surface were also trimmed, if any part of the cell crossed or overlapped with the reported dynamic cell end. The dynamic cell end tracks the water surface as determined by the instruments pressure sensor. Data from cell 10 were excluded entirely as this cell always exceeded the water surface, whilst up to 85% of the data (Algoa 2) from cell 9 were excluded. These cleaned data were then summarized as current roses and histograms of current strength classes.

Figure 12. ADCP mooring deployed in Algoa Bay. The blue PVC tubes on the ADCP mooring are filled with concrete and are approximately 1m in length.

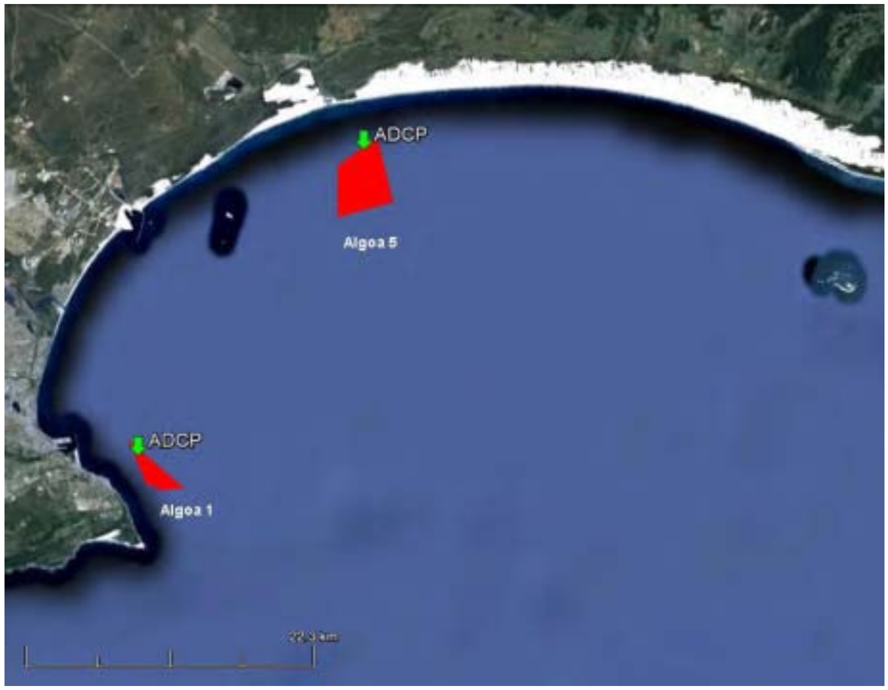


Figure 13. The locations of the two ADCPs that were deployed in January 2013 in Algoa 1 and Algoa 5 (indicated in red).

The raw cleaned data from all three ADCP deployments (Algoa 2 and those currently in situ at Algoa 1 and Algoa 5) will be archived at DAFF and should be made available to future mariculture operators to be used in project development and planning.

Thermister strings are being used to measure water temperature at various depths to get an accurate temperature profile of the water column within these two potential ADZs as well (Figure 14). Bottom type has been assessed using benthic grab sampling in conjunction with sediment classification and analysis at multiple locations within the footprint of each proposed ADZ (Figure 15). These will help to confirm the absence of reefs. Single-beam echo sounding has already been used to provide an accurate measurement of depth and bottom type/profile.

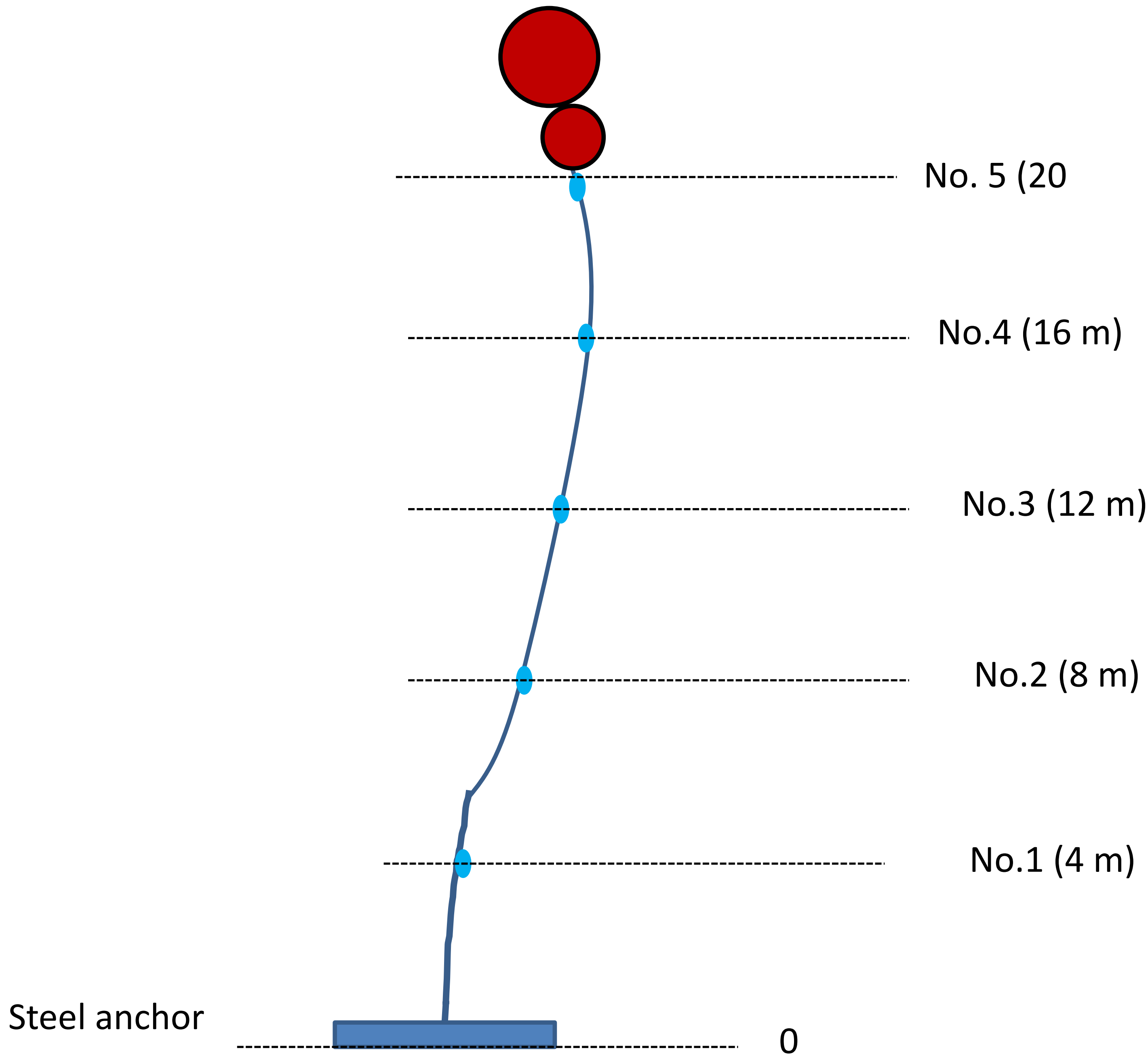


Figure 14. **Schematic showing the design of the thermister string to be deployed in Algoa Bay. Nos. 1-5 depict the positions of the temperature loggers. A steel anchor of ~50 kg is used to secure the device and two large sub-surface buoys ensure that the string stays upright.**

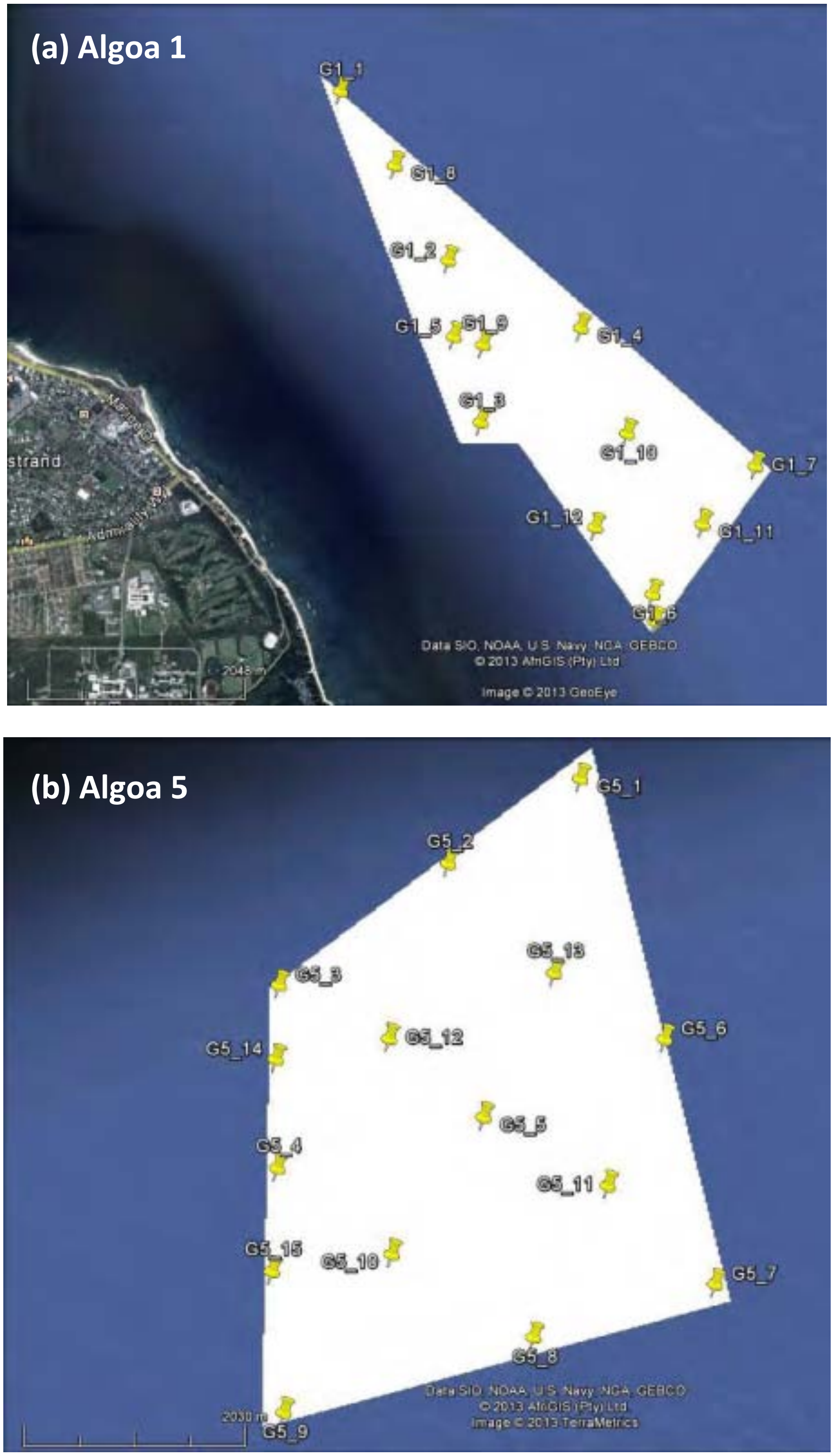


Figure 15. Locations of sites where benthic grab samples were taken (a) in Algoa 1, and (b) Algoa 5.

5.3 *In situ* characteristics of Algoa 1 and Algoa 5.

5.3.1 Bathymetric surveys and bottom type

Data on bathymetry and bottom type are available for both Algoa 1 and Algoa 5. Depth at Algoa 1 was found to range from 21.3 m at the inshore areas to 39.7 m further offshore (Figure 16). Depth gradients over the entire ADZ appear consistent and uniform, indicative of an area lacking in any reef.

No reef was detected according to bottom type analysis of the sediment at Algoa 1 either (Table 4). Sediments at Algoa 1 ranged from mean particle sizes per sample of 383.0 to 1341.1 µm and can be described as consisting of medium and very course sands. The percentage of total organic content comprising the sediments ranged from 2.27 to 5.04 %.

Depth within Algoa 5 ranged from 22.4 m at the north-western-most corner to 37.6 m at its southern-most offshore areas (Figure 17). For the most part, depth gradients and topography seemed relatively even and featureless. However, there are two areas (in the north-west corner & roughly centre) that may indicate the presence of reef.

Indeed, one of the sediment samples (G5_3) located in the north-west corner revealed reef in the form of rocks (20-30 cm) encrusted with crinoids, sponges and corals (Table 5). Remaining samples were all sediments ranging in mean particle size from 177.6 to 1241.5 µm. Most of the bottom type of Algoa 5 can be described as consisting of very course silts ranging through to course sands. The percentage of total organic content comprising the sediments at Algoa 5 ranged from 2.21 to 3.62 %.

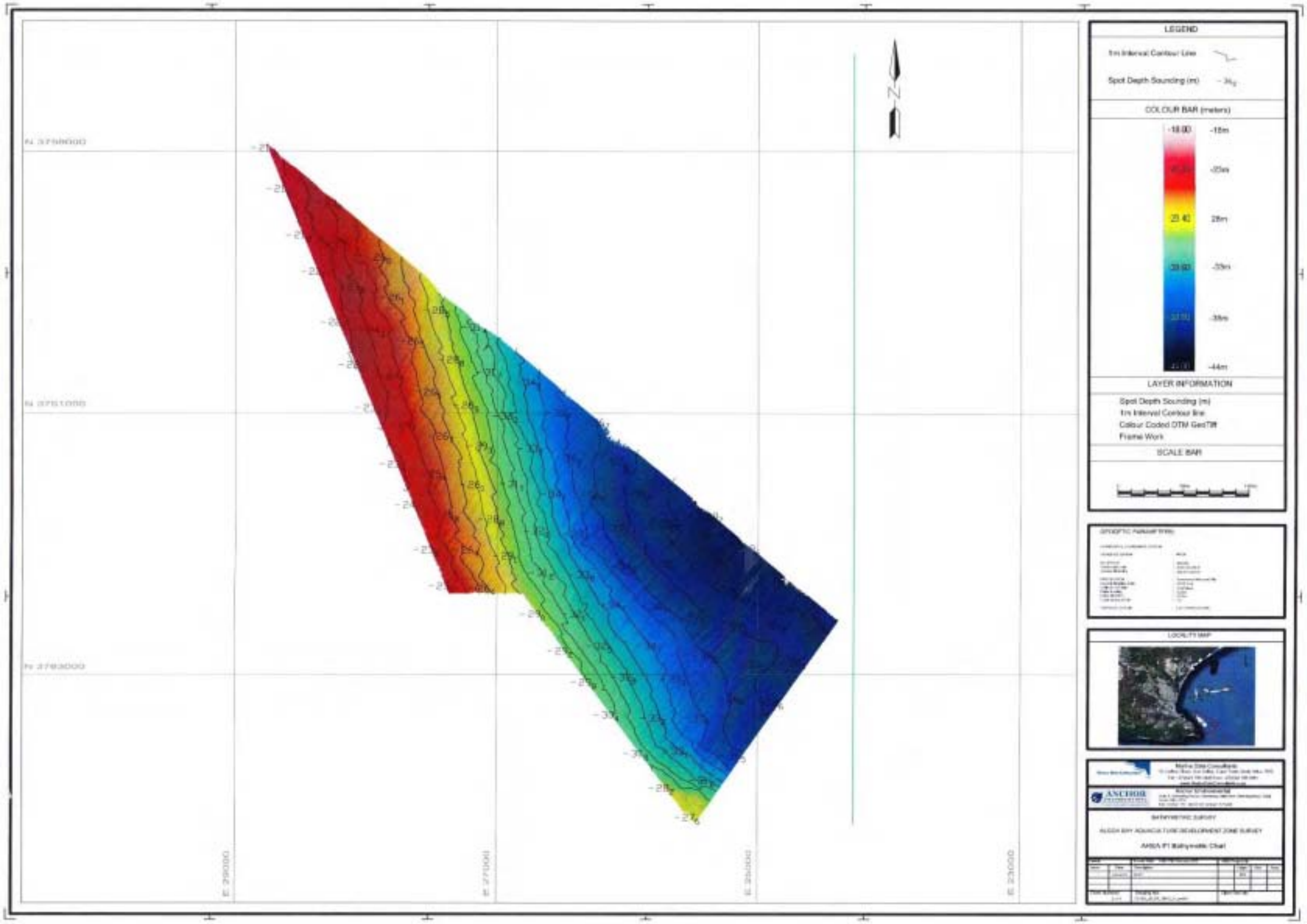


Figure 16. **Bathymetry of Algoa 1.**

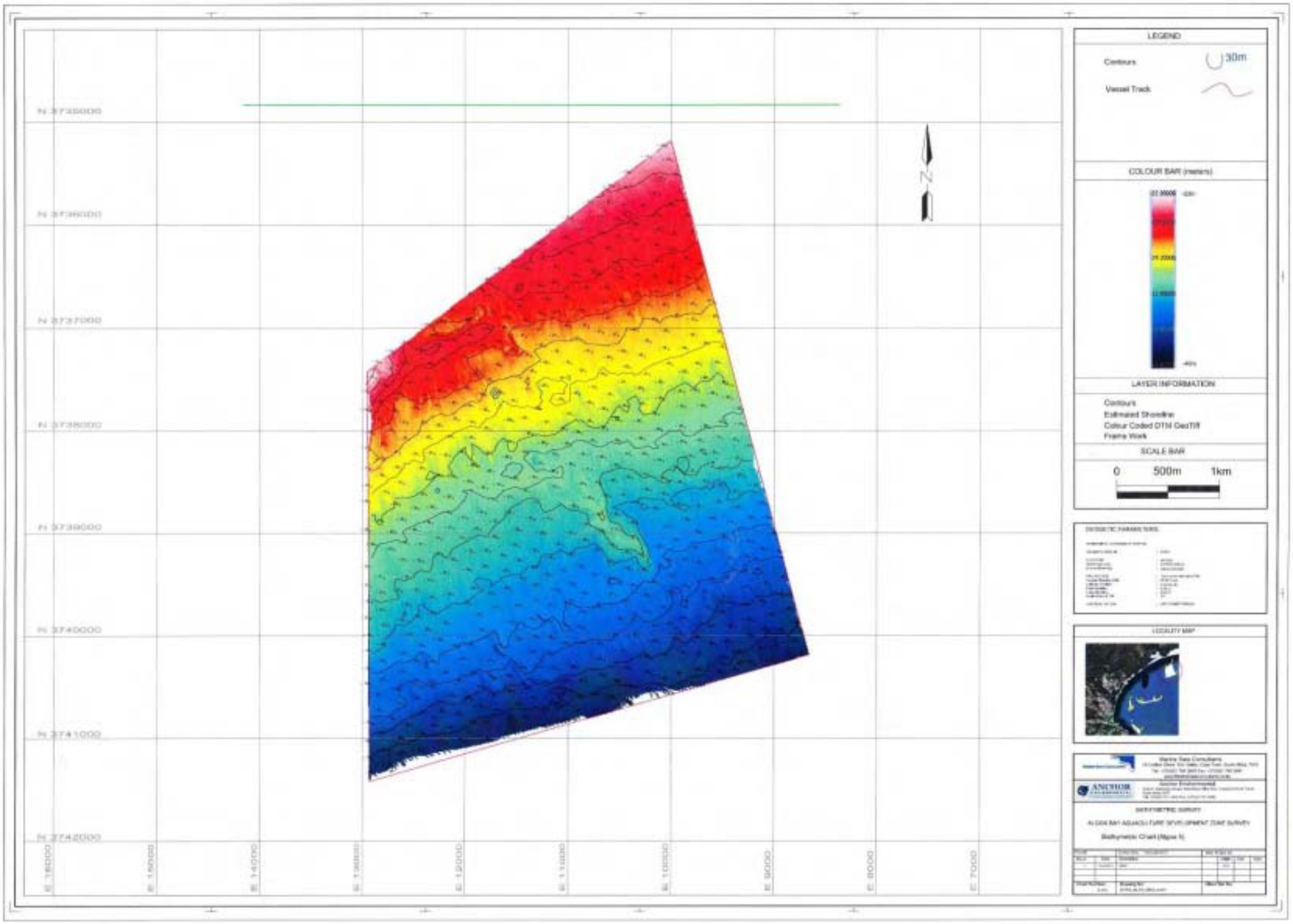


Figure 17. Bathymetry of Algoa 5.

Table 4. Sediment results of bottom type from locations at Algoa 1.

Sample	Mean particle size (µm)	Sorting	Description (Folk & Ward method)	% Total Organic Content	Presence of reef
G1_1	383.0	Moderately Well Sorted	Medium Sand	3.06	No
G1_2	459.5	Moderately Well Sorted	Medium Sand	2.79	No
G1_3	1341.1	Moderately Sorted	Very Coarse Sand	5.04	No
G1_4	454.7	Poorly Sorted	Medium Sand	4.08	No
G1_5	399.1	Moderately Well Sorted	Medium Sand	2.49	No
G1_6	1690.9	Moderately Sorted	Very Coarse Sand	4.73	No
G1_7	658.9	Moderately Sorted	Medium Sand	2.27	No
G1_8	439.6	Moderately Well Sorted	Medium Sand	2.72	No
G1_10	596.8	Poorly Sorted	Medium Sand	4.62	No
G1_11	1213.8	Poorly Sorted	Coarse Sand	4.59	No
G1_12	383.0	Moderately Well Sorted	Medium Sand	4.05	No

Table 5. Sediment results of bottom type from locations at Algoa 5.

Sample	Mean particle size (µm)	Sorting	Description (Folk & Ward method)	% Total Organic Content	Reef
G5_1	198.7	Very Poorly Sorted	Very Coarse Silt	3.33	No
G5_2	177.6	Very Poorly Sorted	Very Coarse Silt	2.21	No
G5_3	25 000	*NA*	Rocks	0	Yes
G5_4	414.2	Moderately Well Sorted	Medium Sand	2.61	No
G5_5	306.7	Well Sorted	Medium Sand	2.73	No
G5_6	180.9	Poorly Sorted	Very Fine Sand	2.51	No
G5_7	343.4	Moderately Sorted	Fine Sand	3.32	No
G5_8	819.4	Moderately Sorted	Coarse Sand	2.85	No
G5_9	851.5	Poorly Sorted	Coarse Sand	3.60	No
G5_10	410.5	Well Sorted	Medium Sand	3.02	No
G5_11	622.7	Poorly Sorted	Medium Sand	3.62	No
G5_12	338.2	Poorly Sorted	Fine Sand	3.06	No
G5_13	265.0	Very Poorly Sorted	Very Fine Sand	2.81	No
G5_14	1241.5	Poorly Sorted	Coarse Sand	3.30	No
G5_15	438.8	Moderately Well Sorted	Medium Sand	2.25	No

5.3.2 Temperature

5.3.2.1 Algoa 2

Temperature data from Algoa 2, derived from the miniloggers attached to the thermister string and from the ADCP, showed both high variability among seasons (summer vs. winter) and high variability hourly during summer when water temperatures fluctuated greatly (Figure 18 & **Error! Reference source not found.**). Temperature drops of more than 7°C in a 12 hour period were recorded at the bottom (21m) and through most of the water column, except near the surface above depths of 9 m which dropped by only a maximum of 2.5°C within 12 hours. During winter, however, temperatures at all depths showed limited variability (<2°C), and approximated 17 °C on the bottom and surface. Temperature variations recorded during summer are far greater than seasonal variations between winter and summer periods. These rapid changes in temperature recorded during summer indicate substantial movement of the thermocline through most of the water column.

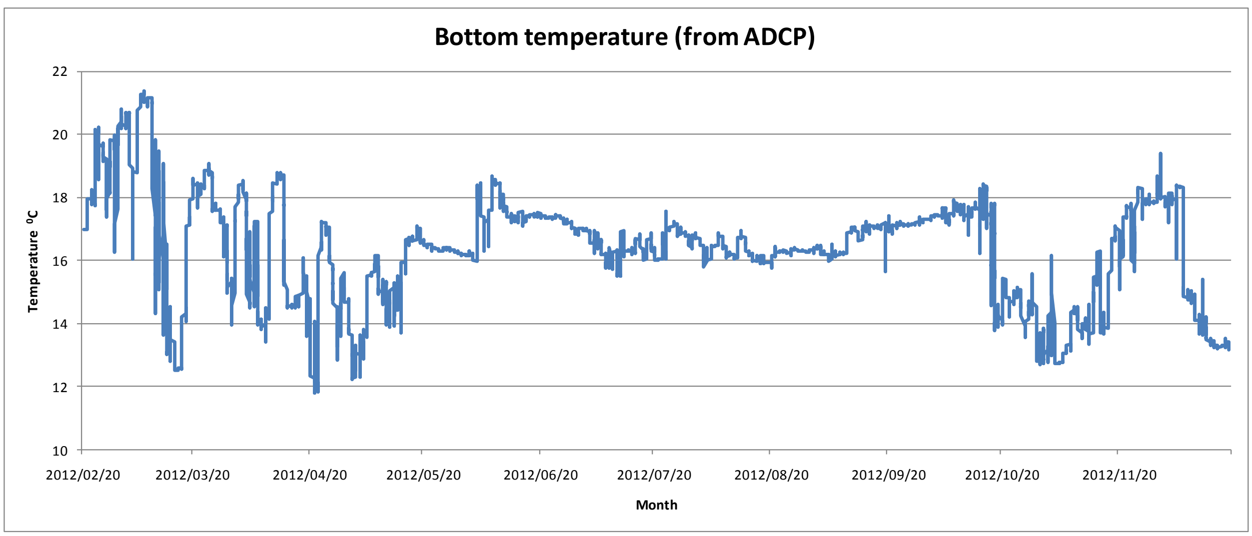


Figure 18. Temperature record (20 February 2012 – 19 December 2012) from 25m water depth as recorded by the bottom moored ADCP in Algoa 2. The average temperature from an 8 minute sampling period every hour was recorded. Min = 11.8 °C, Max= 21.4 °C.

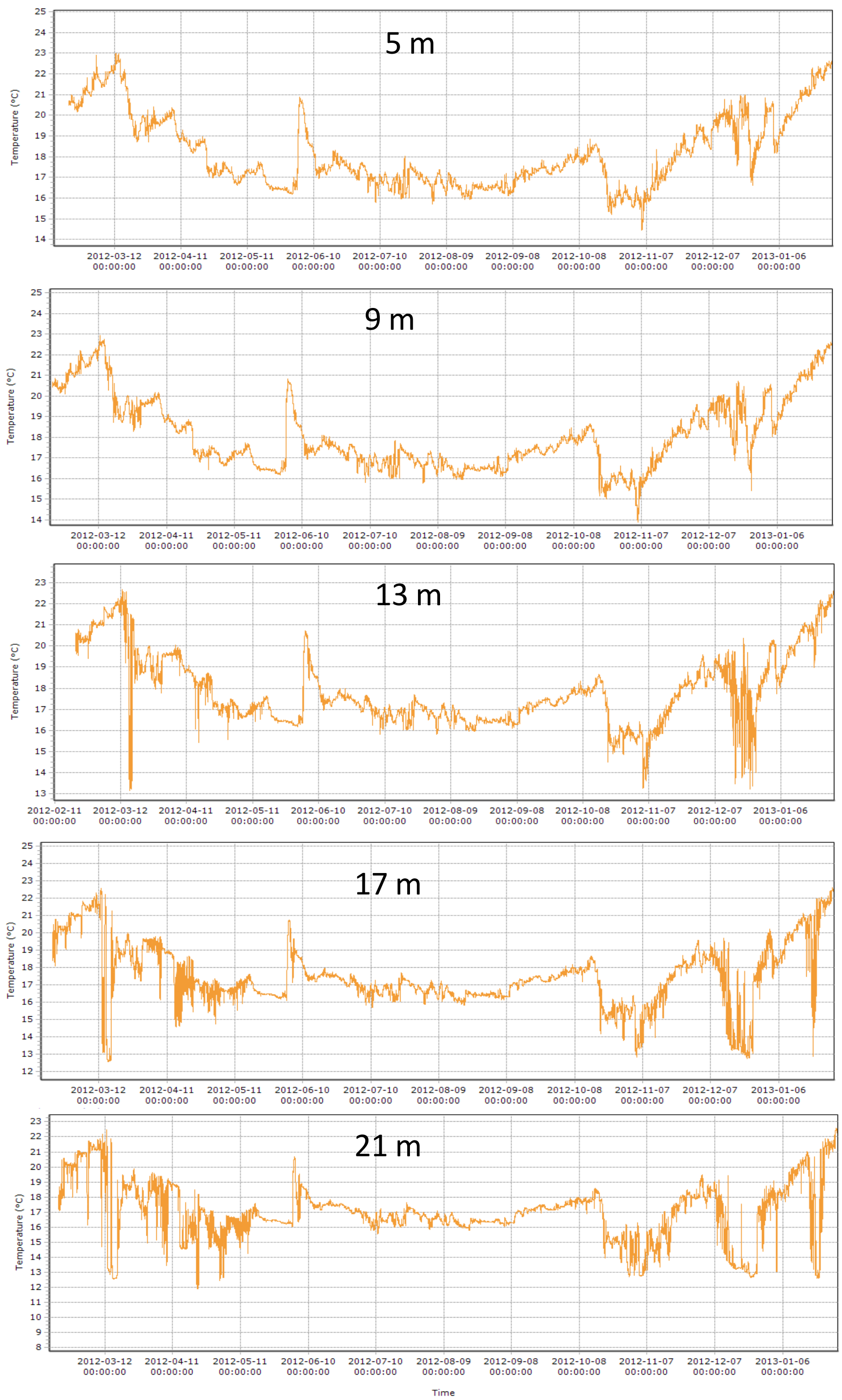


Figure 19. Temperature record (20 February 2012 – 30 January 2013) as recorded by the Vemco temperature miniloggers in Algoa 2. Temperature was recorded once every 6 minutes.

5.3.2.2 Algoa 1

Algoa 1 situated 8 km to the south-west of Algoa 2 and was expected to also experience similar temperature fluctuations. Monitoring data for the period February – June 2014 at Algoa 1 confirms that similar vertical movement of the thermocline took place during late summer- autumn at this site (Figure 20). Indeed the thermocline appeared to move as shallow as 5m from the surface during late March 2013, with a ~5°C drop in temperature over a 12 hour period. Sudden changes with temperature became more common with increasing depth and occurred frequently at depths 13m and deeper. As with Algoa 2, temperature variation became more pronounced with depth, and varied seasonally, with little fluctuation after April.

5.3.2.3 Algoa 5

Published data of temperature in the vicinity of Algoa 5 is presented in Goschen *et al.* (2012). They recorded temperatures at St Croix Island (8 km to the west of Algoa 5) and offshore of the Sundays River. The latter appears to be situated within the footprint of Algoa 5. Although over a limited time period, both sites show clear indications of upwelling. Present *in situ* monitoring provides more data for the summer-autumn of 2013 (Figure 22). A similar pattern of high temperature variability in the summer months, increasing with depth is present.

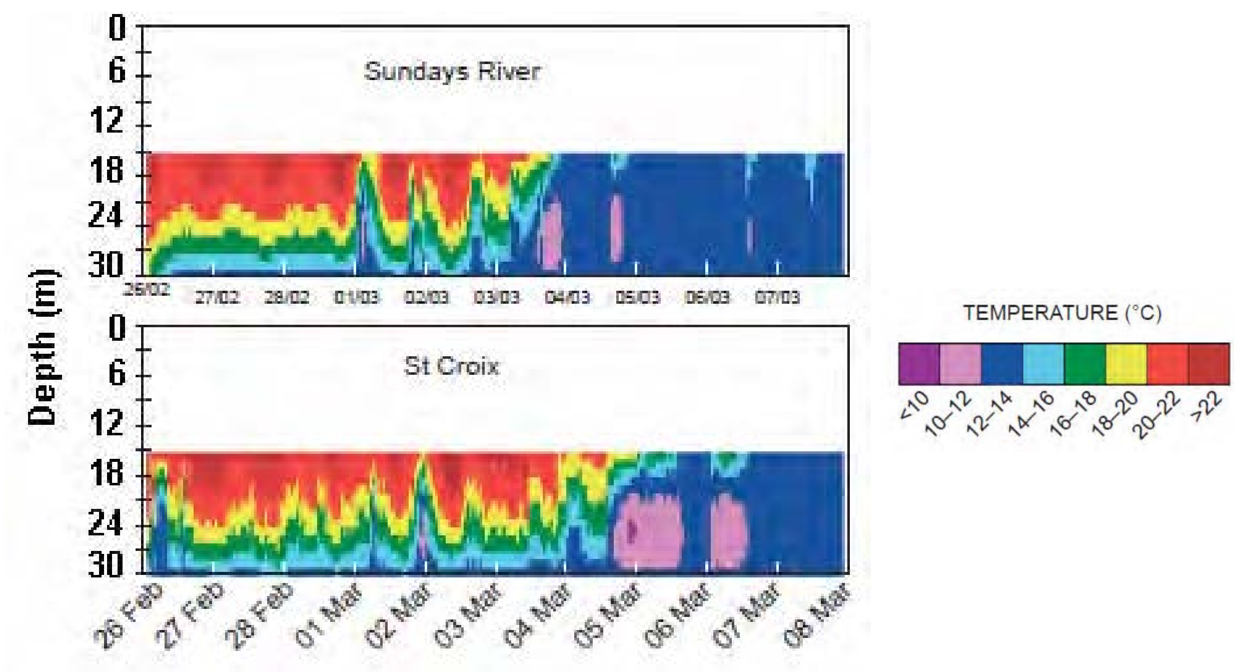


Figure 20. Sea temperatures measured throughout the water column offshore of the Sundays River and adjacent to St Croix Island (from Goschen *et al*. 2012).

Commercial scale fish cages are approximately 15m deep and stock will be exposed to these temperature fluctuations during the summer months. Species selected for farming should either of these sites be approved, will need to be tolerant of the temperature range and variability reported here.

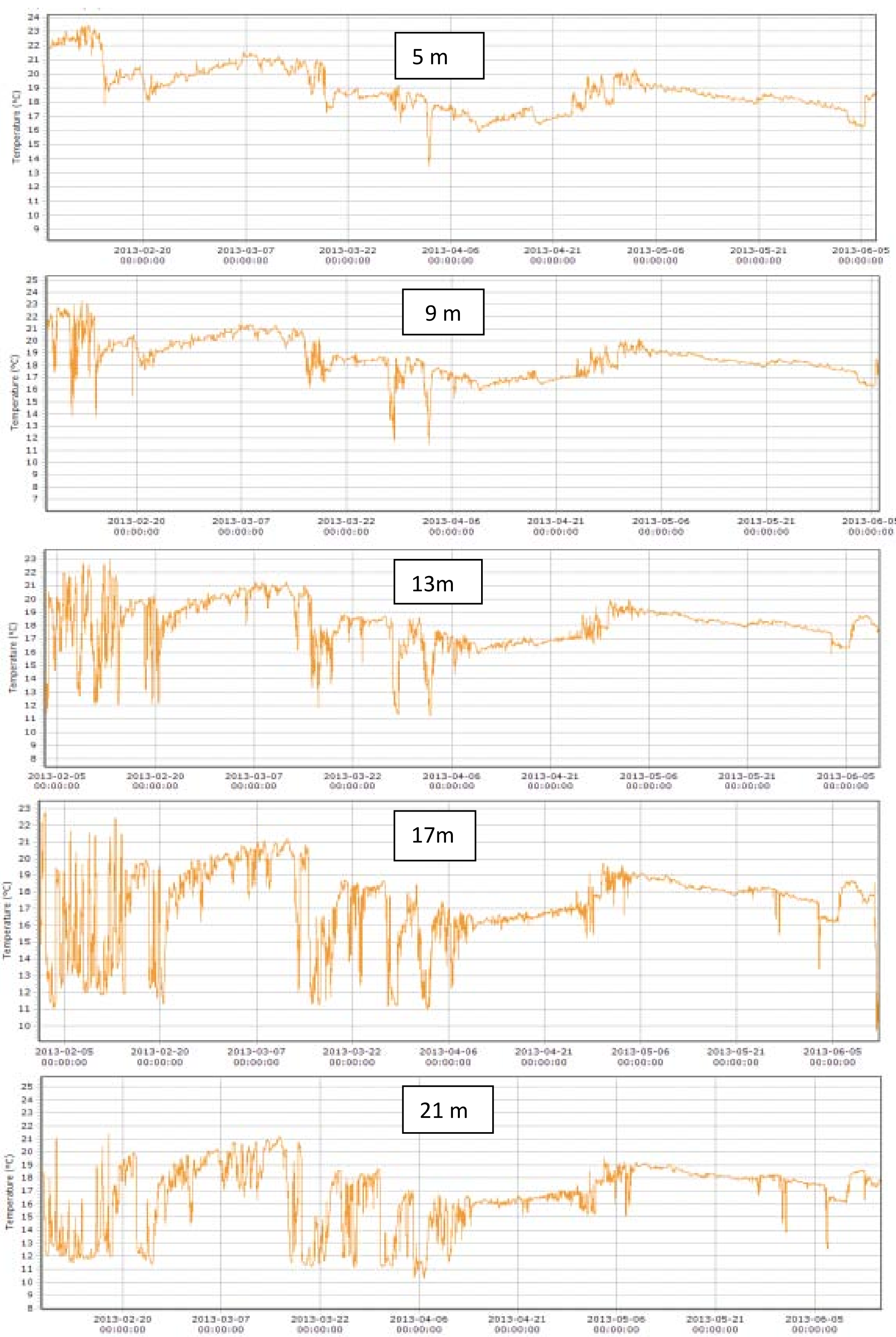


Figure 21. Temperature record (31 January 2013– 10 June 2013) as recorded by the Vemco temperature miniloggers in Algoa 1. Temperature was recorded once every 6 minutes.

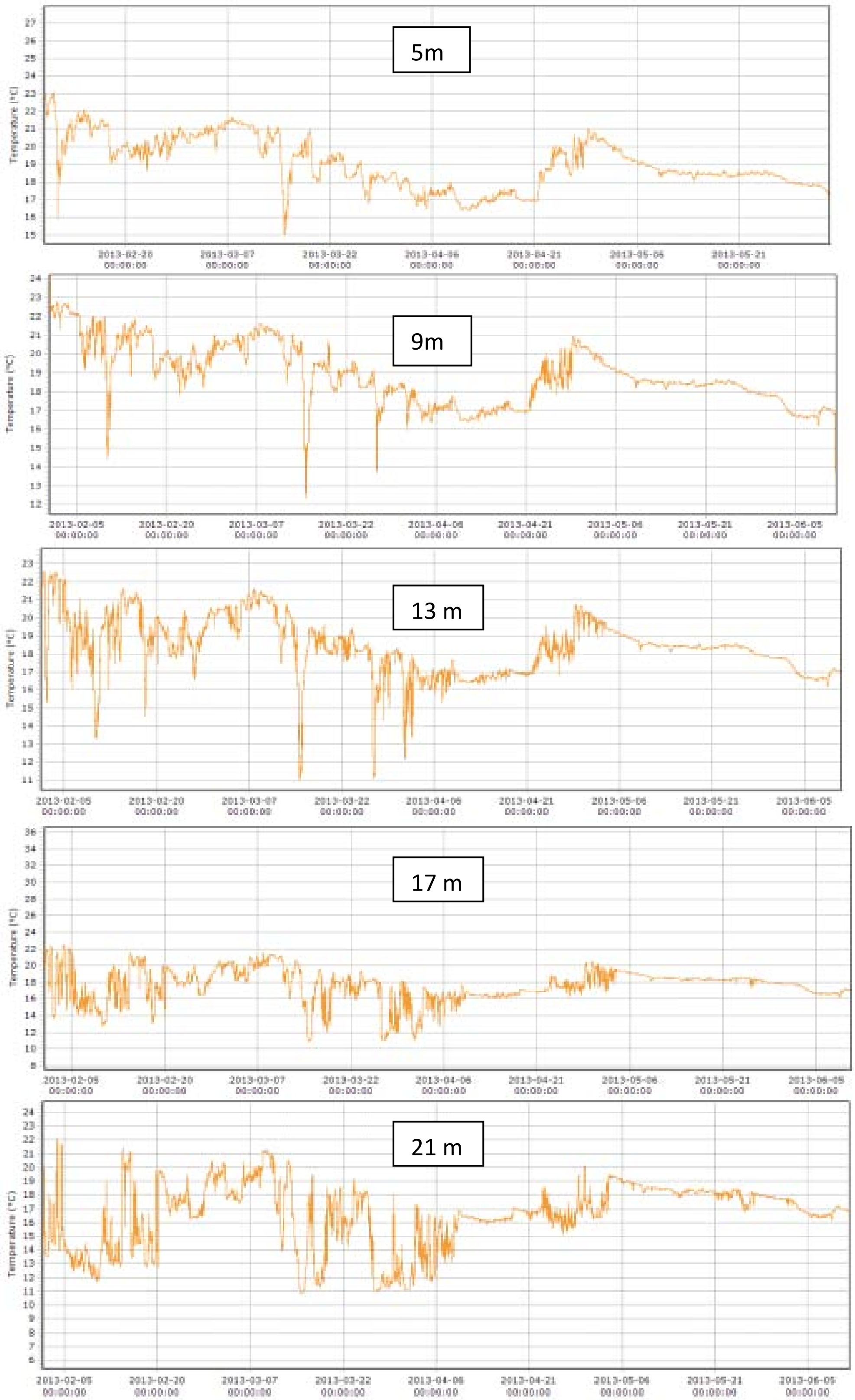


Figure 22. Temperature record (31 January 2013– 10 June 2013) as recorded by the Vemco temperature miniloggers in Algoa 5. Temperature was recorded once every 6 minutes.

5.3.3 Currents and waves

5.3.3.1 Algoa 1

During the four month monitoring period, on average, currents on Algoa 1 were strongest and flowed in a predominately southerly (SE-SW) direction. This indicates that, most of the time, during this seasonal period (February-June) the currents should convey wastes from fish cages out of the bay and away from the popular bathing and surfing beaches, but towards an identified dive sites and squid fishing ground (see § 6.2.1and 6.3.2.) Currents were, however, recorded as flowing in all directions at times, and relatively strong flows (>15 cm/sec) were recorded flowing towards the North and North West (i.e. into the Bay and towards bathing beaches) at nearly all depths. Current flows in these directions (N- NW) were recorded about 20-30 % (cumulative frequency) of the time. Westerly flowing currents, towards nearby scuba diving sites, (see § 6.2.3) and easterly flowing currents were rare, and occurred approximately 6 % of the time.

Current velocities in the lower water column (deeper than 15m) at Algoa 1 exceeded 10 cm $.s^{-1}$ for 34 - 43% of the time. Currents shallower than 10 m exceeded 10 $cm.s^{-1}$ for more than 50% of the time and reached a maximum velocity of 62 $cm.s^{-1}$. This suggests that currents at Algoa 1 (during the February – June period) are suitable for the adequate dispersion of wastes that should not lead to excessive organic build-up under the cages about one third to one half of the time. This is substantially better, from a waste dispersal perspective, than the current velocities recorded at either Algoa 2 or Algoa 5. Ongoing monitoring at this site will describe the current bearings and velocities for the remainder of the year (until December 2013).

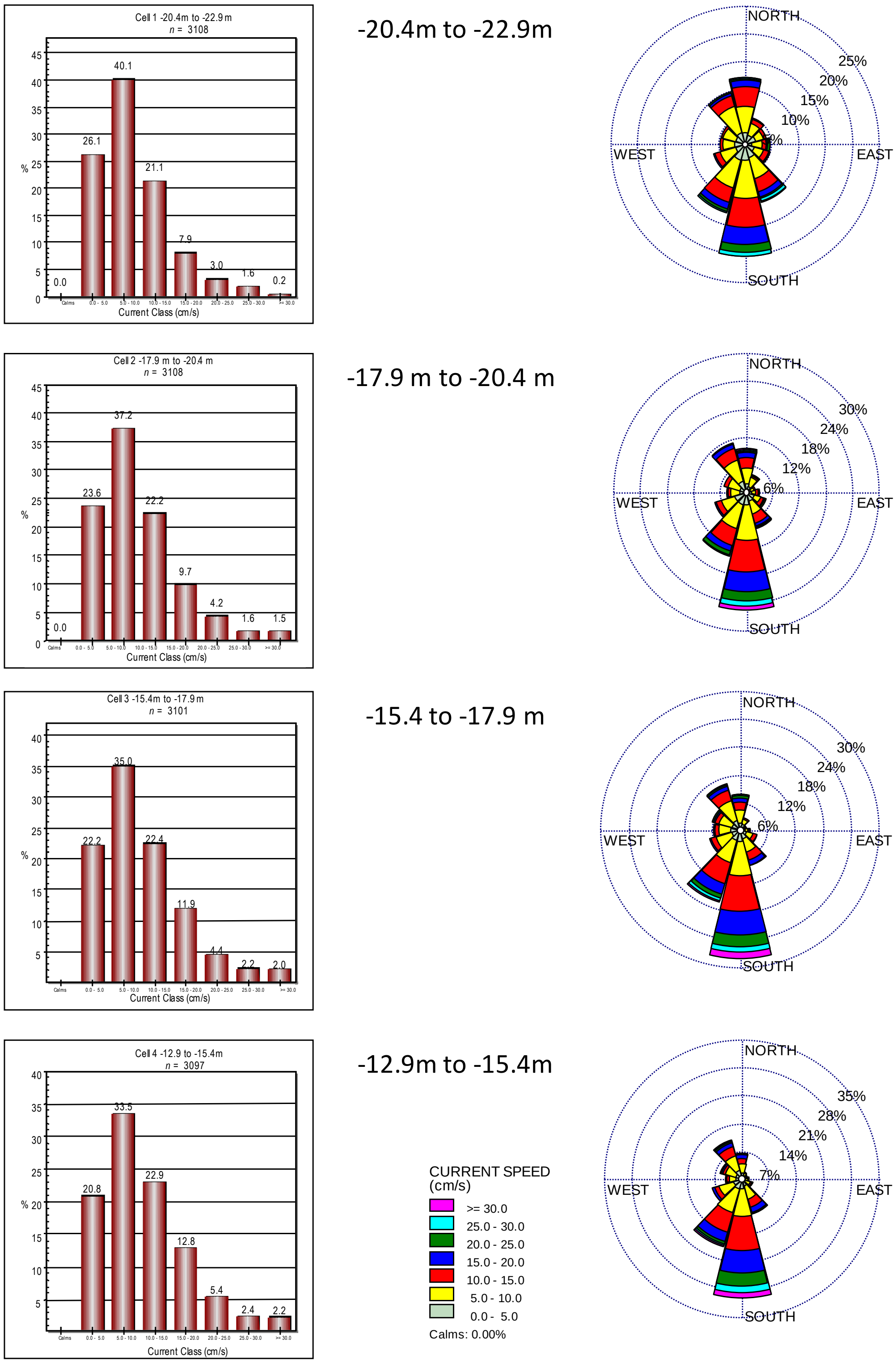


Figure 23. **Current roses showing the directions and speeds of currents, and the associated frequencies of different velocities of currents measured at Algoa 1 during 2 February – 11 June 2013 within different depth strata.**

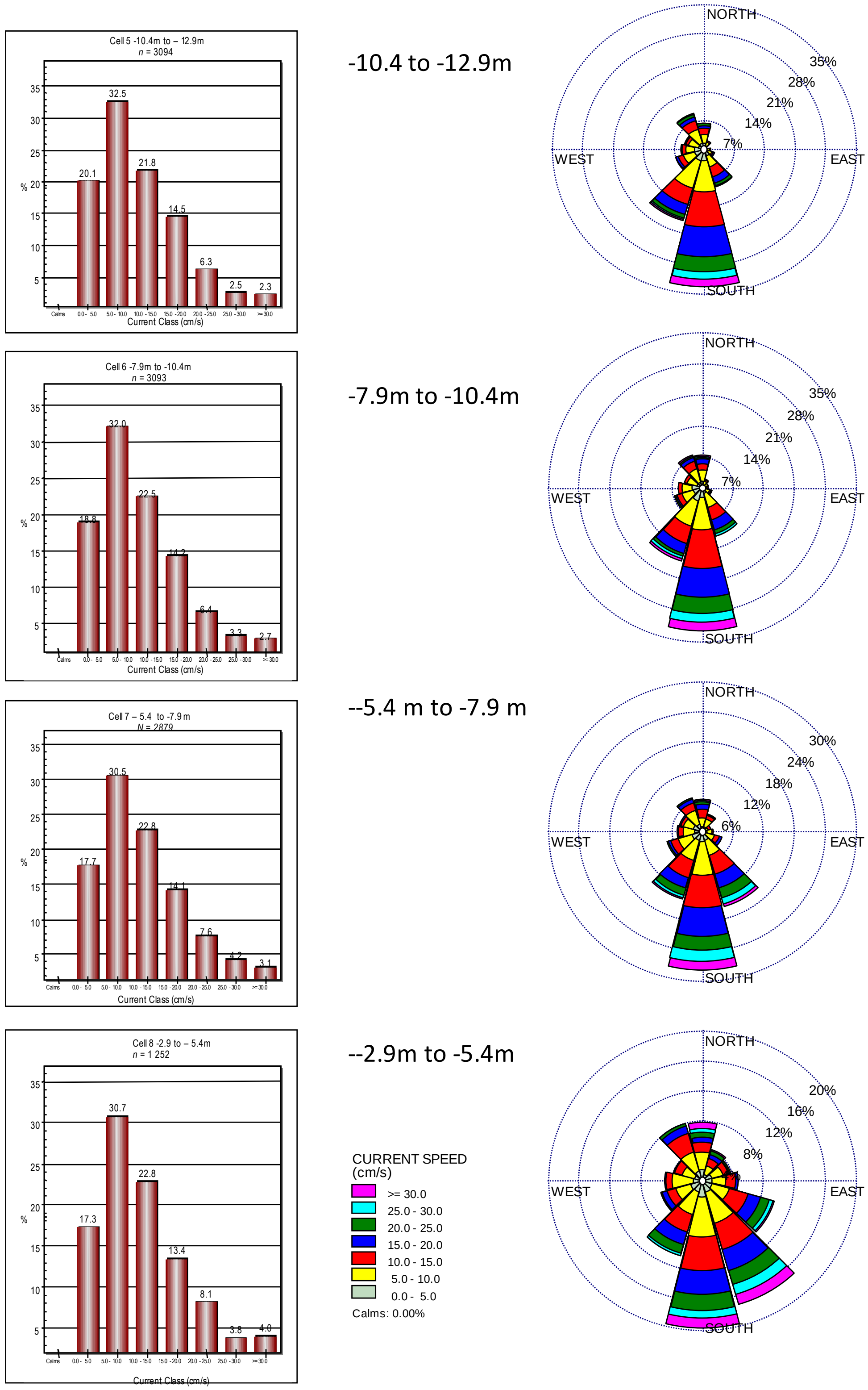


Figure 24 contd. Current roses showing the directions and speeds of currents, and the associated frequencies of different velocities of currents measured at Algoa 1 during 2 February – 11 June 2013 within different depth strata.

5.3.3.2 Algoa 2

Currents measured at Algoa 2 over an 11-month period flowed in south-westerly directions for approximately 30 % of the time at depths from the bottom (24 m) to 6.5 m below the surface (Figure 25). When not flowing in a south-westerly direction, bottom and mid-water currents moved with similar frequency in ubiquitous directions. Contrastingly, dominant flow of surface currents from depths of 6.5 m upwards, moved in south-westerly and north-easterly directions in similar proportions (Figure 25). These surface currents are likely to be influenced by wind in addition to physical oceanographic factors.

Current velocities rarely exceeded 30 $cm.S^{-1}$ at all levels in the water column. Highest velocities were generally associated with currents flowing in the two most common directions (i.e. south-west and north-easterly flowing currents), and there was a general trend of decreasing current velocity with depth. Throughout the water column, most velocities (≈ 70 % of the time) ranged between 0 – 10 $cm.S^{-1}$, and for approximately 90 % of the time never exceeded 15 $cm.S^{-1}$.

Significant wave height, defined as the average of the highest $^{1}/_{3}$ of waves for a given period (in this case 8 min per every hour), approximated 1 m for 60 % of the time monitored, and was less than 2 m for 95 % of the time (Figure 26). Significant wave heights of 3.5 m or higher were experienced 1 % of the time. This equates to approximately 3 days (72.6 hr). The maximum significant wave height recorded was 5 m with a wave period of 13 seconds. Wave period approximated one wave every 12 seconds 41 % of the time, and generally ranged from 9 to 15 seconds (90 % of the time) (Figure 26).

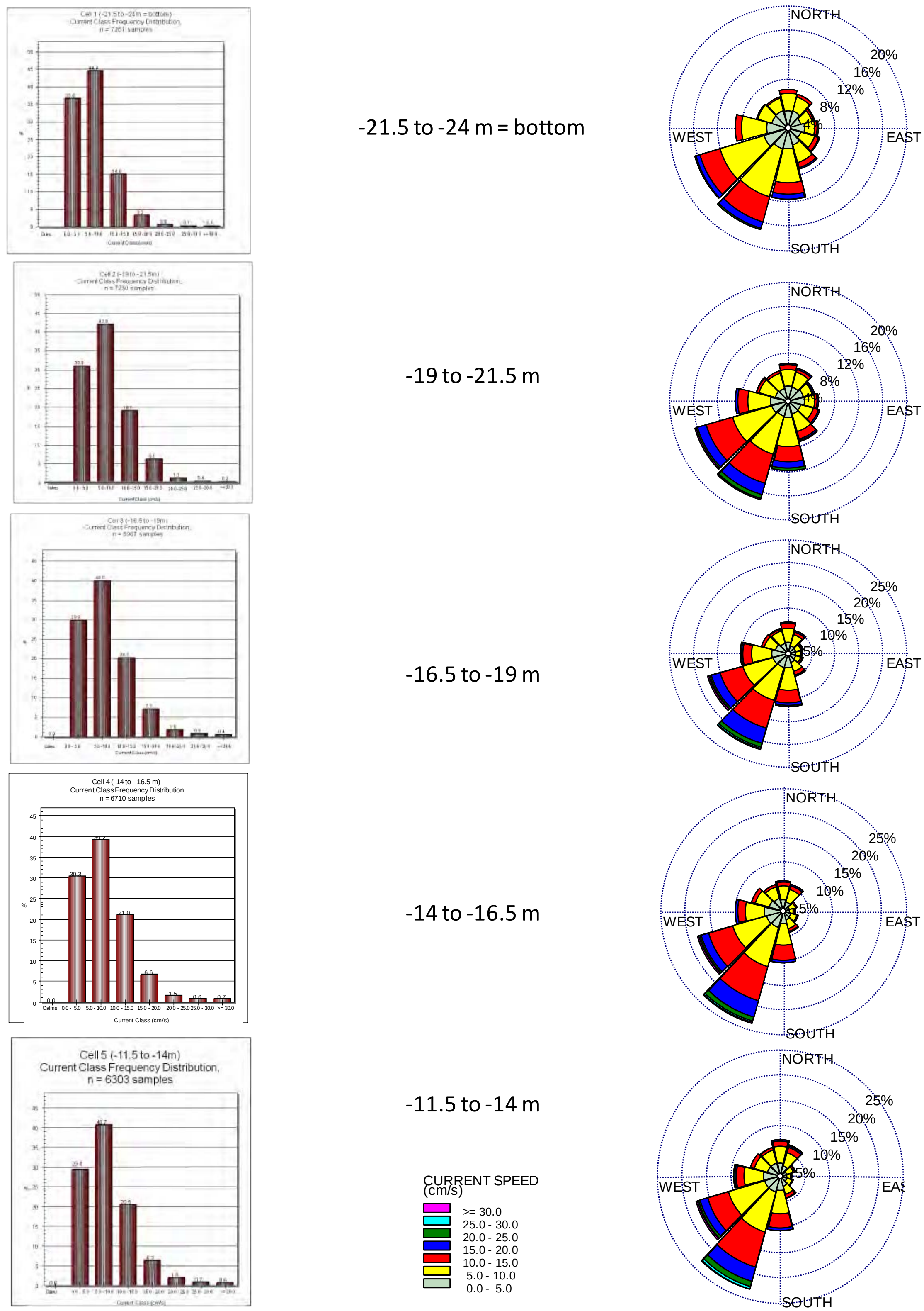
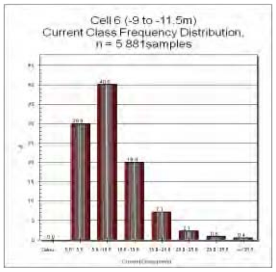
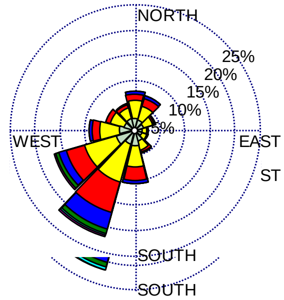
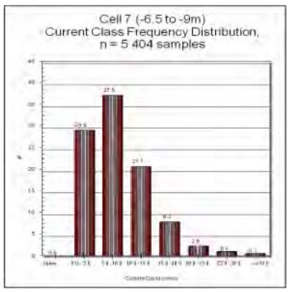


Figure 25. **Current roses showing the directions and speeds of currents, and the associated frequencies of different velocities of currents measured at Algoa 2 during February – November 2012 within different depth strata.**

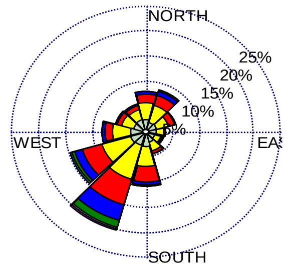


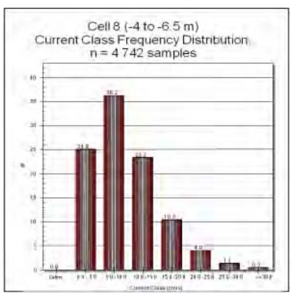
-9 to -11.5 m



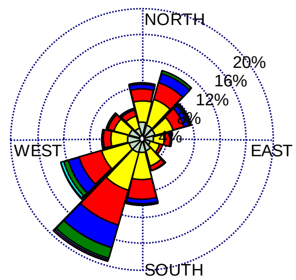


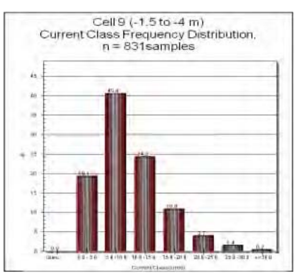
-6.5 to -9 m



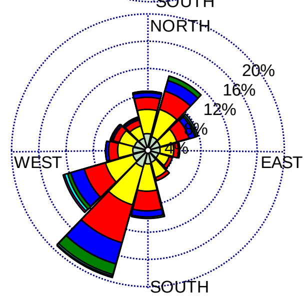


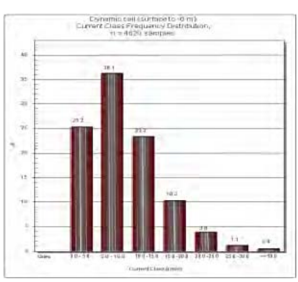
-4 to -6.5 m



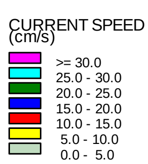


-1.5 to -4 m





Dynamic cell surface to-6 m



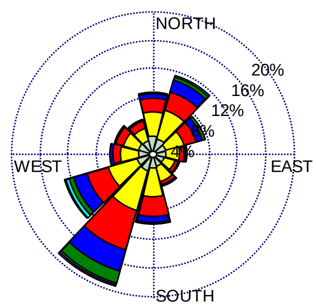
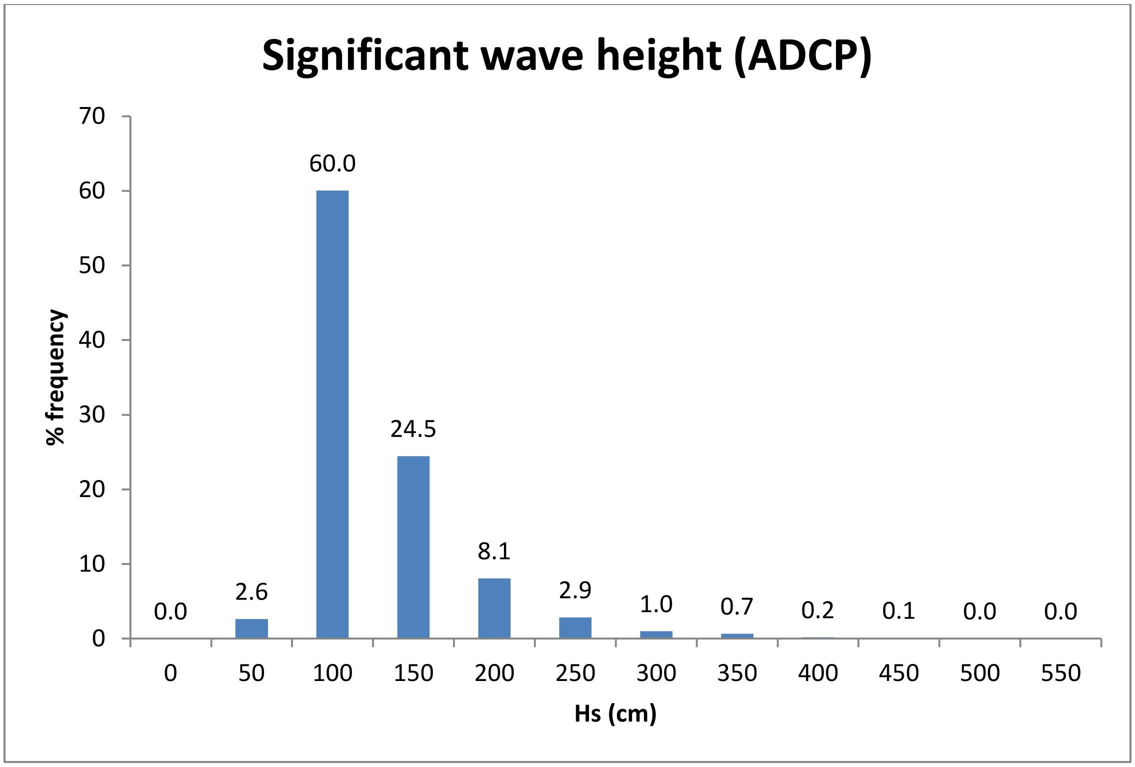


Figure 21 contd. Current roses showing the directions and speeds of currents, and the associated frequencies of different velocities of currents measured at Algoa 2 during February- November 2012 within different depth strata.



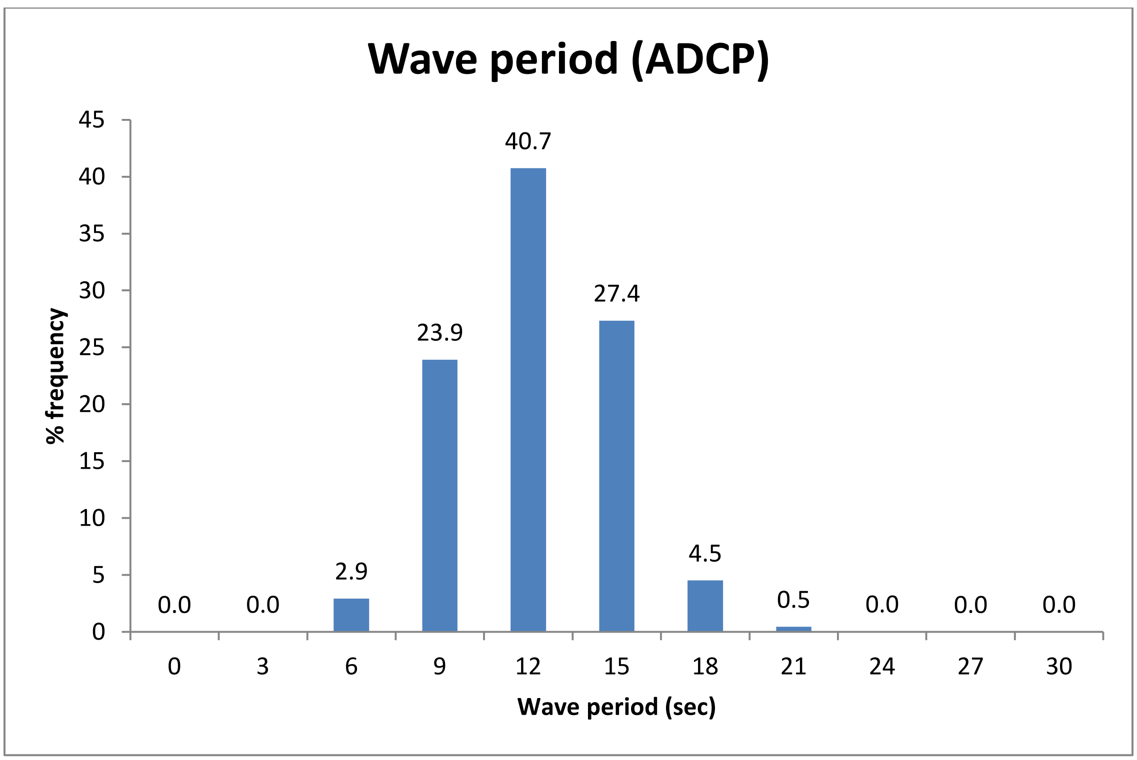


Figure 26. **Significant wave height (top) and wave period (bottom) frequency distributions as recorded by ADCP moored in Algoa 2 for the period 20 February 2012 – 19 December 2012. The average significant wave height from an 8 minute sampling period every hour was recorded (n = 7 261 records). During this period, maximum significant wave height was 5m (13 sec period).**

5.3.3.3 Algoa 5

Data on waves and currents in the vicinity of Algoa 5 are now available for the period 31 January- 10 June 2013 (Figure 27). Through most of the water column, currents flowed predominately towards the west, with a significant east flowing component (i.e. coast parallel), except the near the bottom where predominant current directions were northwest-southeast (slightly more to the NW). Closer to the surface (shallower than 11.5m) currents also flowed shore parallel, but for approximately equal periods in both directions. As with Algoa 2, current strengths decreased with depth through the water column, but were somewhat greater on average than those recorded for Algoa 2 and less than those recorded for Algoa 1. Near the bottom (16-25 m), currents were less than 10 cm/sec for 70-80% of the time, whilst near surface currents (<11.5m) were greater than 10cm/sec for 40-45% of the time and fairly regularly exceeded 30 cm/sec (maximum = 51 cm/sec).

Significant wave heights were anticipated to be greatest (average & maximum) on Algoa 5 as it is more exposed to the predominant south-westerly swell and lies furthest east and is thereby afforded less protection by the lee of Cape Recife. Monitoring over the February 2013 to June 2013 period does suggest that this is the case (bearing in mind that the peak winter storms are yet to come), with average significant wave heights exceeding 1.5 m approximately 20 % of the time, and a maximum significant wave height of 3.4 m (11 second period) recorded (Figure 29). On Algoa 2, over the same months during 2012, the maximum recorded significant wave height was similar (3.4 m), but significant wave height only exceeded 1.5 m for ~6 % of the time. This indicates that in terms of exposure to waves, Algoa 5 is the least suitable potential ADZ for the floating circular cage types most likely to be used in South Africa’s pioneering sea cage industry.

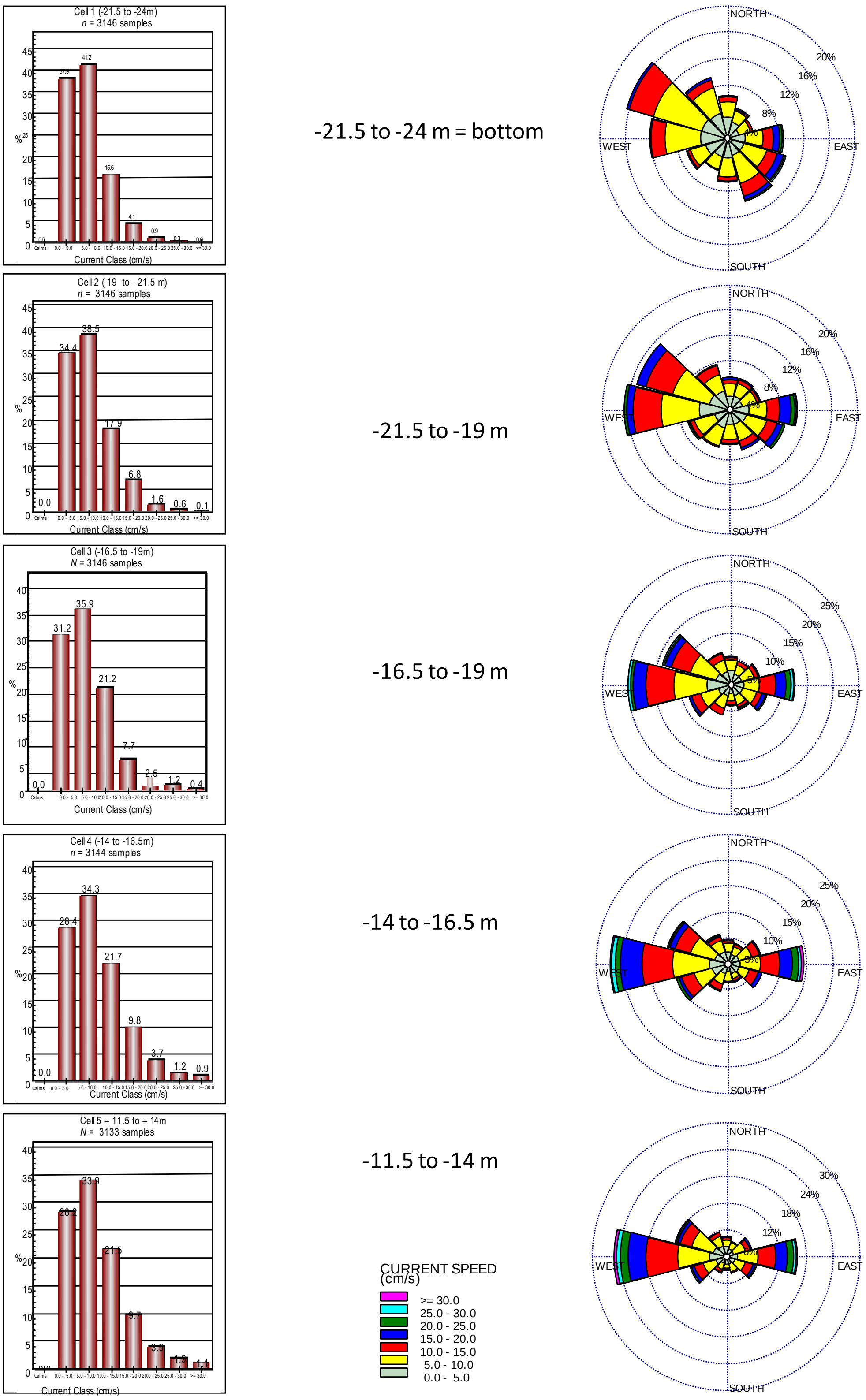


Figure 27. Current roses showing the directions and speeds of currents, and the associated frequencies of different velocities of currents measured at Algoa 5 during the period 31 January– 11 June 2013 within different depth strata.

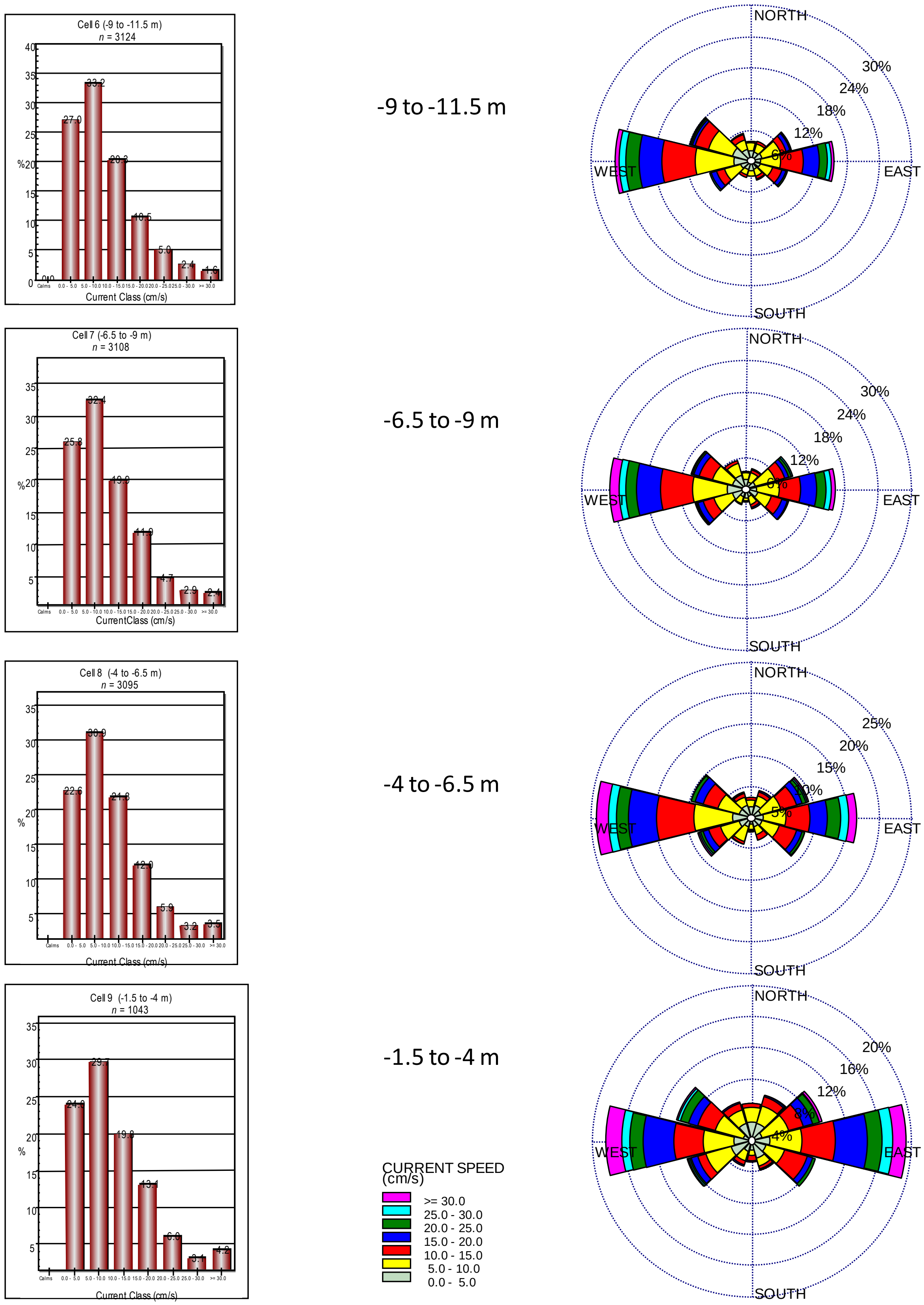


Figure 28 contd. Current roses showing the directions and speeds of currents, and the associated frequencies of different velocities of currents measured at Algoa 5 during the period 31 January– 11 June 2013 within different depth strata.

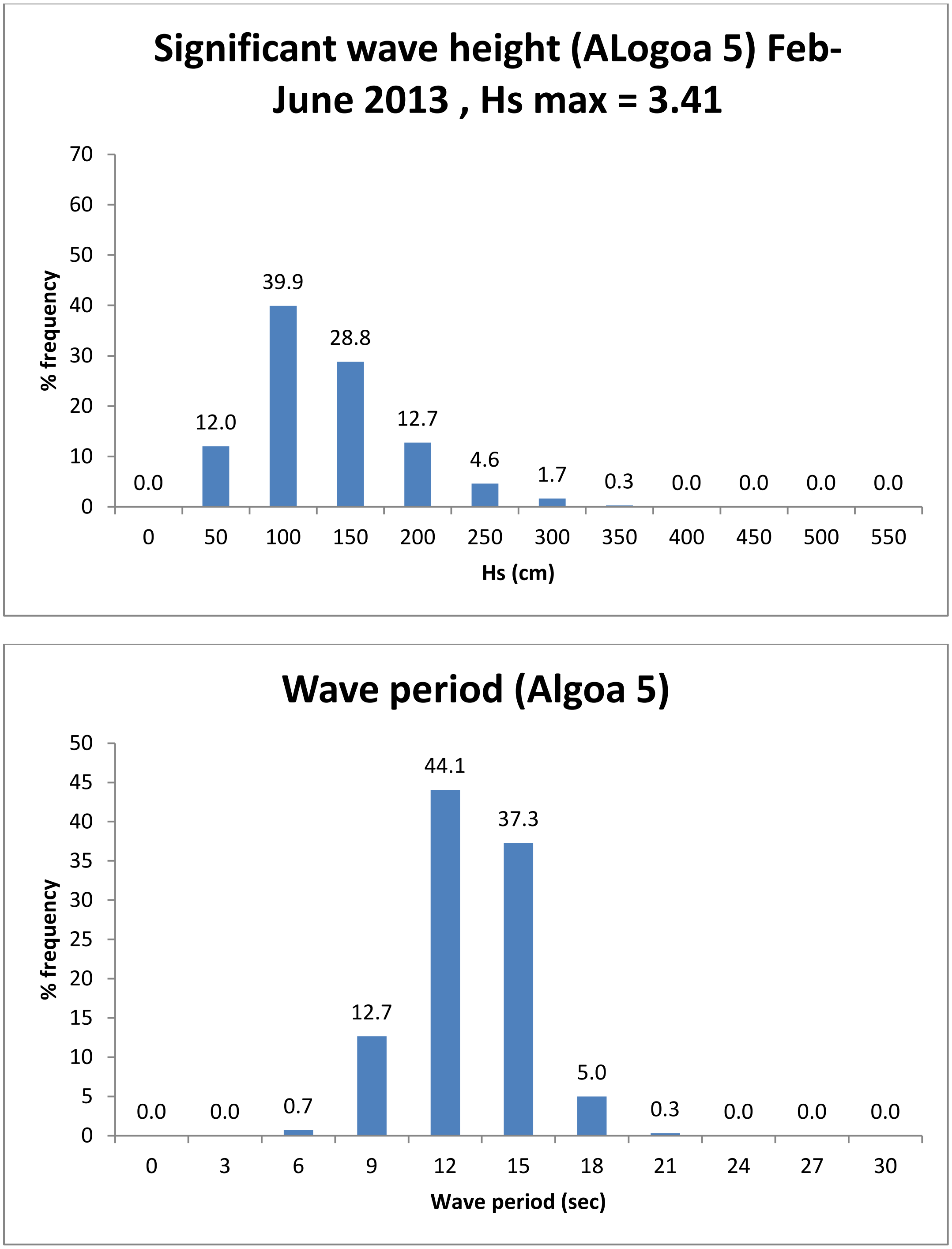


Figure 29. Significant wave height (top) and wave period (bottom) frequency distributions as recorded by ADCP moored in Algoa 5 for the period 31 January 2013 – 11 June 2013. The average significant wave height from an 8 minute sampling period every hour was recorded (n = 3 147 records). During this period, maximum significant wave height was 3.41 m.

5.3.4 Marine organisms

Best available knowledge of the presence of marine organisms at Algoa 1 and Algoa 5 is restricted to general distribution records of species occurring in Algoa Bay and of sightings made whilst doing *in situ* surveys of each potential ADZ (Table 6).

Table 6. Species confirmed to occur within the bounds of each proposed ADZ during fieldwork

Algoa 1		**Algoa 5**	
Thunnus albacares	Yellowfin tuna	*Sphyrna* spp.	Hammerhead shark
Katsuwonus pelamis	Skipjack	*Spheniscus demersus*	African penguin
		Sterna hirundo	Common tern
		Morus capensis	Cape gannet
		Delphinus delphinus	Common dolphin

Site specific observations are therefore extremely limited due to the short amounts of time spent within each potential ADZ. It is likely that most pelagic and coastal species found in Algoa Bay occur within the ADZs at least some of the time. From the limited data available and with considerations on the environmental disturbance regimes of each of the two proposed ADZs, it is likely that more species are frequent Algoa 5 for longer periods of time due to its isolation and proximity to St Croix Island.

6 Affected User Groups

6.1 Methodology

Marine user groups can be broadly defined as recreational or commercial. Recreational marine activities that most likely to be affected by fish cage farming in the two potential ADZs include recreational boat (skiboat) fishing, recreational scuba diving and yacht sailing. Other recreational marine activities such as open water swimming, surf skiing, kayaking, wind and kite surfing that may be affected are also considered. Data on the spatial extent of the potentially affected recreational marine activities identified above were sourced from literature (guide books etc) and from comment and data made available by interested and affected parties (IAPs) during the public participation phases. The degree of spatial overlap of the identified activities with the potential ADZs is then assessed and qualified.

A number of commercial marine activities take place within the broader Algoa Bay region; these include shipping, marine ecotourism, and a range of commercial fisheries. Mining and gas exploration may also take place within Algoa Bay in the future. Shipping lanes and anchorage areas were mapped from navigational charts and excluded during the SEA phase. Marine ecotourism (whale and shark watching) concession areas were obtained from the Department of Environmental Affairs (DEA) and similarly excluded during the SEA Phase. The economic assessment report deals with potential impacts on these industries. Commercial fisheries that operate in the Algoa Bay area are described; and spatially referenced catch and effort data for these fisheries were obtained from the Department of Agriculture, Forestry and Fisheries (DAFF) and mapped using GIS.

These descriptions of the potentially affected marine user groups are largely qualitative, an assessment of the potential socio-economic impacts of ADZ declaration on these activities is provided in the economic specialist report.

6.2 Recreational user groups

6.2.1 Non-motorised water sports

Water sports such as surfing, kite boarding, surf-ski paddling, stand up paddle boarding, open water swimming and sea kayaking have seen significant growth in Nelson Mandela Bay over recent years. Competitions like the Ironman ultra-triathlon events and the Ocean Racing Series both use Hobie Beach as a venue (Nelson Madela Bay Metro Municipality, Afri-coast Engineers 2012). In addition to the social recreational value of these activities, these water sports and major events are economically impotent to the region.

The closest point to land of Algoa 1 is over 2 km and the popular swimming and water sport beaches off Summerstrand are approximately 3.5 km distant. Algoa 5 is more than 3 km offshore and remote (~30 km) from the metropole. Mariculture development of these two sites is unlikely to affect non - motorized recreational marine users in terms of sea space, despite the popularity of these activities in the Algoa Bay area. These activities mostly take place within 1km of the coast as shown in the proposed beach aquatic safety zone (Figure 30).

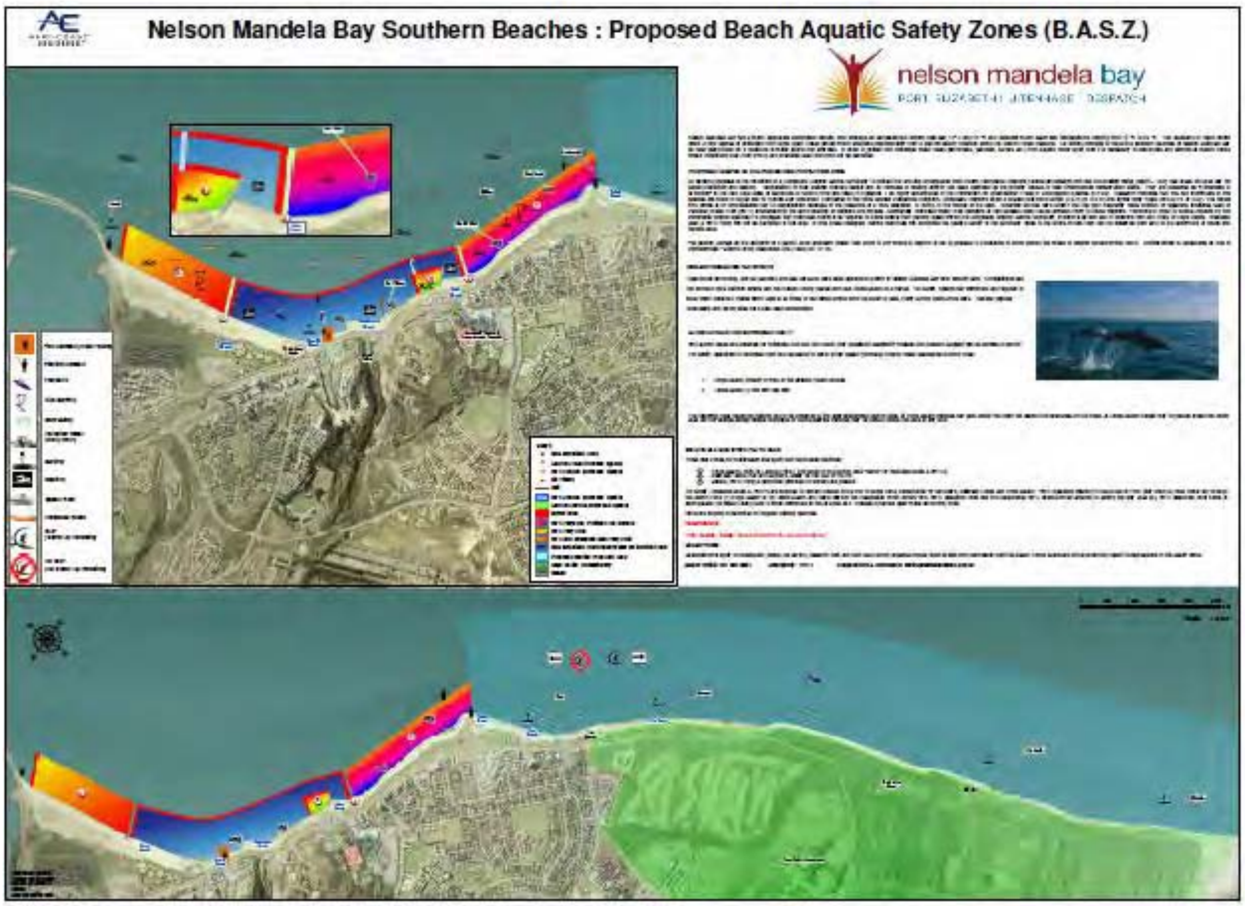


Figure 30. Proposed Beach aquatic safety zones and marine recreational areas for the Summerstrand beaches (adjacent to Algoa 1).

There has been concern expressed by IAPs that fish farm development at Algoa 1 could affect/pose a risk to these user groups. There currently is a risk of shark bite to marine water sports people anywhere along South Africa's coastline (the probability of a shark bite incident increases with both the density of sharks and the density of water users, and the probability of an incident occurring in a popular water sports area such as Port Elizabeth is relatively higher than in remote areas with few water users). It is probable that marine predators, such as sharks, will be attracted to finfish cages that may appear to be a source of food. Indeed monitoring of fish cage trials previously undertaken in Algoa Bay did record increases in fish diversity and abundance under cages stocked with fish and an incident where two ragged tooth sharks successfully entered a fish cage (Nel and Winter 2008). Despite this, these authors stated that the fish cages "do not seem to present a great attraction for cetaceans, pinnipeds or sharks".

Nonetheless, sandbar sharks in Hawaii exhibit site fidelity in the vicinity of fish cages, whilst tiger sharks although transient, may repeatedly visit fish cages (Papastamatiou *et al* 2010). White sharks have been documented entering fish cages to prey on captured stock (Galaz & De Maddalena 2004). An Australian study has shown changes (increases in residency time) in white shark behaviour where a food reward was realized from shark cage diving operations at the North Neptune Islands, but this effect was localized (Bruce & Bradford 2011). In contrast, a study in False Bay South Africa found little evidence of conditioning of white sharks around Seal Island in response to low level (three operators) cage diving operations (operating permit conditions and chumming practices did however, differ between the two countries) (LaRoche et al 2007).

Figure 31. White shark that entered tuna cage off Australia to feed (source: http://yalikedags.southernfriedscience.com/?p=375)

It is clear that fish cages may provide a food reward to large sharks (that are potentially dangerous to humans) and in so doing alter their distributional and behavioural patterns. Certainly anti-predator nets are specifically designed to exclude large predators from entering the fish cages (and getting a food reward) and these are routinely used by fish farm operators as such predators are clearly attracted to the cages in the first place. Effective anti-predator nets lower the likelihood of sharks receiving a food reward from within a fish cage, but wild (and escaped fish) are known to concentrate around the outside of fish cage infrastructure that operate as Fish Attractant Devices (FADs). These fish, or uneaten food sinking out of the cages, may serve to be a suitable and regular food reward to alter behaviour of wild marine predators.

Marine predators are thought to locate food sources by following cues (olfactory, audio, and electrical) up the concentration gradient. Theoretically therefore, a perceived food source (e.g. fin fish farm) 2 km offshore should attract predators away from the coastal areas utilized by water sports people. This may occur providing the food cues are detectable at such a distance (this is unknown and dependent on prevailing oceanographic conditions and species specific physiology). This does not imply that risk of a shark bite incident will lower in the inshore recreational areas; indeed, should the fish cages increase residency times of large sharks in the broader region (e.g. western Algoa Bay), the occurrence of sharks may well increase at the bathing beaches. It is clear that there is a high degree of uncertainty as to possible changes in the risk of shark bite incident to non-motorized marine water users should fish farms be developed in Algoa Bay (Alison Kock, City of Cape Town Shark spotters programme, personal communication). This is due a lack of data and understanding of the site and species specific and indeed individual shark behavioural responses to such a development. Recent research suggests that the inshore areas of Algoa bay are an important nursery area for white sharks (Dicken and Booth 2013). The only conceivable way to address this is with extensive monitoring of shark movement patterns both at the ADZ sites, and at the popular bathing beaches inshore, before and after the stocking of cages. Baseline data would have to extend for at least 12 months to cover seasonal variation in shark movement patterns (preferably longer to include inter-annual variation). Acoustic tracking of white sharks and other large shark species (e.g. bull sharks) is currently under way both within Algoa Bay and elsewhere off the SA coast (including research currently underway by researchers at Bayworld funded by the Nelson Mandela Metropole). Continuation and expanding of these research programmes to include acoustic receivers at the proposed ADZ sites and the popular bathing beaches is a potential monitoring method that could be utilized. The decision making authorities should however, also consider the ethical issue of monitoring large shark movements in response to a fish farm development when there is a high degree of uncertainty regarding the threat to human bather safety associated with the development.

6.2.2 Yachting

Algoa Bay Yacht Club (ABYC) was established approximately 54 years ago. The club now includes a large clubhouse and marina with ~130 yachts moored within the Port of Port Elizabeth. ABYC has been host to many national and international sailing events including the long running Algoa Bay week regatta (http://abyc.co.za). Competitive sailing and social Wednesday evening sailing takes place every week throughout the sailing season. During the scoping phase of this project, the ABYC requested a meeting with the consultants to raise concerns about the proposed mariculture sites (meeting held on the 12 May 2012). During this meeting it was pointed out that Algoa 1 was right in the main sailing area (at this stage Algoa 5 was not yet a potential site). The ABYC was requested to provide a map of the main sailing areas (Figure 32). Clearly yacht sailing within Algoa Bay takes place across a large area between

Cape Recife and the Sundays River mouth and overlaps completely with Algoa 1 and with more than 50% of Algoa 5. Fish cage farming could pose a navigational hazard to yachts and race courses may have to be adjusted to avoid fish farm infrastructure. To minimize this hazard, all fish cage infrastructure would have to be clearly marked on charts and by navigational markers as required by the South African Maritime Safety Authority. It is acknowledged that yachting may be affected by ADZ development within Algoa Bay, however, the relatively large area utilized by yachts within Algoa Bay and relatively small proposed ADZ areas, means that these activities should not be mutually exclusive.

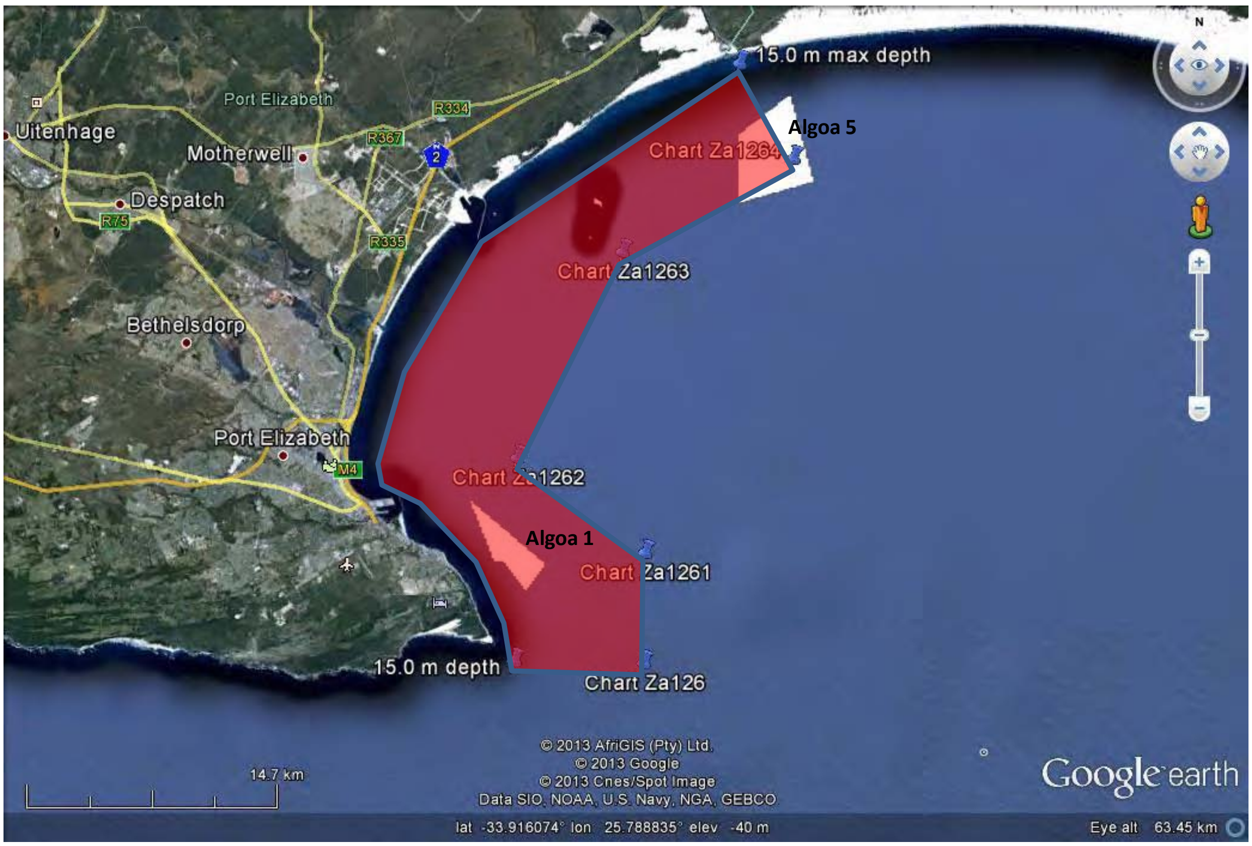


Figure 32. Regular yacht sailing area within Algoa Bay (source: Arthur Rump, ABYC).

6.2.3 Scuba diving

Recreational scuba diving is a popular activity within Algoa bay and at least four dive shops located within Port Elizabeth that supply training and equipment. Recreational scuba divers registered as IAPs during the project scoping and supplied locations of 18 popular diving spots (mostly reefs) in the Algoa Bay area (Figure 33). None of these 18 sites overlap with a proposed ADZ (one of the site selection criteria in the Strategic Environmental Assessment excluded known reef areas), and as such loss of access to any of these dive sites by recreational scuba divers will not occur. Five of these sites are however, 500-1000m from the border of Algoa 1. Modelling of waste (nutrient and chemical) dispersal from a proposed fish farm at Mossel Bay (an area with similar current speeds to Algoa Bay) has been conducted (Mead et al 2009). Settable waste was expected to sink to the sea floor within 200 m of the cages (Mead et al 2009). This study did indicate that elevated levels of dissolved nutrients would likely occur up to 2 km from the fish cages, with nitrate (ammonia is typically excreted by fish, this is broken down into nitrites and nitrates) levels expected to be above background concentrations 8-12km from the site under certain oceanographic conditions (Mead et al 2009). It is not known if a similar settlement rate of particulate or dispersal of dissolved waste will occur from fish cages within the Algoa ADZs, nor the risk of negative impacts (smothering, nuisance algal growth) on the reefs close to the Algoa 1 ADZ. However, given that the potential scale of fish farm development is substantially greater than that assessed in the Mossel Bay study; and the currents are of similar velocity; it is reasonable to conclude that the footprint will be at least as large. Should any therapeutic or antifouling chemicals used in fish cage culture operations reach the reefs at concentrations that are still effective (the Mead et al 2009 study assumed a similar dispersal rate and distance as for dissolved nutrients), this would probably cause further deleterious impacts on diving reef communities.

Figure 33. **Popular recreational SCUBA dive sites within Algoa Bay relative to the location of the two proposed ADZ sites. (Dive site positions provided by Prodive Port Elizabeth)**

6.2.4 Recreational skiboat linefishing

A recreational ski boat fishing club, (Port Elizabeth Deep Sea Angling Club) operates out of PE harbour and the Noordhoek skiboat club has a slipway some 6 km west of Cape Recife. The Swartkops and Sundays estuaries are also used by a few recreational fishing vessels to access the sea, but these are not legally registered launch sites. Recreational boat fishing takes place throughout Algoa bay. Chalmers (2012) estimated annual recreational ski boat fishing effort in the Algoa Bay at 2 118 boat days. Most vessels carried an average of ~4 crew and a resultant 61 074 angler hours of recreational linefishing effort takes place annually with an estimated retained catch of ~21 000 fish from 26 different species (Chalmers 2012). Geelbek, santer, and silver kob dominated the catches in the western sector of the bay (Chalmers 2012).

Should the ADZs be declared “no go” areas this would result in a loss of available fishing ground to the recreational boat fishery. Both of the proposed ADZs straddle areas reported by Chalmers (2012) as having both high and relatively low recreational ski boat fishing effort (Figure 34). However most of the skiboat fishing effort does appear to take place inshore of the proposed ADZs; and indeed bathymetry surveys have indicated little (Algoa 5) or no reef habitat (Algoa 1) around which targeted line fish (and fishers) aggregate (see description of affected environment report). Recreational boat line-fishers would therefore appear to be little affected by loss of fishing ground should the ADZs be declared off limits. Navigational impacts are however anticipated as fishing vessel skippers may have to alter their desired course to and from the fishing grounds to avoid fish farm infrastructure, particularly in the case of Algoa 1 which is situated between popular fishing areas and the port of PE entrance (Figure 34).

The significance of potential impacts relating to disease and parasite transmission and genetic contamination of wild fish stocks and fisheries are dealt with in the Assessment of Impacts section.

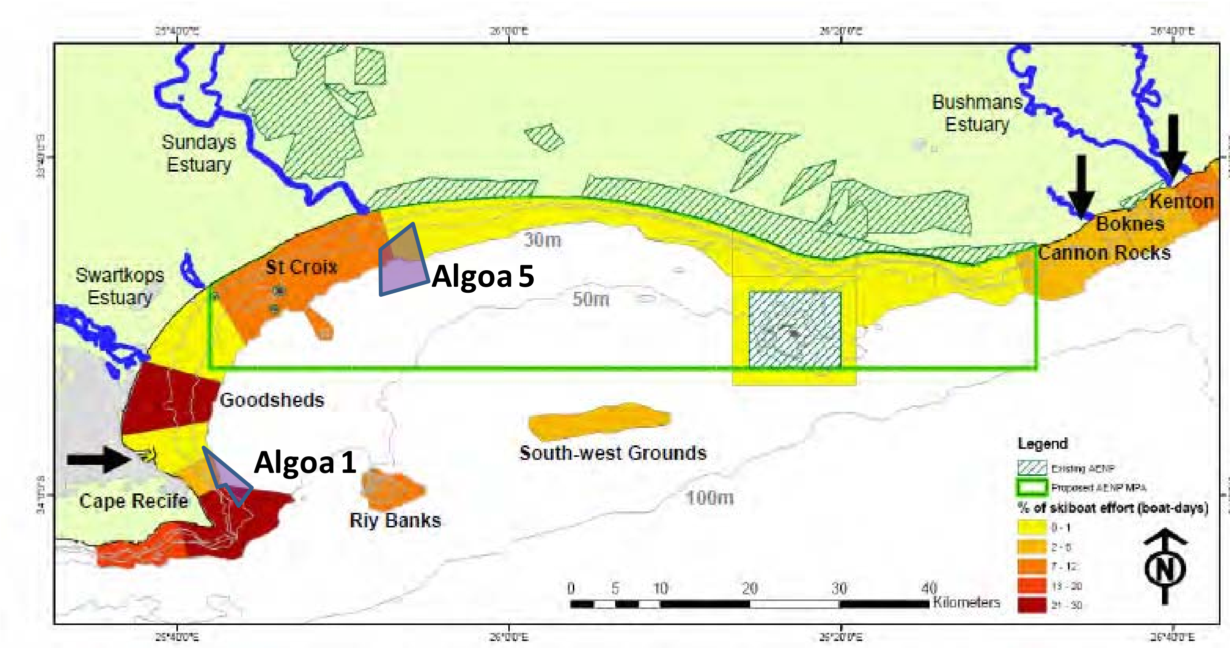


Figure 34. **Estimated distribution of recreational boat line fishing effort throughout Algoa Bay (Source: Chalmers 2012) and position of the two proposed ADZ sites (Algoa 1 and 5).**

6.3 Commercial user groups

Commercial shipping, mining (including oil and gas) and marine ecotourism are dealt with in the economic specialist study.

Four commercial fisheries operate within Algoa bay and may potentially be affected by the declaration of ADZs namely: small pelagic, traditional linefish, squid and shark longline. A description of each of these fisheries sourced from Turpie et al (2012) and area of operation relative to the proposed ADZs is provided below.

6.3.1 Small pelagics

The small pelagic purse-seine fishery targets shoals of small pelagic fish that occur near the surface at night. Once the shoal is located, a net is set around it in a large circle, which hangs from the surface like a circular curtain, and then the bottom of the net is drawn together using a footrope. Fish are pumped from the net into the hold of the boat, where they are kept chilled before being transferred directly into the onshore factory for processing. The boats tend to fish overnight, landing their catches in the early mornings.

The small pelagic fishery in South Africa originated in St Helena Bay on the west coast, originally targeting sardine (pilchard) *Sardinops sagax* and horse mackerel *Trachurus trachurus capensis* (Sauer *et al.* 2003a). These resources declined after 1962 due to overfishing, and mesh sizes were reduced to target the smaller anchovy *Engraulis encrasicolus*, which became dominant in catches for two decades. Sardines have subsequently recovered to a large extent. The fishery also exploits the red-eye round herring *Etrumeus whiteheadi*; the chub mackerel *Scomber japonicas* is a valuable by-catch species. The fishery is managed through quota allocations in the form of TACs for adult sardine, for anchovy and for sardine by-catch. Pilchard is the only targeted species in Algoa Bay, with some incidental by-catch of horse mackerel and chub mackerel, as well as maasbanker.

Concern for declining populations of penguins (and to some degree gannets) on nesting Islands in Algoa Bay led to two experimental area closures for the pelagic fishing industry in recent years. Namely a 20 km radius around St Croix Island and a 5 km radius closure around the Rij Banks was implemented in January 2009 for a three year period (Pichegru *et al.* 2010, 2011). This restriction has now been lifted, but a similar size (10.799 NM radius) pelagic fishing exclusion area is now in place around Bird Island (2012 permit conditions DAFF).

The small pelagics purse-seine fishery nationally involves 95 rights holders and 101 vessels. While the fishery is still concentrated on the west coast, it has spread to the south coast, centered around Mossel Bay and Port Elizabeth. About 4-5 boats are based in Port Elizabeth, and 1-2 in Port St Francis, but the Mossel Bay boats sometimes move eastwards to fish in the Algoa Bay area, so that one can get up to 10 boats operating in the area. Likewise, the Port Elizabeth-based boats sometimes fish further west. In those situations, fish might be offloaded at the nearest port and trucked back to the processing plants.

In the Algoa Bay area, boats typically depart in the early evening to search for fish, but will try to only purse seine the fish as close to the following morning to maximise fish quality (minimise time in the hold). Port Elizabeth boats can travel as far as Plettenberg Bay, though seldom go that far. Location is decided on the basis of communication between vessels and skippers local knowledge. The viable range is reported to extend from Bird Island in the east to Jeffrey’s Bay in the west, with the cost of diesel as well as concerns about deterioration of the fish on board being the limiting factors. In a westerly wind, fishing tends to be in the east. Westerly winds exceeding 15 knots, and strong south easterly winds curtail fishing activity entirely, since the rolling action of the ship affects fish quality. Skippers also look for larger sized fish since these fetch better prices, so might target the last location where good catches were made, but will not target the same area if smaller fish were caught there the day before. . Fishing takes place all year as far as possible (limited by TAC), but activity is influenced by market demand

The spatial distribution in effort and catch in the small pelagics fishery is shown in Figure 35. However, average effort and catch gives a somewhat distorted view of reality, as there is considerable interannual variability in the spatial location of fishing effort. Since the fish are highly mobile, fishing grounds may change quite radically from year to year. For example, in the Eastern Cape this year most of the fish have been found between the Gamtoos and Maitland estuaries, and between the Port Elizabeth harbour and St Croix. In terms of average annual effort and catch, the two proposed ADZs lie within reporting grid blocks that account for a very small proportion of the national catch and effort, but approximately

12 % of the Eastern Cape annual average. Although this may appear to be a significant overlap with important Eastern Cape fishing grounds, the proposed ADZ areas only cover a small portion of the reporting grids, and given the mobility of the target species, the fishery should still have access to the shoals as they move away from the ADZ.

Proclamation of either or both the proposed ADZs within Algoa Bay would appear to have a minor affect the Algoa Bay small pelagic fishery in terms of loss of fishing grounds. Should any future finfish cage operation use frozen fish food at any stage of production however, there is a small but potentially highly significant risk of disease introduction that could decimate small pelagic stocks. A pilchard herpesvirus, thought to be introduced via frozen pilchards imported for direct use in tuna fish cages, (this has never been confirmed, an introduction via ballast water is also a possible explanation, but given the apparent origin of the outbreak in the tuna farming centre of southern Australia, the former appears more likely), spread though Australian and New Zealand pilchard stocks in 1995 and 1998-99. This caused pilchard mortalities of up to 70 % resulting in huge economic losses to the fishing industry and associated ecosystem level impacts (Crockford et al 2005, Whittington et al 2005). It should be noted that South African commercial fisheries already import and use frozen bait.

6.3.2 Squid jig fishery

Squid *Loligo vulgaris reynaudii* was historically targeted by a (mostly foreign) demersal trawl fishery and landed as by-catch in the South African inshore trawl fishery. A dedicated jig fishery for squid was initiated in 1984 (DEAT: MCM 2005), and the landed catch is now worth more than R180 million per year. The jig fishery first concentrated in the area between Plettenberg Bay and Port Elizabeth, though it now ranges further east as far as the Wild Coast. Squid fishing in the early part of the fishery was from boats that range from small ski-boats to deck boats of about 20m length, though the latter have come to dominate the fleet (Sauer *et al.* 2003a. The boats are equipped with powerful lights for night fishing and blast freezers. The fishery operates in depths of 20 – 120m, though mostly in the shallower waters (see below), where adult squid are targeted in spawning aggregations.

The squid jig fishery usually produces in the order of 6-7 000 tons per annum, though catches of up to 12 000 tons have been recorded in the past. Squid by-catch in the demersal trawl fishery fluctuates between 200-600 tons annually. Squid only live for two years, and there is substantial interannual variability in stock abundance (reportedly amongst the highest for all South African fisheries) that is linked to a variety of influencing factors. There is a high level of uncertainty regarding the status of the squid stock, with initial estimates (Roel & Butterworth 2000) suggesting that effort levels at the time (~3.6 million man hours per annum) were unsustainable and were placing the resource at a high risk (~90%) of collapse. Assumptions implicit in this assessment included the contention that jig-fishing has a negative impact on recruitment, invoked to account for the decline in trawl CPUE observed at the time that the jig fishery commenced. Subsequent refinements of the model by Glazer & Butterworth (2006) allowed them to conclude that spawning success is not strongly affected by jig fishing activity and that current levels of effort (around 3 million man hours per annum) and even higher levels of effort may in fact be sustainable, although further increases above current effort levels do still carry a high estimated risk of stock-collapse.

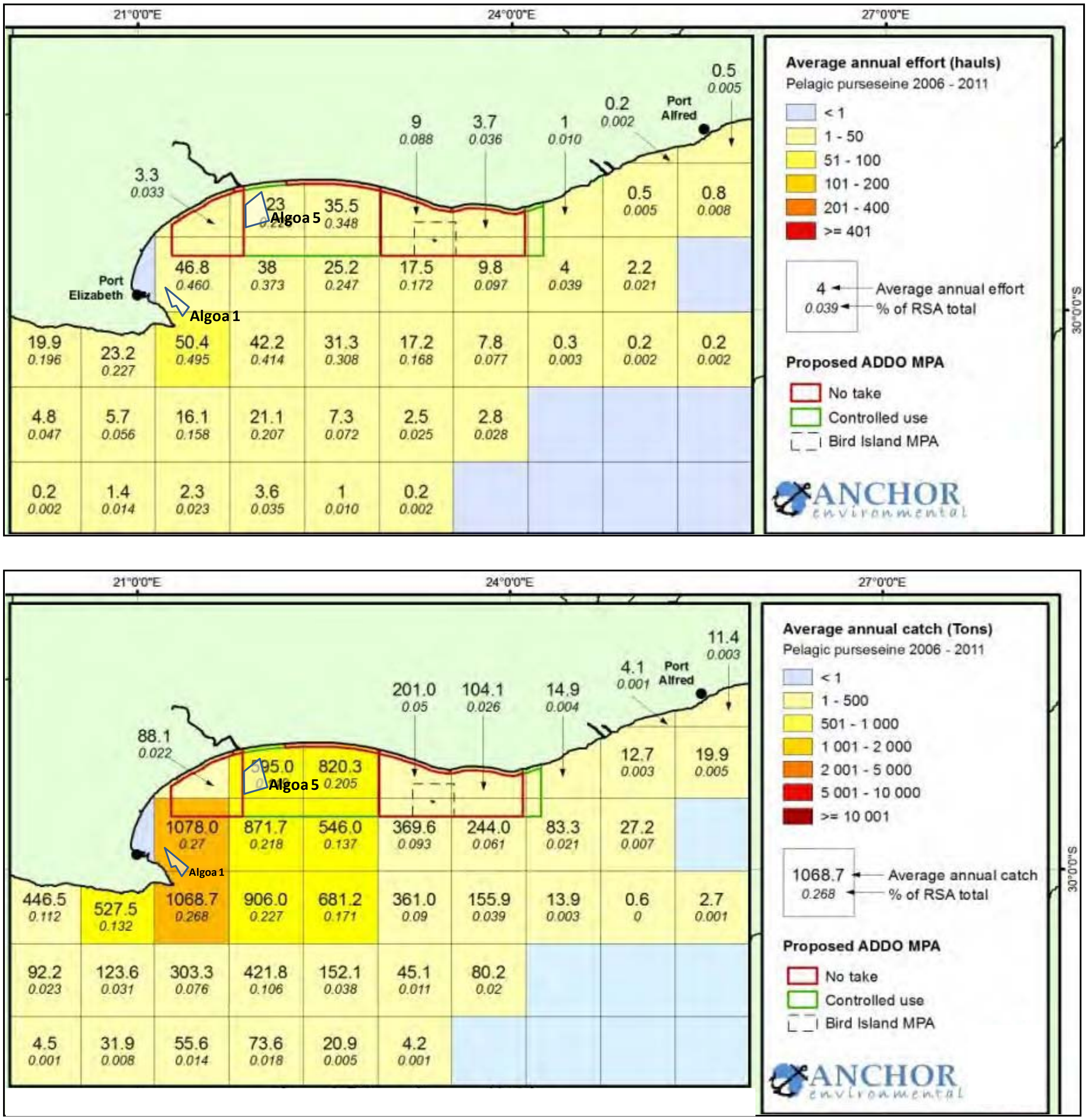


Figure 35. Average annual effort (top) and catch (bottom) in the small pelagic sector in the Algoa Bay area 2006-2009 and the positions of the proposed ADZ sites. (Data source : DAFF)

The squid jig fishery is currently regulated by means of total applied effort (TAE), which limits the number of vessels and crew allowed. The fishery currently comprises 109 rights holders, 123 vessels and 2 233 crew. Since 1988, the fishery has been closed once a year for four weeks in an attempt to counter the effects of "creeping effort" associated with increases in vessel efficiency and catch technology. The closed season corresponds with the peak spawning season for this species, and generally occurs around the month of November (Glazer & Butterworth 2006). There are some 123 vessels in the fishery, of which about 80 discharge in Port Elizabeth and the balance in Port St Francis. About half of the boats are independent operators but all supply exporters, which comprise about eight big, cold storage/exporters and some smaller ones. Of the larger companies, five are in Port Elizabeth and three are in St Francis. All of squid caught in the jig fishery is exported, mostly to Europe. The only squid sold locally is from the trawl by-catch. In all, the squid fishery provides employment for approximately 3 500 people, including land-based personnel (Roel 1998, Roel & Butterworth 2000).

Larger boats (>12m) are able to range as far as squid are distributed. Smaller vessels based in Port Elizabeth (about 15% of the fleet) can range from the Gamtoos River to Bird Island. Fishing location is chosen on the basis of communication with the fleet about current catch rate, checking existing marks, and skipper knowledge. The decision of where to fish is also influenced by weather and season. Boats must shelter when winds are >25 knots. In strong easterly winds the boats typically fish the Tsitsikamma area, but they fish anywhere in a westerly wind provided the swell is not too big (<4m). In winter, fishing is mostly on sea anchor in deep areas (100-200m), whereas in summer fishing is mainly on nests in 20-60m depth.

A typical trip lasts three weeks, with duration determined by crew morale, freezer capacity and catch rates. If catches are too slow to be economically viable (due to operating costs and the requirements for paying minimum wages) then the boats come in to port and tie up. The boats are all freezer boats, and food and fuel are not limiting factors for trip length. Fishing is typically close to port so it is not difficult to turn around trips quickly. If the catch rate drops below the estimated breakeven rate for a 3-week trip, then the boats will remain in port. Fishing decisions are subject to the MPAs at Sardinia, Bird Island and Tsitsikamma, closed seasons, and range is restricted by SAMSA regulations to 40NM or 200NM limit. There is also a crew limit (TAE).

The distribution of effort and catch for the squid jig fishery in the Algoa bay area for the period 2006-2011 is shown in Figure 36. The Algoa 1 site clearly overlaps with an important squid fishing ground with nearly 8 % of the entire South African average annual effort and just over 1 % of the average annual catch report from the grid block that overlaps the proposed ADZ. The discrepancy between effort and catch in this catch reporting block is largely due to the fact that vessels shelter from SW winds in the lee of Cape Recife, even during times when catches may be poor. Discussions with industry members suggests that the southern half of the proposed Algoa 1 is an important squid fishing ground and the industry would be strongly opposed to exclusion from this area. The ADZ could be resized by "trimming" the southern half of the proposed site and this would remove much overlap with the important squid fishing ground. Algoa 5 overlaps with a less important, but not insignificant fishing ground (accounting for nearly 1 % of average annual fishing effort), and due to the possible closure of much of the surrounding area to the fishery should the Addo MPA be proclaimed, the industry may well oppose a further loss of available fishing area.

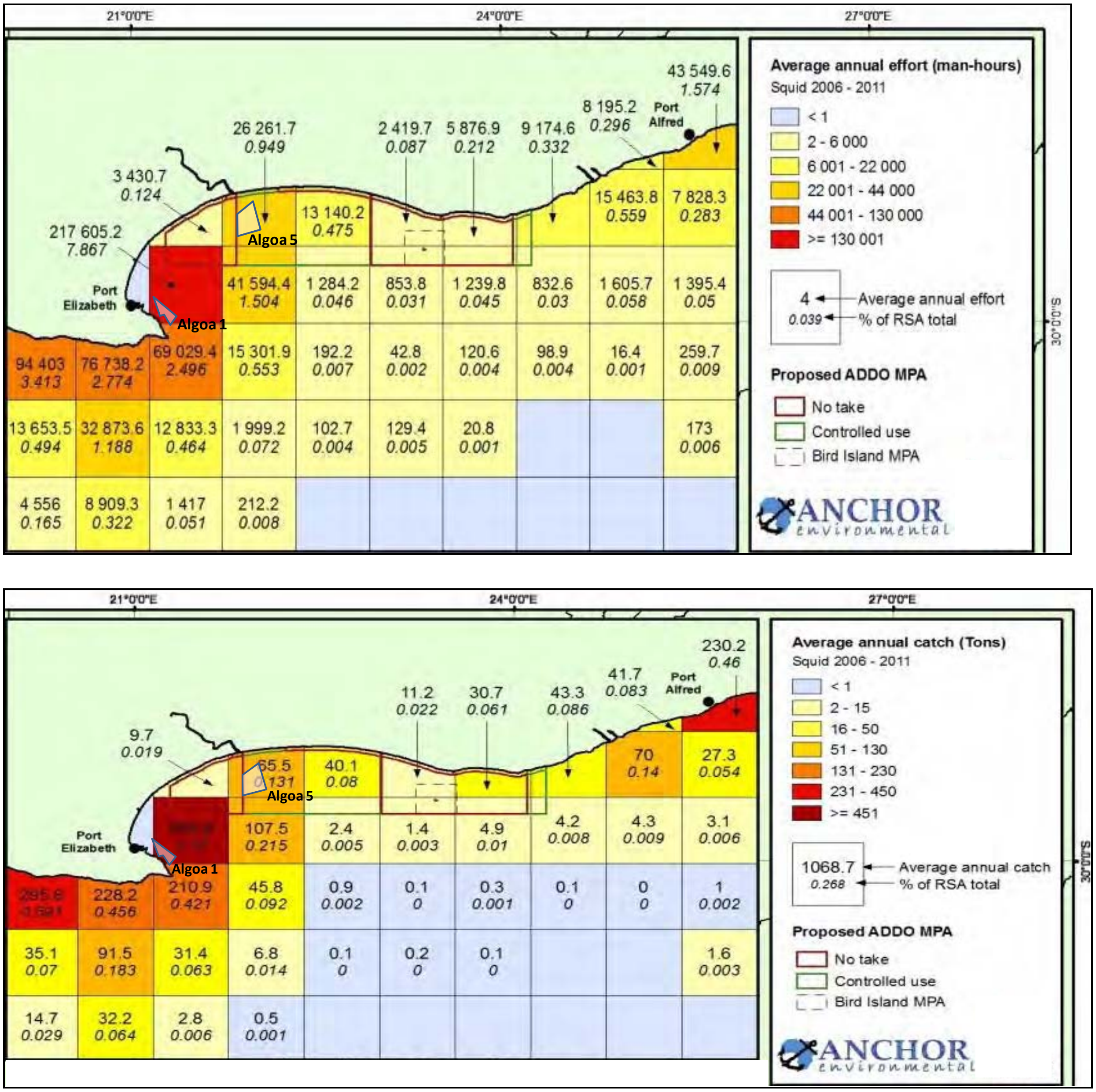


Figure 36. **Reported annual average catch and effort by the squid jig fishery in relation to the proposed ADZs within Algoa Bay, 2006-2011 (Data source: DAFF)**

6.3.3 Traditional linefishery

The South African commercial line fishery dates back to the 1500s (Thompson 1913). It is a boat-based fishery in which fish are caught on lines with no more than 10 baited hooks per line. The fishery thus operates inshore where fish are accessible on day or short overnight trips and in water shallow enough to be caught using manual labour with hand lines or rods and reels. By the late 1980's, the majority of vessels were highly mobile, trailable ski-boats that could follow aggregations of shoaling species such as yellowtail, snoek, geelbek and kob. When these aggregations occur far from the fishers' base, the boats are driven up to launch sites closer to the fishing grounds, though this practice is more common in the Western Cape than in the Eastern Cape. By the end of the 1990s there were approximately 3 000 fishing boats ranging from 3m dinghies to 15m deck boats carrying a total of around 3000 crew were involved in the commercial line fishery (Griffiths 2000, Mann 2000). This multispecies fishery landed about 250 species, although only about 20 were commercially important (Lamberth & Joubert 1999).

Despite its long history, lack of data has severely hindered the management of the fishery (Griffiths 2000). It was only in the 1980's and 1990's that life history studies and basic stock assessments were conducted for some of the more important linefish stocks (Mann 2000). A management framework that included a comprehensive suite of regulations was introduced in 1985, including revised minimum size limits equal to sizes at maturity (when known), daily bag limits, closed seasons, commercial fishing bans for certain species and the capping of the commercial effort at the 1984 level. These regulations were updated in 1992, but due to the continued lack of biological data, were still largely based on perceived vulnerability to exploitation (Mann 2000). Griffiths (2000) analysed fishery data over a 100-year period, and found that in spite of technological advances over this period, declines in catch rate were indicative of severe overexploitation (i.e. 75-99%). Angler surveys and stock assessments in the 1990's also suggested that the current line fish management framework was failing to provide adequate protection for line fish stocks (Attwood and Bennett 1995, Brouwer *et al.* 1997, Griffiths 1997a, b, Griffiths 2000, Griffiths *et al.* 1999, Mann *et al.* 1997, Sauer *et al.* 1997). This led to the development of a new Line fish Management Protocol (LMP) that uses stock data or trends in catch composition and catch rate to determine management actions (Griffiths *et al.* 1999). Apart from fast growing species such as snoek and yellowtail, most commercially-exploited line fishes are thought to have been depleted to dangerously low levels (DEAT 2005a). The Minister of Environmental affairs and Tourism declared an environmental emergency in the traditional line fishery in December 2000, and restricted the number of vessels and fishers in the commercial fishery, as well as bag and size limits for commercial and recreational line fishers. The commercial line fishery was split into three regional management zones, restricting the movement of vessels from one region to the next within the 2006-2013 long-term rights allocation (MCM 2006).

Since 1985, all commercial line fish permit holders have had to submit catch returns to the National Marine Linefish System (NMLS) database. Although there are some problems with underreporting (Attwood and Farquhar 1999, Brouwer *et al.* 1997, Griffiths 2000, Mann *et al.* 1997, Sauer *et al.* 1997), these data provide a fair reflection of major trends (Penney 1997), are reliable in terms of CPUE and catch composition (Griffiths 2000, Attwood & Farquhar 1999), and can provide a useful basis for study of the fishery.

Until 2003 the commercial fleet was large (~3 000 vessels nationally) with a large number of part-time participants who typically had other fishing interests or alternative sources of income. The mobility of the fleet was also not restricted. After 2003 the number of licensed vessels in the commercial fleet were diminished to about a tenth of their former numbers. However, effective effort has not diminished to the same degree, since the ski boats have since became larger, with longer travel ranges, and have the ability to handle rougher weather. They are also now mostly operated and crewed by full time professional line fishers. Along with these changes, operating costs (particularly fuel and bait) have increased dramatically since 2003.

A total of 455 long-term traditional line fish rights have been issued in South Africa (valid 1 January 2006 to 31 December 2013), of which 62 licences have been issued for management zone B (Cape Infanta to Port St Johns). Of these, about 25 vessels operate in the Algoa Bay area. With an average of 8 crew, the total crew employed is about 200, and these crew each support about 5 people.

Within the Algoa Bay area, line fishers target mainly reef fish (silverfish red roman, santer, red stumpnose), which are the mainstay in that they are consistent if not necessarily always the most abundant, followed by geelbek, yellowtail and kob when available. Fishers are constrained in terms of what species they can target, and by bag and size limits as defined by a species list attached to their permit conditions. A traditional line fishing rights holder who also holds a hake handline right may not activate both rights on the same day.

In the Eastern Cape, the decision to fish is not influenced by market conditions. Fishing effort is primarily limited by weather and sea conditions. Because the boats are small, ski boats go out when the wind is less than 15 knots. They are also affected by currents. Fishing takes place throughout the year but there is some seasonality in catches. Ski boats do not have any means of preservation on board and typically go out for about 12 hours if fish are biting (by day or night). Overnight trips are becoming more common to make catches. The range of the boats is limited to 40 NM out to sea (by SAMSA certification), and the actual distance travelled is influenced by safety and fuel concerns. Chukkies may take ice and stay out for two to four days, and are thus also able to fish further afield. Fishing location is chosen on the basis of recent fishing experience and the skippers' local knowledge, and apart from distance offshore is only constrained by MPAs (Bird Island MPA in Algoa Bay, Tstikamma west of Port St Francis).

Total catch in the traditional line fishery within the Algoa Bay region has averaged just over 500 tons per year during the period 2006 – 2010. The catch has been dominated by three species – geelbek, carpenter and kob, with geelbek making up 45% of catches and more than half of total landed value. The current landed value of the average annual catch is in the order of R12 million.

The fishery has changed considerably over time, however. In the long-term catch composition data (1985-2010) for the Algoa Bay area, reef-associated fish species (mostly Sparids) accounted for about 32% of the total line-fish catch. It must be noted that for much of this period (1985-2004) catches of hake and snoek were included, thus down weighting the contribution of reef fish in the catch composition. These species (hake and snoek) are no longer available to the line fishery, as after 2004, the hake handline fishery was managed as a separate sector and the official policy of reducing effort cross subsidization between sectors effectively removed the freezer boat (squid fishery) component of the line fishing fleet, largely reducing snoek catches that were historically made by these vessels offshore of Tsitsikamma. During the period 1985-2005, the average catches in the same area were 1252 tons per year on average (numbers of fishing rights were reduced in 2004), and the catch was dominated by carpenter, hake and kob, with geelbek only making up 10% (Figure 37).

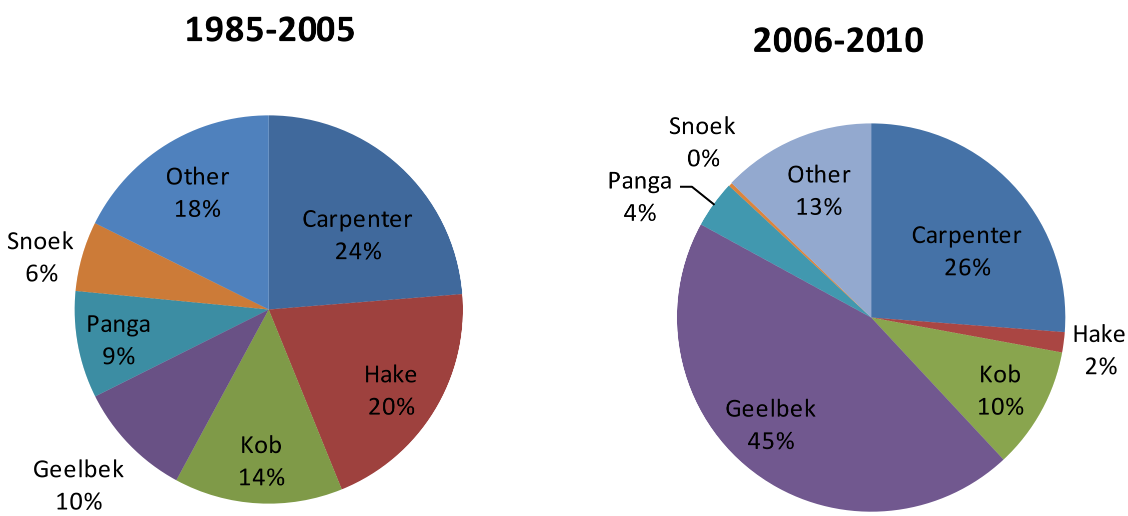


Figure 37. Change in the composition of line fish catches in the Algoa bay area after 2006 (source Turpie *et al* 2012).

Effort and catch data were drawn from the National Marine Linefish System (NMLS) database for the period 2006 to 2011. Data from before 2006 do not provide a good reflection of the fishery as it is at present, as those catches included handline hake. Also, when hake were targeted there was no fishing inshore between Sundays Rivers and Bird Island, but that area is now an important fishing area. Post 2006 data is also better since the long term rights allocation in 2006 impacted the fishery. Prior to analysis, all trips where exclusively squid were reported were excluded as were tuna pole fishing trips. According to the fishers, the last two years are probably the most representative.

Spatial mapping of effort and catches in the line fishery is less accurate than in other sectors, because of the logbook method employed by fishers, which is to describe location in relation to numbered sections along the coast and estimated distance offshore. No bearings are given, and no GPS data are recorded by the fishers with which to calibrate these estimates. This means that in plotting the data, estimates of the bearings have to be made. These are done very coarsely as due east, south or southeast of the coast (for the coast east of Cape Agulhas). Our estimates of spatial patterns differ slightly from those of Chalmers (2012) because of differences in assumptions, and in both studies, these plots differ from the

VMS data, which show effort to hug the coastline. Thus for example, fishing effort at the Rij banks appears to be only on the northern half, but in reality is more centred on the banks, and much of the fishing effort west of the point is probably closer inshore.

The overall plot of effort clearly shows the limited range of the traditional line fishing boats, and in the Algoa Bay area, effort by the PE based boats ranges mainly within the area up to the Sundays River and Rij banks, as well as around the point to the west of Cape Recife, whereas effort by the Port Alfred-based boats ranges westwards to Bird Island, where fishing is to the north and south of the Bird Island MPA (Figure 38).

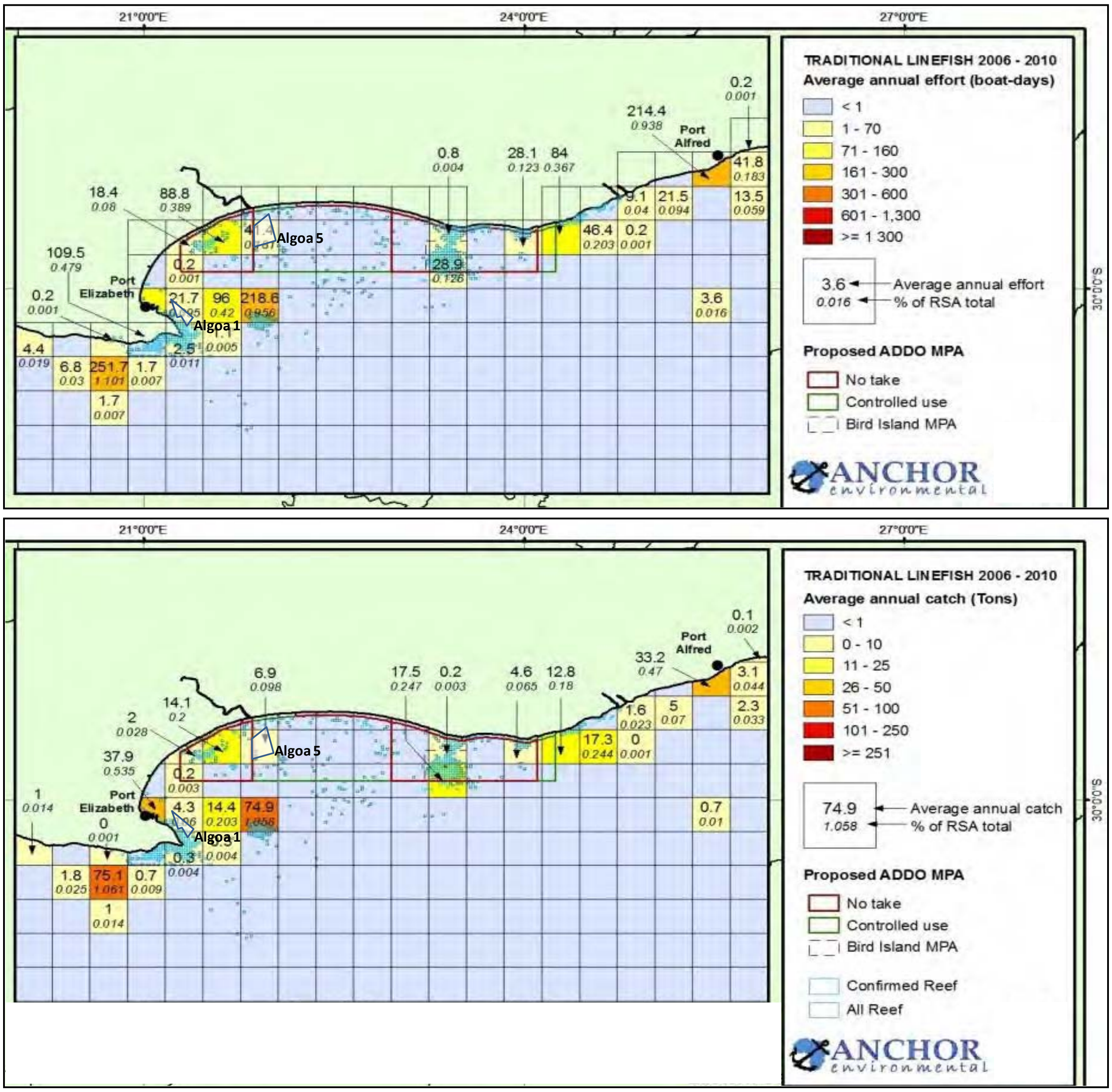


Figure 38. Average annual linefish effort (top) and catch (bottom) over the period 2006-2010 in relation to the proposed ADZs within Algoa Bay.

In total, only 2-3% of the average annual reported catch and effort for the Algoa Bay area is for grid blocks that include the proposed ADZs. Given that the ADZs include none (Algoa 1) or very little (Algoa 5) reef substratum, it appears that they will have little negative effect on the commercial line fishery in terms of loss of fishing ground.

The same concerns about the possible introduction of diseases or genetic contamination of wild stocks by cultured fish (many potential cultured species are also targets of the linefishery, and their overexploited status makes the small populations particularly vulnerable to these impacts), as expressed for the recreational skiboat fishery above, are also valid for the commercial linefishery.

6.3.4 Shark longline

Demersal sharks in South Africa are either targeted directly or caught as by-catch, with the bulk of the catches being taken by the traditional linefishery, the inshore trawl fisheries, and the demersal shark longline fishery (Da Silva and Bürgener 2007). Longline permits for the directed catching of sharks were first issued in 1991 (Crawford *et al.* 1993). At this time, more than 30 longline permits were issued to target shark (pelagic and demersal species combined). Many of the permit holders did not make use of these permits (due to interests in other fisheries) or sought to use their permits to exploit loopholes in the legislation to catch other species (DAFF 2012). As a result, the numbers of demersal shark longline permits was reduced to 11 in 2004 and finally 6 permits in 2005, when the decision was made to include catches of pelagic sharks with the pelagic tuna and swordfish sector. Demersal shark longlining then started to focus increasingly on three species – soup-fin shark *Galeorhinus galeus* common smooth-hound sharks *Mustelus mustelus* and bronze whaler sharks *Carcharhinus brachyurus* – which now dominate the catches. In the Algoa Bay area, the fishery targets smooth hound, soupfin, smooth hammerhead *Sphyrna zygaena*, bronze whaler, blacktip *Carcharhinus limbatus*, dusky *Carcharhinus obscures* and cow sharks *Notorynchus cepedianus*.

Currently, demersal shark longlining is restricted to coastal waters (up to 100 m depth), and are permitted to fish up as far as East London, and use longlines with up to 3 000 hooks. Vessels are tracked by a Vessel Monitoring System (VMS) and all landings are independently monitored and skippers are required to complete logbooks per longline set. There is generic reporting of skates and carcharhinids (DAFF 2012). There are a total of six rights holders in the demersal shark longline fishery. One of these operates in the Algoa Bay area, using a single vessel.

This operator fishes year-round, but some species (dusky, blacktip, bronze whalers and hammerheads) are reportedly more common in summer. Fishing is possible in winds of up to 25 knots. Wind direction influences the choice of where to fish – prevailing winds mean that fishing is more in the west during winter, and in the east (Sundays to Port Alfred) during summer. The time spent at sea is limited by the need to maintain the quality of fish, which is kept on ice. About three trips are undertaken per month, and vessels stay out for up to 9 days at a stretch. Boats do not stay on the same fishing grounds for long periods of time. Fishing is usually close to shore, as that is where the sharks are most abundant. Distance travelled is also influenced by the fact that the boat has to return to port to offload, thus the easterly limit for the PE-based fishery is East London and the westerly limit around Mossel Bay

Both Algoa 1 and particularly Algoa5 overlap with areas where the shark longline operator is active with ~8% of the average annual reported catch and effort taking place within grid blocks that overlap with the proposed ADZs (Figure 39). Algoa 5 appears particularly important to this fishery, with numerous sets historically made within the actual proposed ADZ area and some 5 % of the annual average catch made within this reporting block. Considering the potential future loss of fishing ground to this operator should the restricted zones of the proposed Addo MPA come into effect (areas that account for around 20% of annual average catch and effort as estimated by Turpie et al 2012); the further losses associated with ADZ declaration would be proportionately larger.

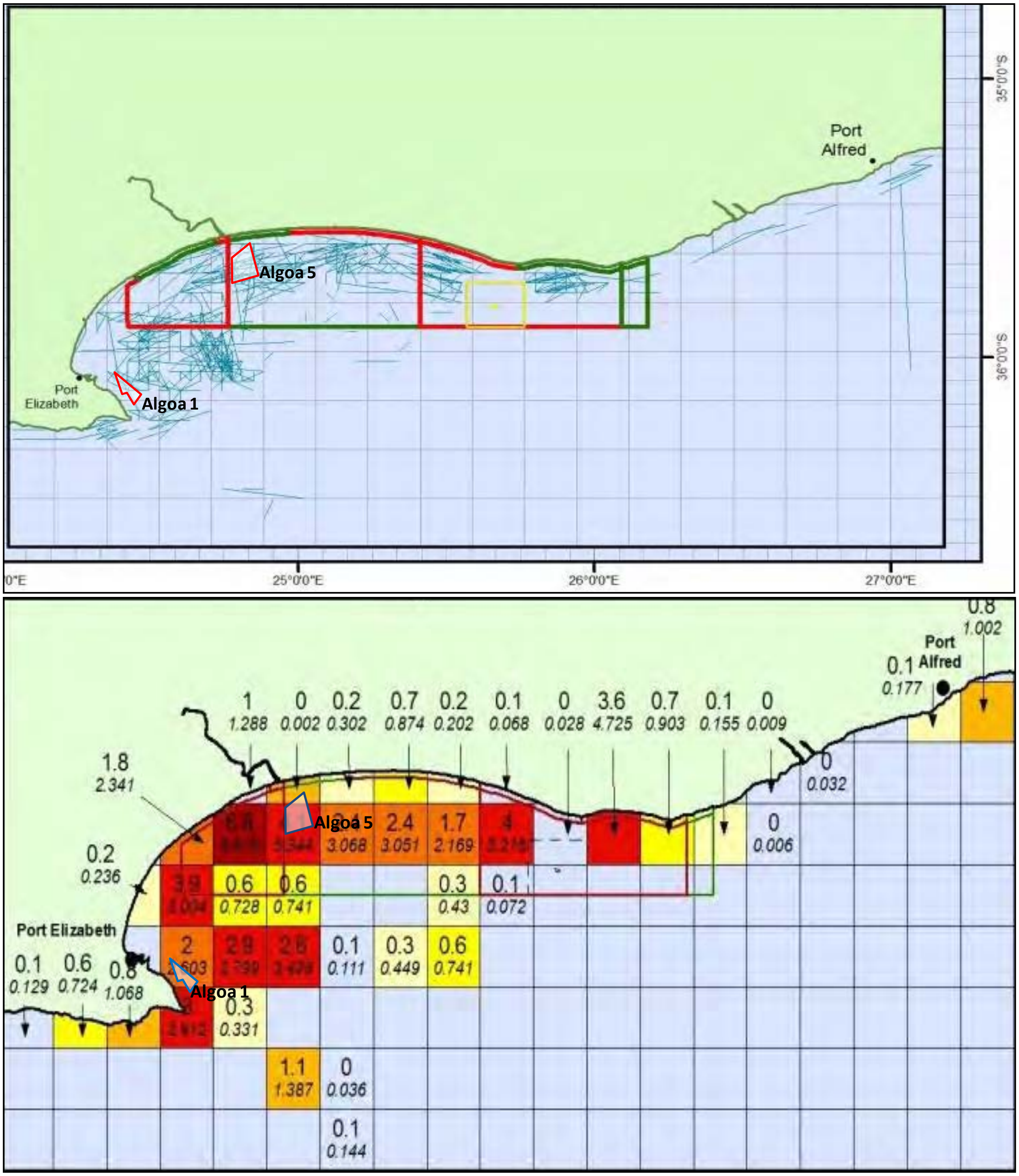


Figure 39. **Reported shark long line sets (top) and average annual catch (bottom) made by the PE based shark long line operator over the period 2006-2012. The proposed Addo MPA is also shown (Data source: DAFF).**

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