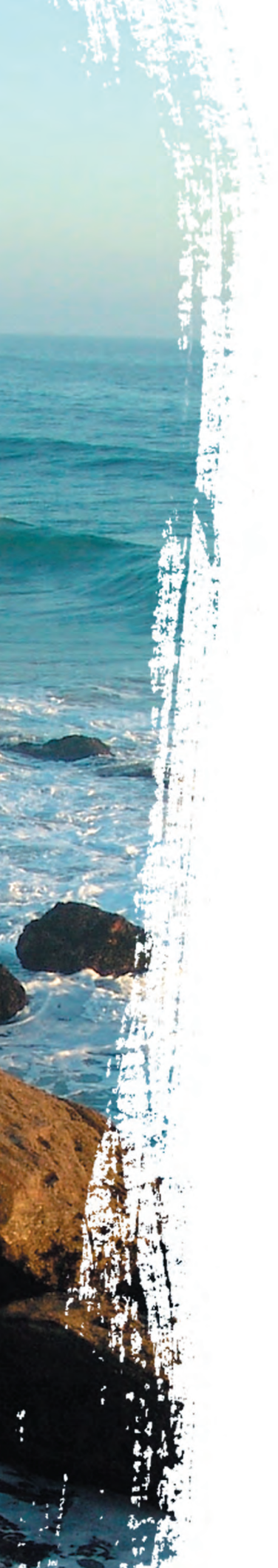

Chapter 7
Marine and coastal resources

At a glance

This chapter focuses on the contribution by the marine sector to the national economy and the livelihoods of South Africans. At the same time it deals with over-exploitation and its associated costs, degradation, and loss of the resource. Improved protection measures need to be enforced to protect the resource base, to ensure beneficial opportunities through sustainable management and equitable benefit-sharing. A significant proportion of the resource base has been lost owing to rapid and uncontrolled coastal development and poorly managed fish stocks through over-fishing, causing depletion and collapse. Increases in effluent discharges and pollution have added to these losses. Climate change and decreased quality of fresh water flow to estuaries contribute to large-scale changes. Continued resource losses affect the livelihoods of coastal communities dependent on coastal resources, with the added impact of health risks due to water quality. Enforced legislation can reverse unsustainable trends with resultant socio-economic benefits and opportunities.

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7.1 INTRODUCTION

The marine and coastal resources of South Africa are a rich and diverse national asset, providing important economic and social opportunities for the human population, which, in turn, has developed a strong reliance on these resources for commercial opportunity and gain, food, recreation, and transport. These resources have facilitated job creation and general economic upliftment in coastal regions. Increasing human and environmental pressure on the country's marine and coastal ecosystems, however, has changed the functioning and structure of many of their components, and uncontrolled or mismanaged use has led to over-exploitation, degradation, and resource loss[1].

These pressures have driven an overall decline in marine productivity, creating significant socio-economic opportunity costs. Direct impacts by humans are exacerbated by the fact that sea water links and disperses marine populations over vast areas, easily spreading invasive alien species and pollutants. Climate change is also predicted increasingly to damage our marine and coastal resources. Our understanding of these effects remains speculative, but they could be as severe as those of the uncontrolled human exploitation that has taken place to date[2].

The general South African public, however, especially coastal stakeholders, appears to be increasingly aware of the value of our seas and coast and of the importance of effective management. Protection, in the form of marine protected areas and improved management, has most recently been receiving high priority at national and international levels, and several of the acts, policies, and protocols used to govern South Africa's marine and coastal environment are either under review or have recently been revised to promote improvement. It is still too early to measure their effectiveness, but dramatic change for the better is required if the country is to benefit from the opportunities available and reverse the current negative trends.

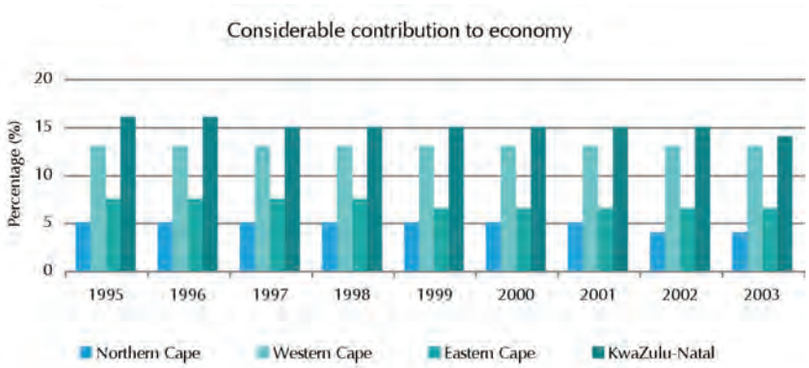


Figure 7.1: Annual gross domestic product (GDP) proportional contribution by coastal provinces of South Africa, 1995–2003 (at constant 2000 prices)

Source: Statistics South Africa (2005)[3]; Department of Environmental Affairs and Tourism and Council for Scientific and Industrial Research (2005)[4]

7.2 ECONOMIC AND SOCIAL VALUE

7.2.1 Economics

The marine and coastal environment and its associated resources contribute considerably to the South African economy in terms of employment, recreation, and tourism. Since the 1980s, the four major coastal cities of Cape Town, Port Elizabeth, East London, and Durban have shown the fastest economic growth of all cities in the country. In 2000, the estimated value of the direct benefits derived from all coastal goods and services in South Africa was approximately R168 billion, with indirect benefits contributing a further R134 billion (according to the *White Paper on Sustainable Coastal Development* of 2000).

The coastal contribution to the national economy is most frequently measured as the total annual gross domestic product (GDP) emanating from the coastal provinces (even though not all economic activity in these provinces depends on marine and coastal resources). The

Packing frozen rock lobster tails: marine resources contribute to the economy. *Photography: Tony van Dalsen*

overall GDP contribution from the four coastal provinces in 1995 was R322 277 million and increased steadily to R401 674 million in 2003 (at constant 2000 prices). Their proportional contribution to South Africa's national average GDP, however, decreased from 42.5% in 1995 to 38% in 2003 (see Figure 7.1). KwaZulu-Natal has contributed the greatest proportion to GDP since 1995, followed by the Western Cape, Eastern Cape, and Northern Cape, respectively. The overall contribution from the Western Cape has remained at approximately 13%, while that of the other three provinces has declined over time[3].

7.2.2 Employment

The primary, secondary, and tertiary aspects of the fishing industry are important sources of direct employment for nearly 28 000 people living at or near the coast. Compared with other employment sectors, fishing provides high-quality employment, generating substantial individual incomes. Fishers earn on average R36 000 per year, although gross earnings vary among different skills groups (that is, among unskilled and semi-skilled workers and managers). The earnings from South African commercial fisheries in 2000 totalled approximately R1 billion. Commercial fisheries employing the highest number of people are the line, squid, hake trawl, and west coast rock-lobster fisheries (see Figure 7.2). In terms of earnings, however, the deep-sea hake fishery pays the highest wages, followed by squid, linefish, and pelagic fisheries (see Figure 7.3). The Western Cape employs some 83.2% of the workers in the fishing industry, followed by the Eastern Cape (13.6%), KwaZulu-Natal (2.3%), and the Northern Cape (0.9%).

Yellowtail catch for sale in the Kalk Bay harbour.

Photography: Tony van Dalsen

7.2.3 Transformation

Following the introduction of democracy in South Africa in 1994, the fishing industry has undergone dramatic changes, mostly facilitated by the new fisheries policy, the Marine Living Resources Act (No. 18 of 1998, amended as No. 68 of 2000) (MLRA)[6]. This act, amongst other requirements,

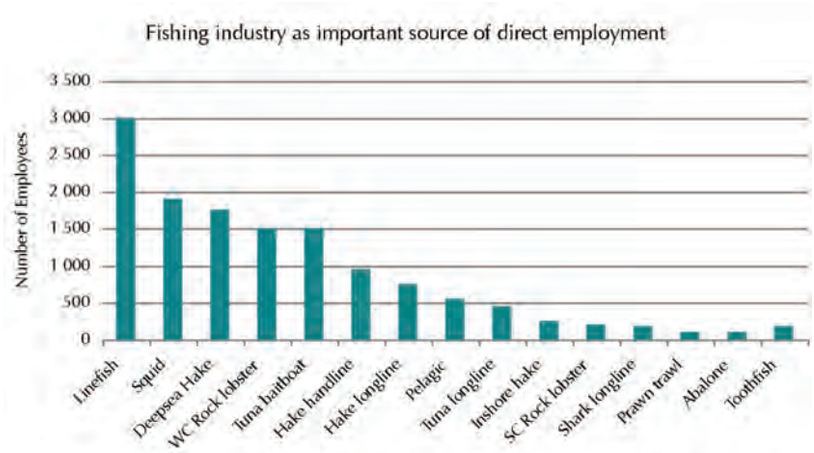


Figure 7.2: Number of people employed per commercial fishing sector, 2000

Source: Fishing Industry Handbook (2004)[5]

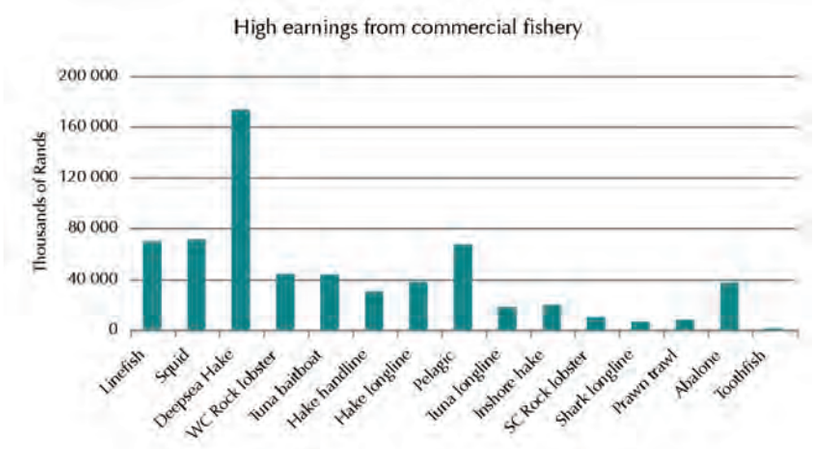


Figure 7.3: Total annual earnings for each commercial fishery, 2000

Source: Fishing Industry Handbook (2004)[5]

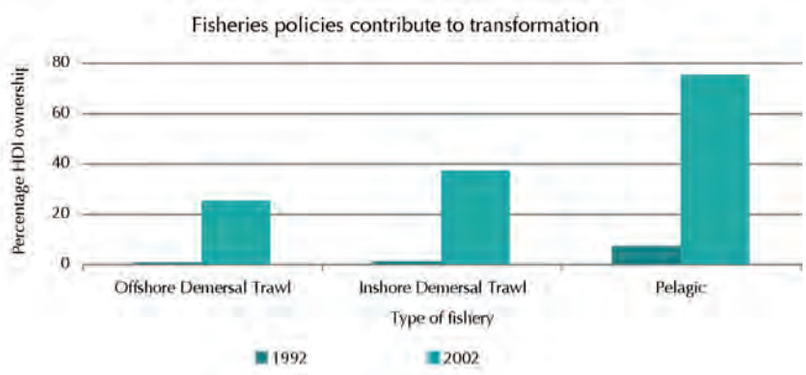
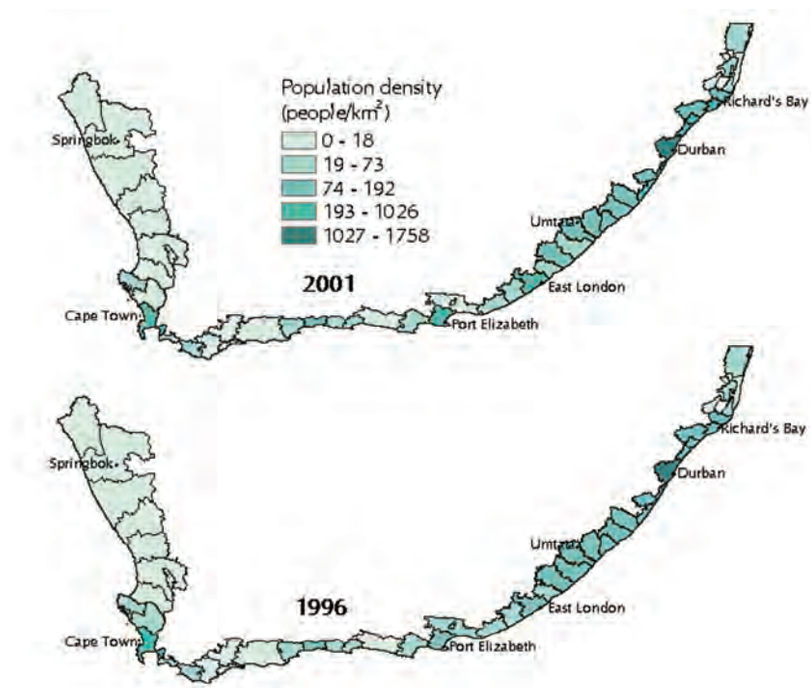


Figure 7.4: Proportion of historically disadvantaged ownership in the three largest commercial fisheries of South Africa, in 1992 and 2002

Source: Department of Environmental Affairs and Tourism and Council for Scientific and Industrial Research (2005)[4]

specifies the "need to restructure the fishing industry to address historical imbalances, to achieve equity".

Transformation of the fishing industry is being addressed from three angles. First, fishing rights have been redistributed from a small number of mainly white-owned companies (less than 300) to a larger number (almost 6 000) of smaller companies owned by historically disadvantaged individuals (HDIs). Second, established companies have undergone internal transformation that includes improved employee rights and minimum wages. Finally, subsistence fishers have been formally recognized and management structures are being developed to improve allocations and maintain sustainability through commercial, recreational, and subsistence fishing[6]. The Department of Environmental Affairs and Tourism (DEAT) has estimated that by 2003 at least 60% of commercial fishing rights had been allocated to HDIs or HDI-owned and -managed companies[7]. Small-scale fisheries, such as those of abalone (which require minimal infrastructural resources), have been most successful at transformation (that is, 88% of the rights of small companies are HDI-owned and 84% of Total Allowable Catch [TAC] is located in HDI-owned companies). The larger, more capital-intensive fisheries, such as those of deep-sea hake, have transformed to a lesser extent (with 74% of their rights HDI-owned and 25% of total allowable catches located in HDI-owned companies). As shown in Figure 7.4, the proportion of deep-sea hake fishery HDI-ownership increased from 0.5% in 1992 to 25% in 2002; that of inshore demersal trawl from 1% to 37% HDI during the same period; and that of pelagic fishery from 7% to an impressive 75% HDI.



Map 7.1: Population density (people/km²) in South African coastal municipalities, in 1996 and 2001

Source: Department of Environmental Affairs and Tourism and Council for Scientific and Industrial Research (2005)[4]

The fishing industry is one of South Africa's top three industries in terms of transformation[7], but this success has not been achieved easily. Following the passing of the MLRA in 1998, annual allocation of fishing rights was introduced in an attempt to initiate transformation. The dramatic increase in the number of rights applications (from <300 in 1990 to 12 000 in 1999) had been underestimated, however, resulting in long delays in the issuing of rights, accompanied by numerous legal challenges. Furthermore, short-term (annual) rights allocations led to financial insecurity, lack of a sense of ownership, increased poaching, and the destabilization of the fishing industry. Various procedures were introduced to address these consequences, including a Rights Verification Unit, an Appeals Committee, and the allocation of medium-term fishing rights (for the four years 2002–2005). With these measures in place, applications decreased by 50%, medium-term rights have been allocated to most commercial fisheries, litigation has almost ceased, and stability has largely been restored[6]. On 1 March 2005, the Minister of Environmental Affairs and Tourism announced the intention to issue long-term (8–15-year) fishing rights, to provide greater security and further stability in the country's fishing industry.

7.3 MODIFICATION, DEGRADATION AND LOSS OF RESOURCES

Marine and coastal resources in South Africa are displaying signs of modification and degradation and, in some instances, destruction. The section that follows highlights some of the key factors contributing to these damaging processes.

7.3.1 Population pressure

Coastal cities around the world have grown dramatically over the past 50 years and are predicted to continue doing so for the near future. The main reasons for this increase are the appeal of living near the coast, increased tourism, sufficient wealth for coastal retirement opportunities, an increase in coastal holiday-home purchases, and the quest for employment and basic livelihoods[8]. As much as 40% of South Africa's population lives within 100 km of the coast, resulting in substantial development pressure for infrastructure such as housing and roads.

The 1996 and 2001 South African census data reflect a relatively small change in population densities within coastal provinces at a municipal level (see Map 7.1). A closer look shows a more dynamic picture: whereas population density decreases have occurred in the region between Cape Town and Saldanha Bay in the Western Cape, there have been noticeable population increases in the Eastern Cape's Nelson Mandela Metropole. Overall population growth and increased development thus continue to pose severe threats to resources of the coastal zone as reported in the 1999 National State of the Environment Report.

7.3.2 Coastal land use

The coastal land in South Africa has been classified as natural, degraded, urban, and agricultural[a]. Most urban land use occurs in the three largest coastal metropoles: Cape Town (25%), eThekwini (27%), and Nelson Mandela (12%) (see Table 7.1). Cape Town, eThekwini, and iLembe are the municipal areas that have been most transformed from their natural state. Not surprisingly, the sparsely populated Namaqua region has the highest proportion of natural land cover (98%), followed by Cacadu (92%), Eden (76%), Amatole (75%), and Nelson Mandela (74%).

Urban development

The areas of natural or undeveloped coastal land in South Africa are increasingly under threat from large-scale urban developments, mostly residential or recreational estates (such as golf estates). Many are currently being planned or already being developed in the Western and Eastern Cape in particular, with the Saldanha Bay and George local municipalities showing the highest rates of development. Most of the undeveloped KwaZulu-Natal and Wild Coast regions lie within marine and/or nature reserves, so development there is more restricted, but pressure is mounting to 'open up' these areas for exploitation.

Port and harbour development

Much coastal development has to do with constructing new ports or harbours or expanding existing ones. South Africa currently has seven ports, the most westerly being Saldanha Bay and the most easterly, Richards Bay. In 2002, construction of the most recent port development in South Africa, the Port of Ngqura (Coega) began in the Eastern Cape. This port, expected to be operational by 2008, will be South Africa's eighth and is anticipated to bring significant trade, industry, and economic growth to the region, although not without environmental costs.

Mining

South Africa's marine and coastal environment is mined in the northeast for heavy metals (titanium and zirconium), in the south for fossil fuel (oil), and in the northwest for diamonds.

An unavoidable consequence of mining is disruption of the sediment, which ranges from extensive, in the case of titanium, to limited in the case of oil[1]. In most instances, mining completely destroys the biological community, including vegetation, in-fauna, and epi-fauna. Newly introduced environmental policies require coastal mining

Durban's small craft harbour.

Photography: South African Tourism

Diamond boats off the coast at Port Nolloth.

Photography: South African Tourism

Table 7.1: Land use in coastal Metropolitan and District Municipalities

Coastal Municipalities	Total area of Metro (km^2)	Natural land-cover		Transformed						
				Degraded land-cover		Urban land use		Agricultural land use		Total transformed
		Area (km^2)	(%)	Area (km^2)	(%)	Area (km^2)	(%)	Area (km^2)	(%)	(%)
Cape Town	2 479	976	39.4%	81	3.3	627	25.3	796	32.1	60
eThekwini	2 275	805	35.4	262	11.5	628	27.6	580	25.5	65
Nelson Mandela	1 941	1 445	74.4	5	0.2	246	12.7	245	12.6	26
Amatole	23 546	17 613	74.8	2 580	11.0	718	3.1	2 636	11.2	25
Cacadu	58 194	53 476	91.9	1 566	2.7	94	0.2	3 059	5.3	8
Eden	23 295	17 633	75.7	592	2.5	145	0.6	4 925	21.1	24
iLembe	3 252	1 194	36.7	467	14.3	45	1.4	1 547	47.6	63
Namaqua	126 735	124 771	98.5	643	0.5	195	0.2	1 126	0.9	2
O.R. Tambo	15 920	8 206	51.5	3 262	20.5	696	4.4	3 756	23.6	49
Overberg	11 371	6 153	54.1	162	1.4	67	0.6	4 989	43.9	46
Ugu	5 044	2 534	50.2	855	16.9	85	1.7	1 570	31.1	50
uMkhanyakude	12 483	9 034	72.4	1 275	10.2	5	0.0	2 171	17.4	29
uThugulu	8 186	4 529	55.3	494	6.0	89	1.1	3 073	37.5	45
West Coast	31 079	20 904	67.3	759	2.4	110	0.4	9 305	29.9	33

Adapted from: Department of Environmental Affairs and Tourism (2005). South African Estuaries Catchment Landcover Programme. http://www.environment.gov.za/soer/estuary/index.html

Source: Thompson, M.W. (1996). Standard Land-Cover Classification Scheme for Remote Sensing Applications in South Africa. South African Journal of Science ***92****, 34–42.*

operations to conduct comprehensive rehabilitation throughout the mined area. If the requirements are followed, rehabilitated mined areas can normally recover within a few years.

Coastal dunes in northern KwaZulu-Natal are mined for heavy metals and, although rehabilitation of the dune vegetation is considered successful, surrounding wetlands, estuaries, and water supplies are adversely affected. In the offshore marine environment, oil and gas extraction does not appear to cause major benthic disruption[1]. The possibility of an oil spill is probably the greatest threat to the marine environment from this industry. Inshore and offshore diamond mining involves the extraction and re-suspension of benthic sediment, resulting in fine sediment plumes that can contain heavy metals and may reach toxic concentrations[9], or settle on reefs and rocky shores and suffocating the organisms living there[10]. South Africa's Exclusive Economic Zone (EEZ) north of Saldanha Bay reaching to the South African–Namibian border is primarily zoned for diamond mining concessions, although less than 1% of this area is currently being mined[10]. At present, none of this marine area has formal protected status.

7.3.3 Pressures on estuaries

Estuaries comprise a key component of coastal and marine ecosystems as spawning grounds, contributing significantly to overall fisheries production. As a stand-alone resource, the total landed catch of estuarine and estuarine-associated fish is approximately 28 000 tonnes per annum, having a value of about R950 million[11]. As part of the National Biodiversity Strategy and Action Plan (see Chapters 5 and 6), Turpie (2004)[12] summarized the available information on the health of South African estuaries. The most severe direct pressures on estuaries are reductions in freshwater input (quantity) and water quality, habitat alteration,

changing mouth dynamics, over-exploitation of resources (for example, fish), sedimentation, recreational disturbance, and pollution. Estuaries around intensively developed areas (the Western Cape southwest coast, Port Elizabeth, and southern KwaZulu-Natal) are on the whole in the poorest condition. Compounding the existing threats, climate change poses a potentially serious future threat to estuaries, particularly along the western and southern coasts, if predicted declines in rainfall and thus freshwater availability are correct.

7.3.4 Beach driving

In December 2001, off-road vehicles (ORVs) were banned from the coastal zone of South Africa because of the extensive environmental damage that they cause. Three years after the off-road vehicle ban was implemented, it was reported that several aspects of the environment had improved. Most conclusive is the increase in successful breeding pairs and overall numbers of African black oystercatchers (*Haematopus moquini*), white-fronted plovers (*Charadrius marginatus*), and the endangered Damara tern (*Sterna balaenarum*)[13]. Coastal breeding birds such as these were previously affected by disturbance or mortality caused by off-road vehicles within the coastal zone, and continued monitoring of other coastal flora and fauna is expected to reveal similar recovery patterns. In response to appeals and claims of socio-economic declines resulting from the ban, however, the Department of Environmental Affairs and Tourism is considering lifting it partially in certain 'sacrificial' areas to allow limited beach access by off-road vehicles.

7.3.5 Invasive alien species

Invasive alien species are second only to habitat destruction as a primary cause of biodiversity loss. Marine fauna and flora have accidentally, and occasionally intentionally, been transported around the globe through human activities[14]. The most frequent means of introducing marine invasive species is through the ballast-water of ships, which is discharged when loading cargo at ports or harbours, along with any surviving organisms. The dynamic nature of South Africa's marine environment appears to have prevented many marine invasives from becoming established, but, once established, they are extremely difficult to control or eradicate and can significantly reduce ecosystem productivity.

Of the ten currently known alien invasive species in our marine waters, only two (the Mediterranean mussel, *Mytilus galloprovincialis*, and the ascidian, *Ciona intestinalis*) have major damaging ecological or economic impacts, while one (the European green crab, *Carcinus maenas*) has the potential for adverse effects (see Table 7.2). Invasion by the Mediterranean mussel has displaced indigenous intertidal species along much of South Africa's coastline. It has also, however, formed the basis of a substantial mariculture industry on the west coast and is being considered for small-scale commercial exploitation that will benefit local communities[14]. A more thorough exploration of the entire coast is expected to reveal several other invasive species, specifically in the eastern part of South Africa, which is currently poorly surveyed for such species[15]. Since 2001, two ascidian species, one anemone, one oyster, and one red alga (half the total number of recorded alien invasive marine species) have been recorded as invasive species in South Africa, and the problem of marine invasives is expected to get worse, as they significantly threaten the future stability and functioning, and therefore the resource potential, of our marine and coastal systems.

Sodwana Bay in northern KwaZulu-Natal, famed for its game fishing and scuba diving. *Photography: South African Tourism*

The European green crab (*Carcinus maenas*) is one of the invasive species in our marine waters.

Photography: Charles Griffiths



Table 7.2: Invasive marine species recorded in South Africa, 2004

Species name	Common name	First recorded in South Africa
Ciona intestinalis	ascidian	1955
Clavelina lapadiformis	ascidian	2001
Diplosoma listerianum	ascidian	2001
Metridium senile	anemone	1995
Sagartia ornate	anemone	2002
Carcinus maenus	European green crab	1983
Littorina saxatilis	periwinkle	1974
Mytilus galloprovincialis	Mediterranean mussel	1979
Crassostrea gigas	oyster	2001
Schimmelmannia elegans	red algae	2002

Source: Department of Environmental Affairs and Tourism and Council for Scientific and Industrial Research (CSIR) (2005)[4]

7.3.6 Water quality and emissions to sea

Pollution of coastal waters can originate from land-based sources (industrial, municipal, agricultural run-off), shipping activity (accidental or deliberate discharges, garbage, and dumping) and atmospheric gases[1]. By international standards, South Africa's coastal waters have very low levels of pollution[16, 14]. There are as many as 67 discharge points, however, through which as much as 1.3 million m^3 of wastewater is discharged daily into the marine environment (see Figure 7.5 and Figure 7.6). This daily discharge is 62% greater than five years ago, even though the number of discharge points has only increased by four, which indicates a significant increase in wastewater volume per discharge point. Most of these discharges are released into the surf zone (37) with fewer points of discharge into estuaries and offshore (16 and 14, respectively) (see Figure 7.7). An alarmingly high 23 points discharge into the surf zone in the Western Cape alone, where 275 000 m^3 of wastewater (90% of which is domestic effluent) are discharged each day. Offshore discharges along the KwaZulu-Natal coast amount to 500 000 m^3/day, of which 61% is industrial and the rest domestic effluent (see Figure 7.6). The Eastern and Northern Cape have considerably lower amounts of wastewater discharge than either of the other two coastal provinces. The severity of wastewater pollution in the marine environment has continued to grow since it was reported in the 1999 National State of the Environment Report.

Oil-stained penguins in the water on Dassen Island, Cape Town. *Photography: Trace Images*

7.3.7 Oil pollution

Since 1987, approximately 82 000 tonnes of oil have been accidentally or deliberately discharged into South African coastal waters. The worst oil pollution incident occurred in 1992, when the Katina-P oil tanker sank off the coast of Mozambique, releasing over 67 000 tonnes of oil into the ocean. This devastating oil spill was by far the worst such incident in several decades. Other oil spills have released between 1 500 and 3 000 tonnes of oil into the sea per incident (see Figure 7.8). Stringent legislation promulgated since 1999 has greatly assisted in preventing further large-scale oil pollution incidents in South African waters.

7.3.8 Harmful algal blooms

Phytoplankton forms the basis of primary productivity in marine ecosystems and is essential in supporting large fisheries. Blooms of certain phytoplankton species can occur because of increased nutrient loads, either natural or human-induced, often resulting in harmful, toxic conditions[18].

Along the Southern African coastline, the Benguela upwelling region is most frequently subjected to harmful algal blooms, although isolated incidents have been recorded along the south coast. Blooms most commonly occur between January and May, during the latter half of the upwelling season. They are frequently characterized by a sudden abundance of a particular species of microalga that can lead to discolouration of the water, a phenomenon known as red or brown tide[19]. Once the nutrient supply is depleted, the phytoplankton bloom begins decaying and



the organic-rich material uses up oxygen in the inshore waters, leading to oxygen depletion or anoxic conditions. These, in turn, have resulted in large-scale mortalities of fish and shellfish, often leading to rock lobster 'walkouts'[20, 21] with obvious adverse effects on the respective fishing industries.

The earliest accounts of marine mortalities due to red-tide-induced low-oxygen events were recorded in the 1800s and periodically ever since, and the incidence of low oxygen events appears to be rising. There appears to be a global increase in the frequency and severity of harmful algal blooms, in many cases related to human activities such as coastal pollution[18]. In 1999, the Department of Environmental Affairs and Tourism established a dedicated Red Tide Response Team, with the task of responding to the detection of a red tide event at any of the monitoring stations between Doring Bay and Cape Agulhas. This team is required to take daily water samples to monitor toxicity levels, educate and inform the public, and issue warnings of dangerous toxicity levels.

7.3.9 Climate change

During the past decade, it has become globally accepted that the Earth's climate is rapidly changing and that the effects of anthropogenic activities are becoming increasingly evident[2]. The Intergovernmental Panel on Climate Change (IPCC) states that global average surface temperatures have increased, global mean sea level is rising, and the concentration of ozone in the stratosphere has decreased. Average annual rainfall has also changed and the intensity and frequency of extreme weather events seem to have increased[22].

The monitoring of sea surface temperature, mean sea level, and rainfall in South Africa suggests that changes in the local environment echo global patterns, with significant consequences likely for marine ecosystems. Nearly all sectors of the South African fishing industry could be affected, specifically the subsistence and small-scale sectors, which have limited scope for adapting to changing conditions.

The anticipated further reductions in the amount of freshwater entering estuaries in South Africa will continue cumulatively to have an impact on these already affected systems. Reduced freshwater flow will also lower the extent to which wastewater discharges are diluted before they reach estuaries, thereby increasing the concentration of pollutants in the coastal zone and limiting their capacity to support natural biota. Loss or reduction in the quality of estuarine habitats is likely to have serious consequences for fisheries that target estuary-associated species[2]. Changes in freshwater flow to estuaries along the east coast will have an impact on the east coast prawn trawl fishery, as freshwater flow into estuaries is integral for supplying the food supply and habitat required by juvenile and adult

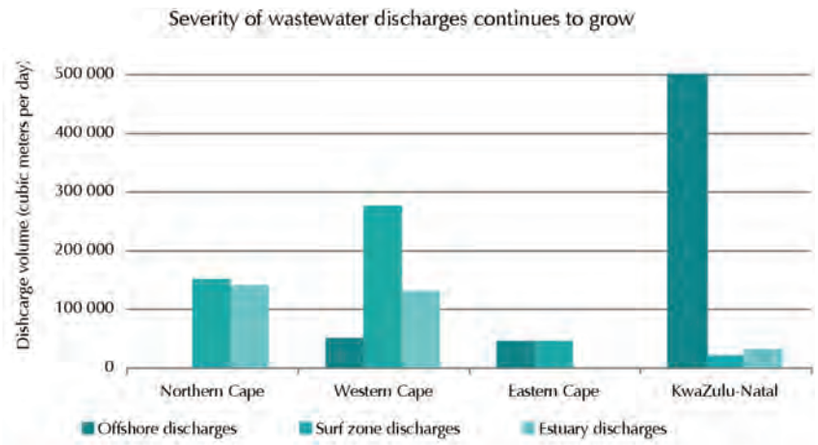


Figure 7.5: Total daily wastewater discharged into the marine environment per coastal province, 2003
Source: Department of Water Affairs and Forestry (2004)[17]

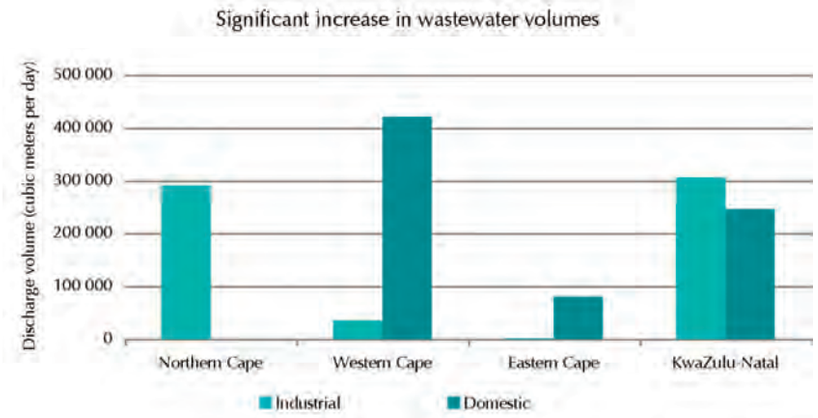


Figure 7.6: Total daily breakdown of industrial and domestic wastewater discharged into the marine environment per coastal province
Source: Department of Water Affairs and Forestry (2004)[17]

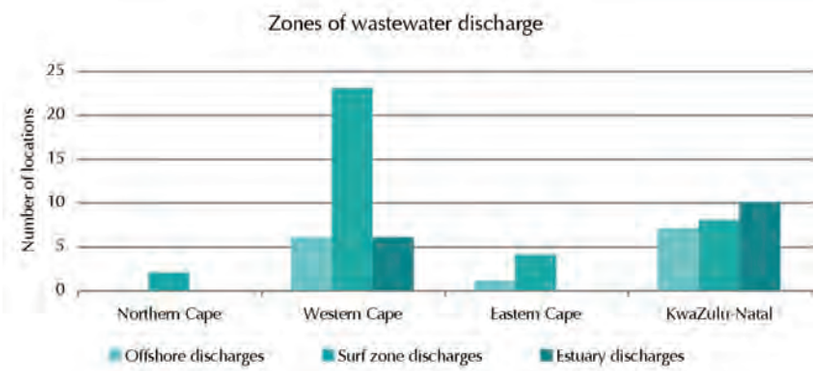


Figure 7.7: Location of coastal wastewater discharge points in the South African marine environment per coastal province
Source: Department of Water Affairs and Forestry (2004)[17]

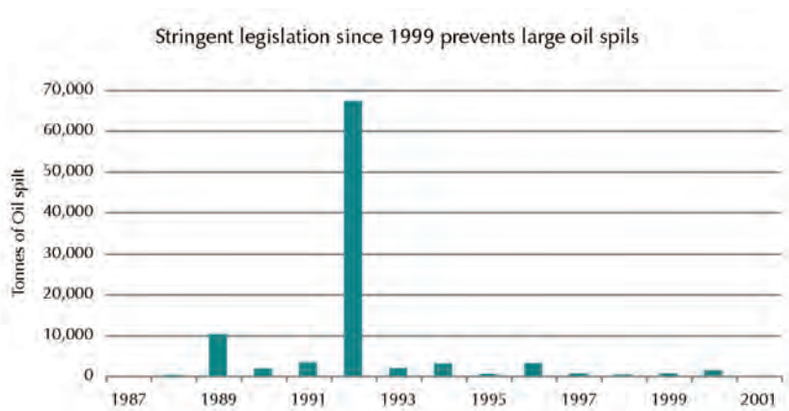


Figure 7.8: Incidents and volume of marine oil spills in South Africa's Exclusive Economic Zone, 1987–2001

Source: Department of Environmental Affairs and Tourism: Marine and Coastal Management and National Ports Authority

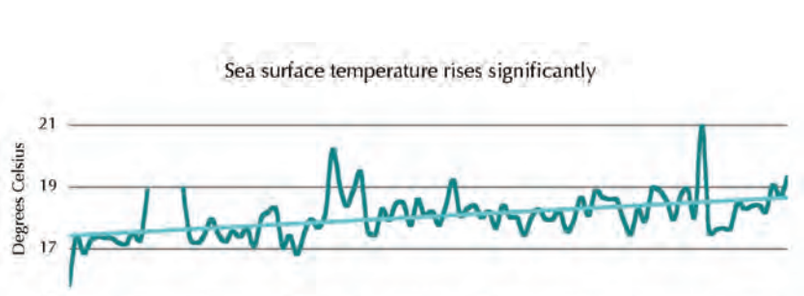


Figure 7.9: Mean annual sea-surface temperature collected from Voluntary Observing Ships (VOS) between Struisbaai and Knysna up to 60 nautical miles offshore, 1903–2004

Source: Southern African Data Centre for Oceanography (SADCO)

prawns[23, 24]. The east coast prawn trawl fishery is small in terms of vessel numbers and total retained catch, but it is economically and socially important to the region[25, 26]. The total catch of the inshore prawn fishery has averaged 70 tonnes over the last ten years, and yields a total landed value of R8.5 million per year[24].

Sea-surface temperatures off southern Africa appear to have increased by about 0.25°C per decade over the last four decades[27], and analysis of data collated from Voluntary Observing Ships (VOS) between Struisbaai and Knysna from 1903 to 2004, reflect this trend (see Figure 7.9). Changes in sea temperature can severely affect marine ecosystems and productivity[28]. As sea-surface temperatures rise, marine species are expected to respond by shifting their distribution patterns, particularly those species that are most sensitive to temperature. Fish species from the east coast are expected to invade waters further south in greater numbers, while the distributional ranges of species in the cooler west coast waters may retreat to greater depths, or become restricted to the immediate vicinity of bodies of upwelled water (through a process whereby cold water is brought to the surface near the coast under the influence of longshore equatorward winds)[2].

An increase in sea-surface temperature is also correlated with a rise in sea level, with increases of 10–15 mm having been measured over the last century. Tide gauge measurements from South Africa indicate that sea levels have risen by approximately 1.2 mm/annum over the last three decades[29] and this trend is expected to accelerate in future, with recent estimates suggesting a 12.3-cm rise by 2020, a 24.5-cm rise by 2050, and a 40.7-cm rise by 2080[30]. The potential impacts on coastal environments include increased coastal erosion, inundation, increased salt water intrusion, raised groundwater tables, and increased vulnerability to extreme storm events[31]. The direct effects of rising sea levels on the ecological functioning of marine biota are less obvious and, while some regions might be directly harmed (for example, salt marshes), others are predicted to undergo shifts in distribution patterns and/or zones (for example, rocky shores) where such shifts are still possible.

7.4 EXPLOITATION AND USE

7.4.1 Pelagic fisheries

South African commercial and recreational fishers exploit over 250 marine species, although fewer than 5% of these are actively targeted and these very few species comprise 90% of the catch[32]. The pelagic purse-seine fishery – targeting predominantly sardine (*Sardinops sagax*) and anchovy (*Engraulis encrasicolus*), with redeye herring (*Etrumeus whiteheadi*) and horse mackerel (*Trachurus spp.*) supplementing the catch – supplies the greatest tonnage of fish landed per year (538 000 tonnes in 2002; see Figure 7.10). The contribution of sardine to the total 2004 South African pelagic catch of 373 000 tonnes reflects the current healthy status of the sardine stock, after a near-collapse in the late 1960s (see Figure 7.11). Recovery of this stock reflects good management, principally based on a large reduction in fishing activities. The further recovery of sardine stocks since 1999 has also assisted other marine species that feed on sardines, such as snoek, yellowtail, seabirds, and seals.

7.4.2 Demersal fisheries

The demersal trawl fishery[b] is South Africa's second largest fishery in terms of the amount of fish landed (163 500 tonnes in 2003; see Figure 7.12) and the most important in terms of value, having contributed some R1.6 billion in 2003 (47% of the total revenue of South African fisheries).

The pelagic fisheries supply the greatest tonnage of fish landed per year (sardines). *Photography: Tony van Dalsen*

The deep-sea hake (demersal offshore trawl) lands the highest value catch, contributing 44% to the total revenue of South African fisheries (the pelagic and line fisheries contribute 20% and 11%, respectively (see Figure 7.10).

In the 1960s, the demersal trawl fishery contributed as much as 90% of South Africa's overall fish landings, but this contribution declined to 60% during the 1990s because of a shift in focus to mixed-species fisheries and increased landings of the by-catch from this fishery. The demersal trawl fishery is non-selective, yielding a high proportion of by-catch and causing extensive environmental degradation of the seabed. Long-line fishing is less destructive on the marine environment (although more dangerous to seabirds) as it targets most demersal trawl species more successfully and discards only a limited amount of by-catch. In 1983, an experimental hake long-line fishery was first introduced in South Africa[14]. This form of fishing was extremely effective in catching a large amount of kingklip (*Genypterus capensis*), also a very valuable and marketable species[26]. In 1986, as a result, catch rates of kingklip began to decline noticeably and, although a maximum limit of 5 000 tonnes of kingklip by-catch was set, catches continued to decrease further[26]. By early 1991, all demersal long-line

Long-line fishing is an effective way to catch large amounts of kingklip, a valuable and marketable species. *Photography: Tony van Dalsen*

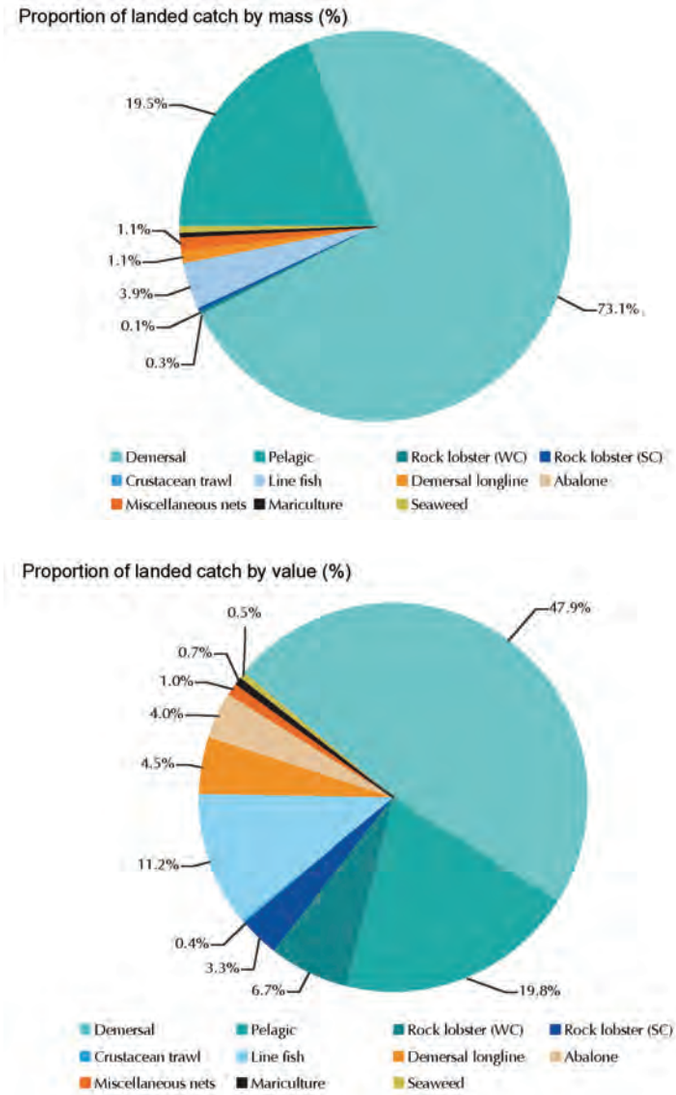


Figure 7.10: Landings of commercial fisheries and the proportion they contributed to fishery (Rand) value, 2000

Source: Fishing Industry Handbook (2004)[5]

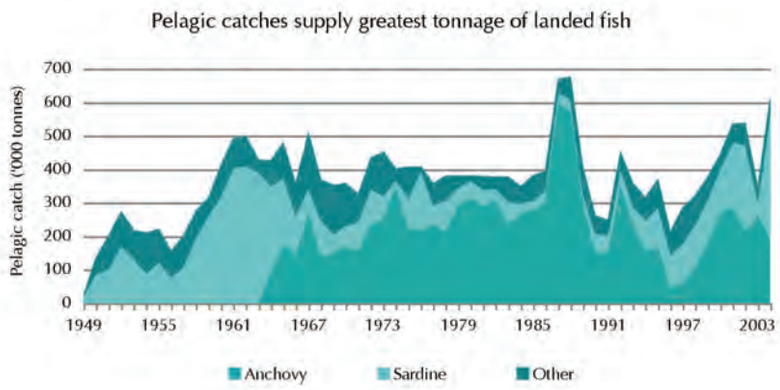


Figure 7.11: Pelagic fisheries catches in South Africa, 1950–2004

Source: Department of Environmental Affairs and Tourism and Council for Scientific and Industrial Research: Marine and Coastal Management - Pelagic Section

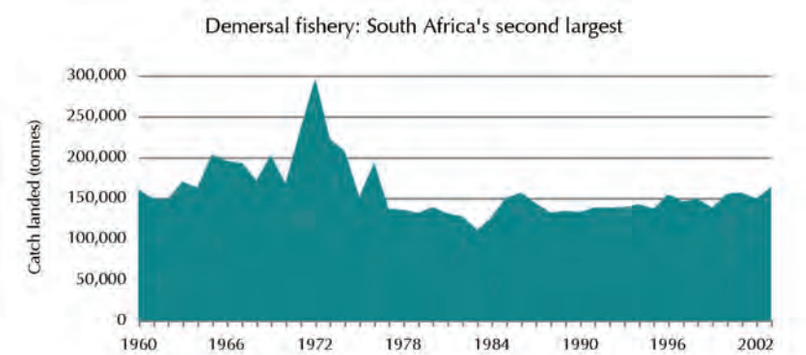


Figure 7.12: Commercial catch landed for hake fishery (*Merluccius paradoxus* and *M. capensis*) from offshore and inshore trawl, hand-line, and long-line catches, 1960–2003

Source: Department of Environmental Affairs and Tourism: Marine and Coastal Management, Demersal Section

fishing was officially stopped, but in 1994 a hake-directed experimental long-line fishery was established, with increasing total allowable catches being allocated each subsequent year[26]. Currently, hake stocks are targeted by demersal trawl (deep-sea and inshore), long-line, and hand-line (from ski-boats) fishing efforts, which place considerable pressure on this resource. Since 1999, the hake resource has shown early warning signs of depletion and, as a precautionary measure, the total allowable catch has been reduced by between 2 000 and 3 000 tonnes each year since 2003. The status of the stocks and the associated environmental parameters are being carefully monitored[33].

7.4.3 Line-fisheries

Linefish comprise the third most important South African fishery with respect to total tonnes landed and total value. In 2000, the total reported commercial linefish catch was 24 103 tonnes, contributing 11% of the total value of South African fisheries[5]. Landings from the open-access recreational fishery are not reported, however, and the total catch from this sector is estimated to be double that of the reported commercial sector.

The uncontrolled exploitation of these stocks has had significant adverse effects: of the most frequently targeted linefish species, at least 18 are classified as collapsed, 4 as over-exploited, 6 as optimally exploited, and only 2 as under-exploited[34]. Factors contributing to the demise of linefish stocks include increased commercial and recreational fishing, in conjunction with life-history traits (in particular, predictable locality, longevity, and late maturity), so these species have become especially vulnerable to over-exploitation[35]. Two linefish species currently being optimally exploited are snoek (*Thyrsites atun*) and yellowtail (*Seriola lalandi*)[32]. Hottentot (*Pachymetopon blochii*), elf/shad (*Pomatomus saltatrix*), red roman (*Chrysoblephus laticeps*), and carpenter (*Argyrozona argyrozona*) are considered to be over-exploited, while some of those that have collapsed are silver kob (*Aryrosomus inodorus*), white steenbras (*Lithognathus lithognathus*), red stumpnose (*Chrysoblephus gibbiceps*) and slinger (*Chrysoblephus puniceus*)[32].

To address the failure of past regulations in managing South Africa's linefish resource, a Linefish Management Protocol (LMP) was developed in 1999, bringing drastic reductions in commercial linefish effort and stringent bag limits for recreational fishers. Little has improved in the status of most linefish species since 1999, however, and the opportunity costs of the degrading of this resource are enormous. New linefish policies, based on the Linefish Management Protocol, were gazetted in May 2005 to help to rebuild linefish stocks.

7.4.4 Rock lobster

The west coast rock-lobster fishery is one of the country's oldest fisheries, dating back to at least 1875, when the first commercial processing plant was established[14]. Commercial, subsistence and recreational fisheries target the rock lobster (*Jasus lalandii*) and are managed using combinations of total allowable catch quotas allocated for zones along the coast, a minimum size limit, closed seasons, daily bag limits, and restricted fishing (08h00–16h00) during seasonal fishing days.

The annual commercial landings of rock lobster have decreased since the 1960s (see Figure 7.13), indicating that the high landings of earlier years were unsustainable[14]. During the 1990s, a decrease in growth rate, and insufficient numbers of juvenile lobsters in the population to sustain a healthy fishery in the immediate future, further reduced total rock-lobster landings, with the total allowable catches down to about half that of the 1980s[14]. Currently, the harvestable biomass (75 mm carapace length) is estimated to be only some 5% of pre-exploitation levels and the spawning biomass approximately 20% of pristine levels[36]. Despite this significant depletion on the west coast, the population has now stabilized, but the reduced growth-increment rate is sufficient to implement a stock rebuilding strategy. There appears, however, to have been a substantial increase in abundance on the southeast coast[37, 38], an area not traditionally considered commercially viable for rock-lobster fishing. After an experimental fishery was introduced in 1999, a limited-scale commercial fishery was implemented in this region (in 2003) with an allocation of 230 tonnes per year[39].

7.4.5 Abalone

South Africa's abalone (perlemoen) resource is at present facing severe crisis, and extreme management measures have been implemented to prevent the targeted species, *Haliotis midae*, from becoming commercially extinct. A combination of extremely high international demand and

exorbitant prices, coupled with insufficient enforcement capacity within South Africa, has led to the establishment of well-organized illegal abalone fishery syndicates. Unlawful harvesting of abalone has always been a problem[c] but, since 2000, poaching levels have escalated dramatically. Recent data indicate that the fishery is collapsing and will disappear as an exploitable resource unless improved enforcement and compliance occur immediately (see Figure 7.14). The opportunity costs in terms of economics and loss of livelihood of allowing this resource to collapse are enormous.

To address this crisis, the commercial abalone fishery underwent severe total allowable catch reductions (by 47%, from 500 tonnes in 1999/2000 to 237 tonnes in 2004/2005)[40]. Even more dramatic, for the first time in history, was the complete closure of the recreational abalone fishery for the 2003/2004 fishing season and thereafter for an indeterminate period.

Compounding the effects of poaching is the ecological change occurring at the centre of the most productive abalone region, between Cape Hangklip and Hermanus on the southwestern coast of the Western Cape, on account of the increase in rock lobster (*Jasus lalandii*) abundance in this region, initially detected in 1994[37]. Rock lobsters consume small invertebrates, including sea urchins (*Parechinus angulosus*), which provide essential shelter for juvenile abalone[38,41]. Decreasing abundance of sea urchins, due to increased predation by rock lobster, reduces recruitment to the abalone population. Intense poaching, together with ecosystem changes resulting in reduced recruitment, has severely reduced abalone density in the main commercial fishing grounds. Data collected from the 1980s until 1998 show densities of between 0.8 and 1.3 abalone/m^2 but, mainly because of poaching, densities in the primary fishing areas are currently below 0.3 abalone/m^2. As broadcast spawners, abalone require a minimum density to ensure reproductive success. It is not yet known if current densities have reached the point where nearest neighbour distances are so great that fertilization is unlikely to occur, but it is likely that recruitment success is already severely compromised.

7.4.6 Patagonian toothfish

Patagonian toothfish, or Chilean Sea Bass (*Dissostichus eleginoides*), occur in the South African EEZ around Prince Edward and Marion Islands. This species is among the most lucrative, being in high global demand, especially in Japan and the United States of America. In 1996, the Department of Environmental Affairs and Tourism issued five fishing companies with experimental licences to harvest Patagonian toothfish from the waters surrounding the Prince Edward Islands. The species, however, is large, slow growing, and long-lived (up to 50 years), and reaches sexual maturity only after about 10 years, making it readily susceptible to over-fishing. Illegal harvesting by foreign vessels has been

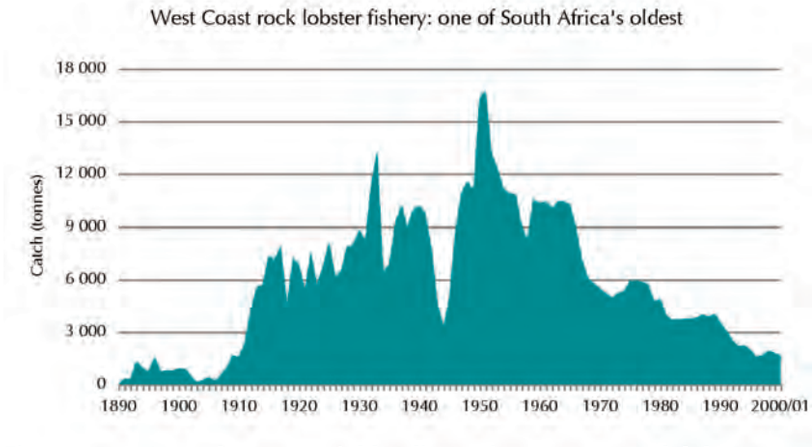


Figure 7.13: Annual commercial landings of west coast rock lobster (*Jasus lalandii*) in South Africa, 1890–2001

Source: Griffiths et al. (2004)[14]

Illegal harvesting of the Patagonian toothfish could lead to its extinction.

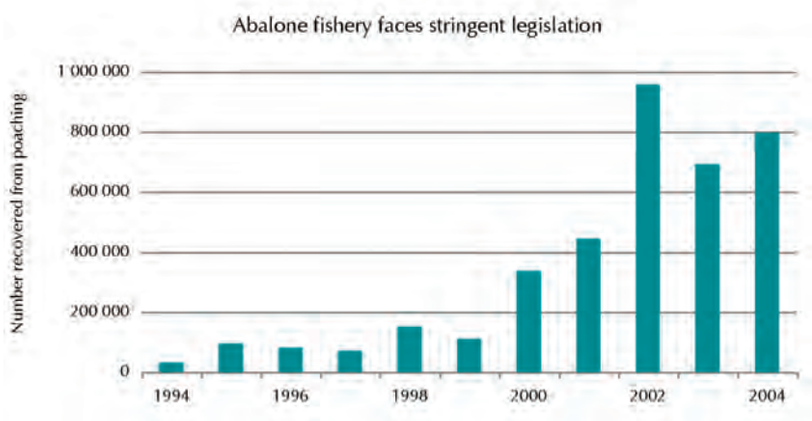


Figure 7.14: Records of numbers of whole abalone confiscated, 1994–2004

Source: Department of Environmental Affairs and Tourism: Marine and Coastal Management, Abalone Section




so rampant that, the data suggest, the species could become commercially extinct by 2007 – a massive loss of a resource only recently considered for exploitation by South Africa.

7.4.7 Other living marine resources

Commercial, recreational, and subsistence fishers along the South African coast target a host of other marine resources. These include mullet (*Liza richardsonii*) by beach-seine and gill-net fishery off the west coast, prawns (*Penaeus indicus, P. monodon, and Metapenaeus monoceros*) by trawl fishery in KwaZulu-Natal, squid (*Loligo vulgaris reynaudii*) in the Eastern Cape chokka fishery, and various seaweed species (for example, *Ecklonia maxima, Laminaria pallida, and Gracilaria spp.*). These fisheries provide important local contributions to fish landings and livelihoods. Most are relatively healthy, but some have seen declining catches in recent years (for example, prawn trawl and mullet fisheries).

Development of new or experimental fisheries is

Box 7.1 Future opportunities: non-consumptive marine resource – the boat-based whale-watching industry in South Africa

Land-based whale-watching at Hermanus in the South-western Cape in the early 1990s rapidly established the reputation of providing some of the best land-based whale-watching in the world. Increasing demand and international trends led to the establishment of legal boat-based whale-watching in South Africa in 1998, and this industry has grown significantly in the past decade, largely associated with the slow recovery of the southern right and humpback whale populations along the coast. The number of boat-based whale-watching permit holders and the number of passengers increased each year between 1999 and 2003, remaining stable in 2004.

Although many species of cetaceans frequent the shores of South Africa, the whale-watching industry focuses on southern right (*Eubaleana australis*), humpback (*Megaptera novaeangliae*), and Bryde's (*Balaenoptera edenii*) whales. The large diversity of many other marine species, including dolphins, seals, and seabirds, contributes to the country's overall marine tourism industry. Each winter, southern right whale populations migrate to the South African coastline, seeking the protection of sheltered bays to mate and calve. The whales occur in greatest concentrations along the south coast, between Kleinmond in the west and Mossel Bay in the east, and generally within one nautical mile from the shore. Owing to the migratory behaviour of some whales, peak tourism periods, and suitable weather and sea conditions, boat-based whale-watching is in greatest demand between July and December, although more generalist marine tours supplement the off-peak whale season in several coastal areas. Humpback and Bryde's whales occur along the Eastern Cape Garden Route throughout the year and improve the viability of year-round whale-watching tours in these regions.

To ensure the protection of whales from any adverse effects potentially inflicted by whale-watching, the industry has become increasingly regulated around the world, with South Africa's regulations among the most stringent. Permits are administered by Marine and Coastal Management: they allow permitted boat operators to approach whales to within 50 m for a maximum of 20 minutes. Boats without a whale-watching permit must remain a minimum of 300 m from any whale. Mother-calf pairs, however, are not to be approached by any boats, and several popular calving and mating grounds have been declared sanctuaries, so as to prevent excessive disturbance. A strict code of conduct for permit-holders has been established and is supported by the South African Boat-Based Whale-Watching Association. Marine and Coastal Management is responsible for policing the industry in South Africa, except in KwaZulu-Natal where Ezemvelo KZN Wildlife takes on this responsibility. Boat-based whale-watching is currently classified as an experimental fishery with permits being annually renewable, but a new policy is being drafted with plans for longer-term permit allocations.

An economic assessment of boat-based whale-watching in South Africa established that the industry currently generates about R45 million in tourism expenditure and contributes approximately R37 million to South Africa's gross domestic product per year, with the potential for even greater economic success. The number of boat-based whale-watching permits could be increased by at least 20% (based on existing demand relative to supply), and possibly up to 40% in the near future (based on the quality of resources and existing, untapped markets). The extent of current boat-based whale-watching activities indicates the increased viability of this industry in many of South Africa's coastal regions, adding significant value to the marine tourism industry. Strong marketing combined with existing tourism growth is expected to lead to growth in demand. In capitalizing on the full future economic potential of the resource, however, management of the industry will need to address sustainable development in terms of its principal mandate of protecting the resource.

Whale-watching at Hermanus. *Photography: South African Tourism*

continually being investigated, and has received far greater attention since 1999. Possibilities exist for developing a new sector of the pelagic fishery, which will target red-eye round herring[5]. Fifteen experimental fishing permits have been issued for octopus (*Octopus vulgaris*), each having an allocated specific catch zone along the coastline. Rights-holders were expected to commence fishing in 2005[42].

Mariculture of marine species commenced in the 1950s and has continued to grow in South Africa, with the successful farming of the introduced Mediterranean mussel (*Mytilus galloprovincialis*) in Saldanha Bay, oysters (*Crassostrea gigas*) in Knysna, and abalone along the west coast. Mariculture permits have also been issued for prawns and seaweeds. Research indicates that certain fin-fish species (such as Cape salmon, *Atractoscion aequidens,* and dusky kob, *Argyrosomus japonicus*) are ideal candidates for successful mariculture ventures, and the experimental farming of Norwegian salmon and turbot is under way[42].

7.4.8 Non-consumptive use

In the past five years, there has been an increased focus on developing non-consumptive marine resource use in South Africa (for example, whale and shark viewing). With rigorous management, such activities can successfully generate interest in marine conservation, socio-economic empowerment, and employment opportunities for coastal communities. There are currently 12 permit-holders for shark-cage diving in South Africa, with the proposed addition of two permit holders in 2005[43]. The overall number of boat-based whale-watching permits issued by Marine and Coastal Management has steadily increased since 1999, with a maximum of 18 permits issued for 2004. These are encouraging trends, suggesting increasing demand for and growth in non-consumptive marine resource use in South Africa.

7.5 PROTECTION AND MANAGEMENT

The monitoring the population trends of The World Conservation Union (IUCN) Red Listed species[d] has been used as a conservation tool in South Africa since the 1970s[44]. In many marine taxonomic groups, however, there is a lack of base-line information on the species, their populations, and their distributions, mainly because of the difficulties involved in collecting such information underwater. Species that are valuable marine resources have mostly been monitored in terms of their commercial status rather than their ecological well-being. The most recent evaluation of South Africa's marine fish status indicates that over 20 species of commercial and recreational marine fish are over-exploited and/or collapsed[32, 45]. Since the beginning of the 21st century, specialized studies on specific targeted fish species (such as Scotsman, Englishman, belman, carpenter, red roman) all further confirm their continuing deteriorating status[46]. On its Red List, the IUCN lists 53 species of coastal fish found in South African waters, but this is a global assessment and its relevance to actual fish populations in South Africa has been questioned[47].

Through habitat degradation and increasing human pressures on estuaries, four South African estuarine fish species are on the IUCN Red List: the doublesash butterfly fish (*Chaetdon marleyi*), the Knysna seahorse (*Hippocampus capensis*), the St Lucia mullet (*Liza luciae*), and the estuarine pipefish (*Sygnathus watermeyeri*), all of which are critically endangered.

All five species of marine turtles occurring in South African waters are on the IUCN Red List as either vulnerable or endangered. Leatherback turtles (*Dermochelys coriacea*) are particularly susceptible to long-line fishing and trawling, but the use of turtle-excluder devices has been made mandatory and has assisted in promoting the status of leatherback turtles from critically endangered in 2001 to endangered in 2004.

Oceanic and coastal bird species are primarily threatened by long-line fishing activities, habitat loss, and disturbance while nesting. On the Red List, the Tristan albatross (*Diomedea dabbenena*), sooty albatross (*Phoebetria fusca*), and black-browed albatross (*Thalassarche melanophrys*) are in the endangered category, while the spectacled petrel (*Procellaria conspicillata*) is listed as critically endangered. Four other albatross species are listed as vulnerable (the wandering albatross [*Diomedea exulans*], the southern royal albatross [*Diomedea epophora*], Salvin's albatross [*Thalassarche salvini*], and the grey-headed albatross [*Thalassarche chrysostoma*]). At least six oceanic and coastal bird species (including the above) have been added to the IUCN Red List as either endangered or vulnerable during the past decade.

Spectators at Boulders Coastal Park watching penguins on the beach. *Photography: South African Tourism*

7.5.1 Legislation

South Africa is signatory to a wide range of international treaties and conventions, including:

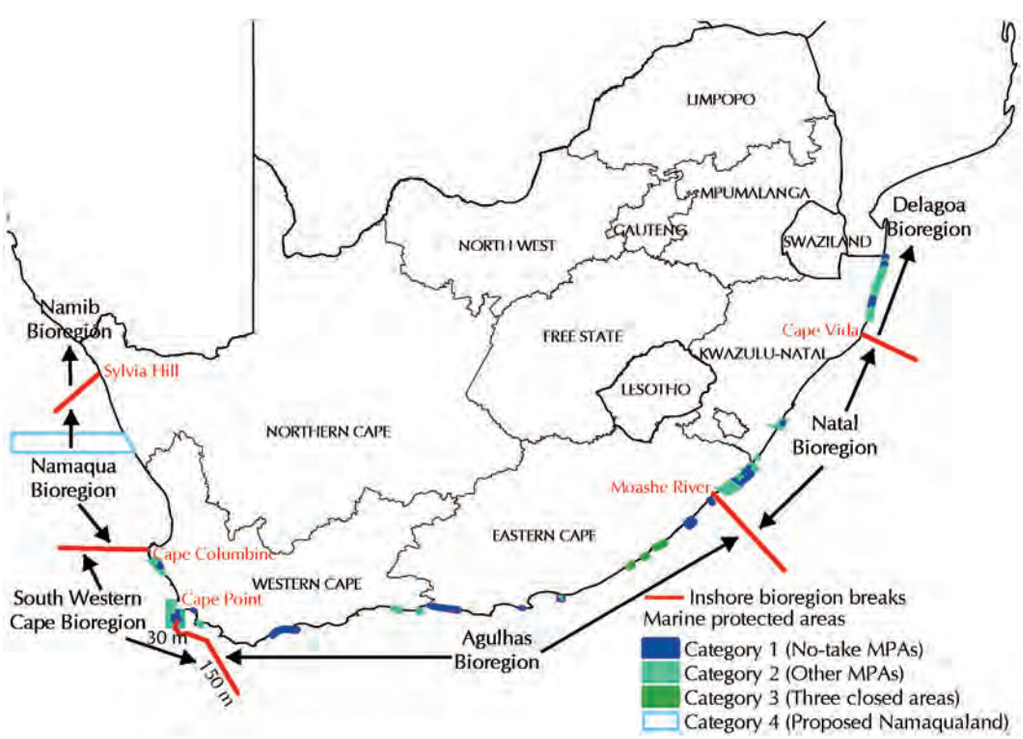
- The International Convention for the Prevention of Pollution from Ships (MARPOL)
- The Convention on Biodiversity
- The United Nations Convention on the Law of the Sea (management of straddling and migratory fish stocks)
- The London Convention (regulating the dumping of waste at sea)
- The Bonn Convention (conservation of migratory species, including seabirds).

Nationally, South Africa's natural environment is governed by a wide range of legislative acts, including the Constitution of the Republic of South Africa (1996), National Environmental Management Act (No. 107 of 1998), the Environmental Conservation Act (No. 73 of 1989) and, of greatest relevance to marine and coastal resources, the Marine Living Resources Act (No. 18 of 1998).

The Marine Living Resource Act (MLRA) for the first time recognizes the subsistence fishing sector and incorporates the fact that many coastal communities of South Africa derive their livelihoods directly from marine resources. This act has greatly widened the parameters of management requirements since 1999, contributing to the overall improved marine legislation. To ensure the sustainability of natural resources around the coast and to secure the future livelihoods of coastal communities, several Sustainable Coastal Livelihood Initiatives were introduced at provincial level. Most of these programmes form part of the National Coastal Management Initiative driven by civil society, government (Department of Environmental Affairs and Tourism), and private businesses. The aim of the programme is to identify, promote, and help to establish

Bird Island, part of Addo Elephant National Park.

Photography: South African National Parks



Map 7.2: Five bioregions of the South African Exclusive Economic Zone

Source: Lombard et al. (2004)[49]

non-consumptive or alternative coastal livelihood resources, and it requires community ownership. A total of 17 Sustainable Coastal Livelihoods projects have been registered in South Africa since 1999 and their total estimated value is R360 million.

7.5.2 Marine Protected Areas

Areas of the ocean closed to fishing activities, particularly 'no-take' Marine Protected Areas (MPAs), are the only effective means of protecting entire marine ecosystems[6]. Marine Protected Areas conserve biodiversity by providing refuge for marine fauna and flora and undisturbed sites for research, monitoring, education, and tourism[1].

Since 1999, South Africa's Marine Protected Areas have come under scrutiny, leading to concerns over the fragmentary approach of declared Marine Protected Areas and the fact that Marine Protected Areas do not systematically encompass the country's marine biodiversity[6]. A total of 22% of South Africa's 3 000-km coastline has some degree of protection, but only 9% of the coastline is protected by no-take Marine Protected Areas (Category 1) with an additional 13% protected by limited extraction (Category 2) and closed area Marine Protected Areas (Category 3). The objective is to achieve 20% of no-take Marine Protected Areas coastline in South Africa.

The country's EEZ marine environment has been divided into five bioregions: Namaqua, South-western Cape, Agulhas, Natal, and Delagoa (see Map 7.2). Since the promulgation of the MLRA in 1998, the Marine Protected Areas network has expanded and improved management strategies have been implemented (see Map 7.3). In 2004, four new Marine Protected Areas were declared in South Africa (Aliwal Shoal, Pondoland, Bird Island, and parts of the Cape Peninsula and Namaqua Marine Protected Area), which increased the length of coastline within Marine Protected Areas in four of the five bioregions. The proportion of the coastline with 'no-take' and 'limited-take' Marine Protected Areas increased in three bioregions, while the proportion of single-species reserves (inappropriate for ecosystem protection) decreased. Most important, the increases in Marine Protected Areas occurred in bioregions where they were most urgently required, except for the Namaqua bioregion, where increased protection inshore and offshore is still needed[6]. The total area of the South African EEZ encompassed in some form of Marine Protected Areas increased from 0.3% in 1997 to 0.4% in 2004, but no protected area currently extends further than 30 km offshore[48] (see Figure 7.15). A 50-km-long Marine Protected Area has been proposed, located between the Groen and Spoeg rivers, stretching to the edge of the EEZ, in the Namaqua bioregion, which would greatly improve the protected proportion of this bioregion and that of the overall EEZ.

Despite the progress already made to safeguard South Africa's coastline, the urgent need remains to protect offshore habitats, especially in the light of the impacts of offshore fishing and mining activities on the marine environment.

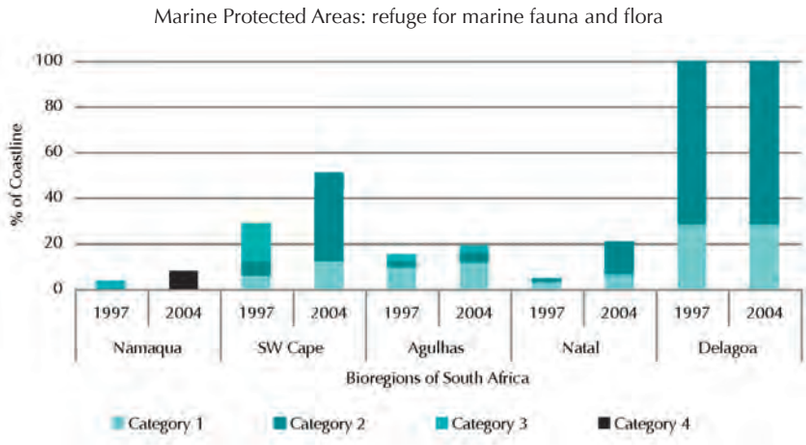


Figure 7.15: Proportions of the South African coastline within marine bioregions included within various categories of Marine Protected Areas (MPAs)

Note:
Category 1 = 'no-take' Marine Protected Areas
Category 2 = some extraction is permitted
Category 3 = protection of a single species only
Category 4 = proposed Marine Protected Areas

Source: Adapted from Lombard et al. (2004)[49] and Branch and Clark[6]

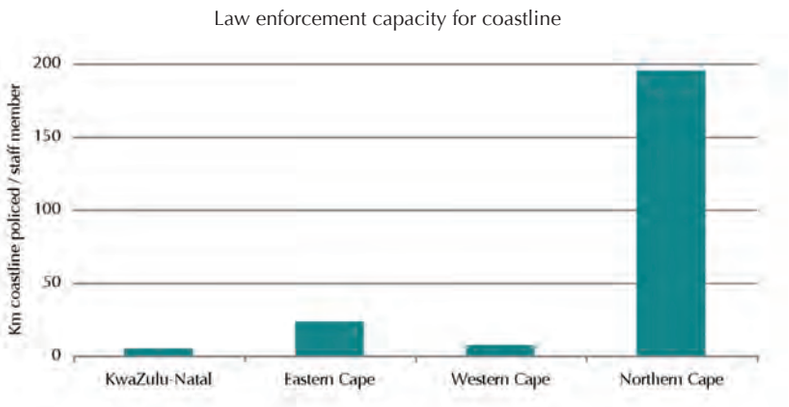


Figure 7.16: Length of coastline (km) policed by each law enforcement staff member in each coastal province

Source: Department of Environmental Affairs and Tourism and Council for Scientific and Industrial Research (2005)[4]

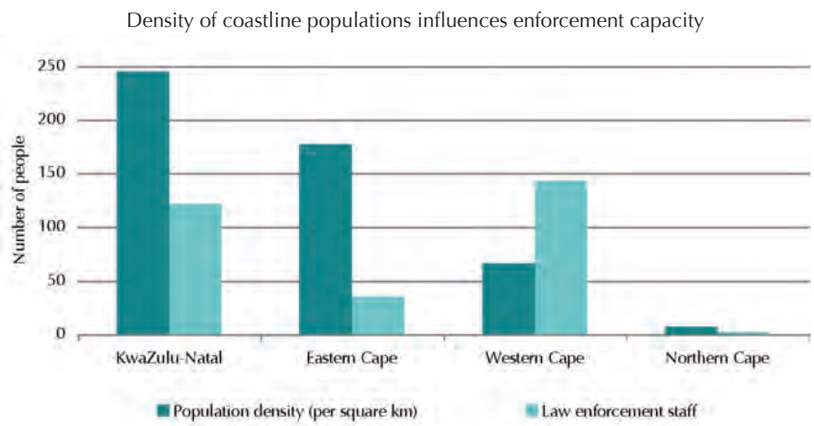


Figure 7.17: Law enforcement capacity vs. population density in South Africa's coastal provinces

Source: Department of Environmental Affairs and Tourism and Council for Scientific and Industrial Research (2005)[4]

Collecting mussels as part of the Mussel-Watch Programme.

Photography: Charles Griffiths

7.5.3 Law enforcement

Law enforcement and compliance within South Africa's marine and coastal environment is the national responsibility of the Department of Environmental Affairs and Tourism: Marine and Coastal Management Branch (MCM) and is carried out by the Chief Directorate: Monitoring, Control and Surveillance. Fishery control officers, field rangers and other general administration or support staff are employed to ensure compliance among the 21 fishery sectors and the general public, in accordance with the MLRA of 1998. In 1999, the Department of Environmental Affairs and Tourism officially delegated responsibility for marine and coastal law enforcement in KwaZulu-Natal to Ezemvelo KZN Wildlife (formerly Natal Parks Board), a parastatal conservation body in the province. Since then, it has also further devolved enforcement and compliance responsibility to provincial and local authorities and other conservation agencies such as South African National Parks (SANParks) and Cape Nature. The 301 staff members currently employed to address compliance in the marine sectors are spread among the coastal provinces (Western Cape [143], KwaZulu-Natal [121], Eastern Cape [35], and Northern Cape [2]), taking into account the length of coastline, population density, and development of fishing industries. The two staff members in the Northern Cape are responsible for 195 km of coastline each (see Figure 7.16), but the population density along this coast is a mere 7 people per km^2 and much of the land is under mining concessions, which do not require patrols. KwaZulu-Natal has the highest population density (245 people per km^2) followed by the Eastern Cape (177 people per km^2). The Western Cape has 66 people per km^2 (see Figure 7.17), but also hosts most of the country's fishing industries and supports a significant number of recreational fishers.

7.5.4 Monitoring and surveillance

To enhance the capacity for monitoring, control and surveillance of South Africa's vast marine environment, the Department of Environmental Affairs and Tourism purchased one offshore and three inshore fisheries and environmental protection vessels, the first of which, the *SAS Lillian Ngoyi*, was launched in December 2004. They are capable of remaining at sea for up to 14 days and equipped to implement oil spill counter-measures as well as search and rescue operations, and their role is to monitor all commercial fishing activities. The presence of the four new patrol vessels is expected to improve levels of compliance considerably and to reduce piracy and pillaging of our resources by foreign vessels.

7.5.5 The Mussel-Watch Programme

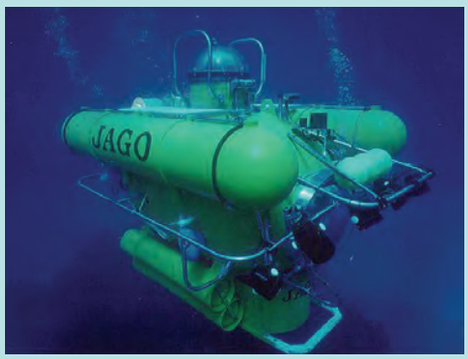
Mussels are good indicators of water quality because they are sessile bio-accumulators (that is, they accumulate pollutants impinging on marine ecosystems). The Mussel-Watch Programme was initiated by the Department of Environmental Affairs and Tourism in 1985 to monitor the heavy metal concentrations in the tissues of the Mediterranean mussel (*Mytilus galloprovincialis*) at 42 sites in the Western and Northern Cape. The programme was expanded to Durban and East London in 2004. Since 1985, levels of lead in the mussel tissue have declined noticeably, although those in areas of False Bay in the Western Cape continue to be unsatisfactorily high. Levels of zinc and cadmium appear to be increasing, although this could be due to natural causes, as the concentrations remain high, even in sample sites that are not affected by human activity[14].

Box 7.2 The African Coelacanth Ecosystem Programme (ACEP)

In 1938, the first known South African coelacanth was caught in the nets of a fishing trawler near the Chalumnae River mouth in the Eastern Cape. Prior to this event, the coelacanth was known only as a fossil fish that was thought to have become extinct nearly 70 million years ago. It was only 14 years later that another coelacanth specimen was encountered in the Comoros region, and further studies of this ancient fish were initiated. In October 2000, recreational Trimix divers encountered three coelacanths at 107 m in Jesser Canyon, Sodwana Bay, KwaZulu-Natal, the first coelacanths to be located in South Africa since 1938. By May 2001, as many as six individuals had been sighted in South African waters. The African Coelacanth Ecosystem Programme (ACEP) was officially launched in March 2002 with an exploratory expedition aboard the *FRS Algoa*, making use of the German submersible Jago to explore submarine canyons as deep as 400 m, not only in search of coelacanths but also to gain further understanding of deep-water marine ecosystems.

Through ACEP, 21 individual coelacanths have so far been documented in South African waters with several individuals known to be staying in the same area for over five years. The coelacanths occupy a depth range between 54 and 144 m in water temperatures between 16 and 23 °C, prey on deep water fish species, and bear live young. Although coelacanth research has revealed much about this unique fossil fish, many questions have arisen relating to the broader environment in which it lives. As many as 58 species of deep-water fish (some of which are new species, recorded in South Africa) have been documented, several new species of deep-water invertebrates are currently being described, 24 canyons (12 previously undiscovered) have been mapped, and 7 new habitat types have been identified as a result of the ecosystem research conducted through ACEP. More knowledge is urgently required about these mysterious deep-sea regions, which are increasingly threatened by advancing commercial and recreational fishing pressures.

The primary focus of ACEP is to develop scientific excellence in offshore marine research. It is a multidisciplinary project operating in South Africa, Mozambique, Tanzania, Kenya, the Comoros, the Seychelles, and Madagascar. Using the coelacanth as an icon unifying these countries, ACEP aims to integrate physical, chemical, and biological sciences within Geographic Information Systems (GIS) to gain a holistic understanding of ecosystem processes that sustain the western Indian Ocean. The aspects being studied through ACEP include:



- Geoscience – canyon formation, bottom composition, and topography of the sea
- Marine ecology – deep-water habitat classification, biodiversity surveys, fish counts, coelacanth studies, and marine reserve sites
- Oceanography – primary production and oceanographic variables such as currents, temperatures, salinities, and dissolved chemicals (nutrients and oxygen)
- Genome resources – the generation and preservation of indigenous genomic information and whole genome sequencing
- Phylogenetics – the relationships between different species
- Larval ecology of deep-sea ecosystems.

In addition, ACEP has strong environmental education sub-programmes and is developing a socio-economic and indigenous knowledge sub-programme. It is principally funded by the Department of Science and Technology and the Department of Environmental Affairs and Tourism, with many other partners providing additional funding and/or support for select components of the programme.

Further information on the African Coelacanth Ecosystem Programme is available at http://www.acep.co.za/

7.5.6 Environmental courts

In March 2003, the Department of Environmental Affairs and Tourism opened the first Environmental Court in Hermanus, Western Cape. The court concentrates on addressing environmental offences, specifically the illegal harvesting of abalone from the immediate region. Following the success of this court, a second was opened in Port Elizabeth in 2004, and the establishment of others around the country is being considered. The specialized courts were initiated to ensure a speedy trial for environmental offenders, with suitably qualified prosecutors and magistrates assigned to the cases.

7.5.7 Multi-sectoral governance

A further, effective means to ensure that marine resources are sustainably utilized and not over-exploited is to develop joint coastal management initiatives, whose aim is to build partnerships between the different government levels (national, provincial, district, and local), civil society, and the

Figure 7.18: Number of beaches awarded Blue Flag status in South Africa, 2001–2005

Source: Department of Environmental Affairs and Tourism and Council for Scientific and Industrial Research (2005)[4]



Box 7.3 The Southern African Sustainable Seafood Initiative (SASSI)

Worldwide, the popularity of seafood is rising, with consumers seeing it as a healthier food choice. This places increasing pressure internationally on retailers and fisheries to provide consumers with more information about seafood sustainability and related conservation issues, including legislation, over-fishing, habitat and ecosystem damage by fishing methods used, and avoidable by-catch and mortality of seabirds, turtles, and marine mammals. Seafood awareness campaigns are based on the principle that informed consumers can drive changes in seafood markets through the choices they make. To conserve and sustainably manage the great diversity of marine species utilized by the seafood trade in South Africa, local consumers need to know enough to make more sustainable seafood choices. Likewise, dealers in seafood need to know the laws that apply to this industry.

To address this information deficit, the Southern African Sustainable Seafood Initiative (SASSI) was initiated in November 2004, with three main objectives: 1) to promote voluntary compliance to the Marine Living Resources Act (MLRA) through education and awareness; 2) to shift consumer demands away from over-exploited species to more sustainable options; 3) to create awareness of marine conservation issues, especially those concerning commonly consumed species. The initiative is aimed at all participants in the seafood industry, from wholesalers to restaurateurs to consumers, and by 2007 will have established a standardized training network for seafood restaurants and retailers in South Africa's major urban centres.

Consumers will be encouraged to look out for 'no-sale' species that are sold illegally. The most important of these that regularly appear on restaurant menus are white musselcracker (*Sparodon durbanensis*) and white steenbras (*Lithognathus lithognathus*). There are also severely over-exploited species that consumers are encouraged to avoid, such as red steenbras (*Petrus rupestris*) and black musselcracker (*Cymatoceps nasutus*). Species from relatively healthy and well managed stocks are promoted, for example yellowtail (*Seriola lalandi*) and snoek (*Thyrsites atun*).

Further information on the SASSI is available at
http://www.wwf.org.za/sassi/

South Africa had 20 Blue Flag beaches in 2005.
Photography: Janet Peace

7.5.8 Blue Flag beaches

Blue Flag is a voluntary international programme that rewards excellence in beach management. It is currently active in 27 countries, mostly European. South Africa joined in 2001 and was the first country outside Europe to gain Blue Flag status. Blue Flag status is given to beaches that meet 14 water quality, environmental education and information, safety, and services criteria. It is awarded for one year only, encouraging continual improvement of coastal management. The number of beaches awarded Blue Flag status has continued to increase in South Africa since 2001 with KwaZulu-Natal consistently having the highest number (see Figure 7.18)[e].

7.5.9 Public awareness and education

Public awareness and education initiatives, aimed specifically at the marine and coastal environment, are addressed through the Integrated Coastal Management section of the Department of Environmental Affairs and Tourism's Marine and Coastal Management Branch. Initiatives that have been implemented include the Interpretive and Informative Signage Project, Adopt-a-Beach Programme, South African Coastal Information Centre, and the Coastal Indicator Programme. By the year 2008, the annual budget allocated for such public education initiatives is predicted to comprise 60% of the total annual Integrated Coastal Management budget (which is R23 million).

private sector. Two such national initiatives exist, both operating under the Coast Care Programme and receiving funding from national government: the Working for the Coast (WftC) Programme and the Sustainable Coastal Livelihoods Programme. Joint coastal management initiatives are anticipated to increase and expand as the benefits of such community level management and involvement becomes more apparent with time.


7.6 CONCLUSION

At an international level, the marine and coastal environment of South Africa is considered to be in a moderately healthy state, mostly because of strong management measures implemented in the past decade. Important management measures recently introduced to South Africa's marine conservation include:

- Improvements in many of the regulations governing the marine environment
- Allocation of long-term (8–15-year) fishing rights
- Transformation (that is, redistribution of fishing rights to historically disadvantaged individuals)
- Legislation preventing vehicles from driving in the coastal zone
- Proclamation of four new Marine Protected Areas (MPAs) and the proposal for a fifth
- Purchase of four new marine patrol vessels to improve protection of the marine environment
- Greater emphasis on public awareness and education.

Implementation of such management measures has directly and indirectly benefited the marine environment, with overall improvement in some sectors of the marine and coastal environment since the 1999 National State of Environment report. The pelagic resource, particularly sardine, appears to have recovered from a depleted state in the late 1960s; several mariculture ventures are proving to be potentially successful; and awareness and demand has increased for access to non-consumptive marine resources (whale and shark viewing).

Certain fisheries, however, particularly linefish and abalone, continue to decline dramatically, and they require immediate intervention. Other issues of concern for the marine environment have recently arisen or continue to pose severe threats, namely:

- Increasing uncontrolled coastal development leading to habitat degradation and changing land-use patterns
- Substantial increases in the amount of wastewater discharged into the marine environment
- Reduced freshwater flow having a harmful effect on estuaries and the associated species dependent on this sheltered environment.

There is also increasing evidence that global climate change is beginning to affect South Africa's marine environment, although there is still uncertainty about the extent of the impacts.

Over-exploitation of natural resources (wild stocks) from the ocean and coastal zone is still, by far, the single greatest threat to the marine environment. Exploitation of marine resources peaked in South Africa in the mid-1960s, when over one million tonnes of fish were extracted annually. Catch rates at this level were unsustainable and have declined considerably since then. With decreasing catch rates, alternative marine resources have been sought, including squid, octopus, and seaweed, and marine 'farming' (mariculture) has developed more intensively.

Improved regulations governing the marine and coastal environment now require focused enforcement efforts, to assist in rebuilding stocks and maximising the long-term, sustainable potential of its socio-economic contribution. Greater scope and encouragement needs to be focused on non-consumptive marine resource use, such as whale-watching, to advance the tourism potential and public awareness of the marine environment and to lead ultimately to greater overall well-being among South Africans in the future.

A SHORT HISTORY

South Africa's formal association with the Antarctic Continent commenced in January 1960 when the first South African National Antarctic Expedition (SANAE) took over the Norway Station near the edge of the ice shelf in Dronning Maud Land[50, 51]. The original Norway Station (renamed SANAE I) has been successively replaced over the years. South African scientists currently occupy SANAE IV, an above-ground station away from the ice edge at Vesleskarvet[f] in the northern Ahlmannryggen.

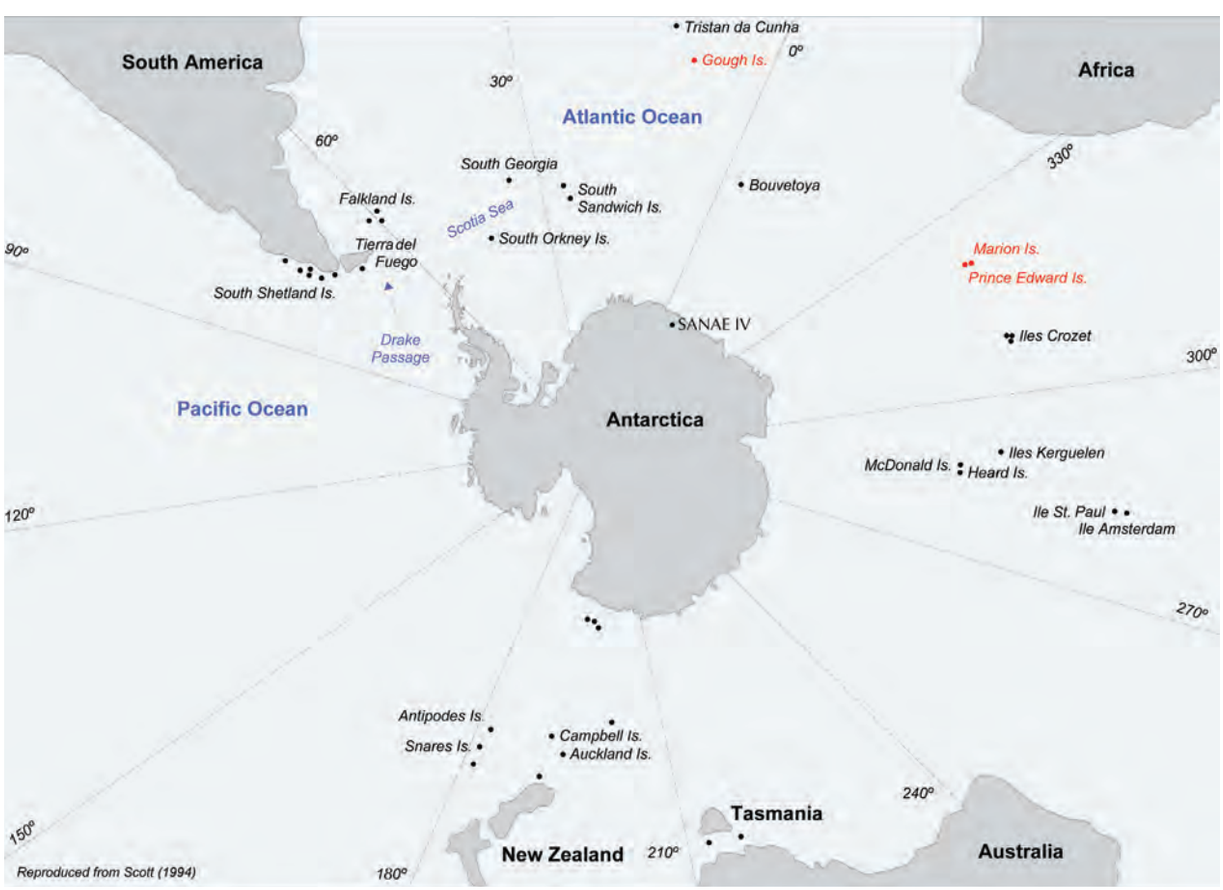
Over the years, many South African scientists have conducted research at all three South African National Antarctic Programme (SANAP) bases, many earning postgraduate degrees in the process. Research has concentrated on life sciences, earth sciences, and physical sciences, the latter mainly focusing on studies of the upper atmosphere[52, 53, 54]. Additionally, oceanographic research in the Southern Ocean has taken place from time to time from South Africa's Antarctic research and supply vessel, the *SA Agulhas*, some as part of international programmes[55, 56].

South Africa annexed the sub-Antarctic Prince Edward Islands (Marion and Prince Edward) in the southern Indian Ocean in 1948 and has occupied Marion Island ever since. Annually, teams of scientists visit and stay on Marion Island to conduct research into the natural sciences and to gather meteorological data[50]. The current base on the island will be replaced with a modern complex of linked buildings by 2007. The smaller Prince Edward Islands is rarely visited and has no permanent structures. Since 1957, South Africa has operated a meteorological base on Gough Island in the South Atlantic. Gough Island forms part of the United Kingdom Overseas Territory of Tristan da Cunha[52].

A DESCRIPTION OF THE ENVIRONMENT

Geomorphology and geology

The nunataks of Dronning Maud Land are small outcrops of exposed rock in sea of ice. Vesleskarvet is 858 m above sea level and has an exposed surface of 22.5 ha, with



Map 7.3: Location of Antarctica, Marion and Gough islands.

200-metre-high cliffs on the northern face dropping into a wind scoop[57] (Steele *et al*. 1994). The rocks of the nunatak are igneous, and occur in the form of large frost-shattered boulders.

The Prince Edward and Gough Islands are volcanic islands that have never been connected to a continent. Marion Island (290 km²; highest point 1230 m above sea level) is still active and experiences occasional eruptions, the last one of significance occurring in 1980[58]. Prince Edward Island, 21 km away, is smaller at 45 km². Landforms are the result of two phases of eruptions: grey lava, now well eroded, and more recent black lava, with many scoria cones[g], often containing crater lakes[59]. Gough Island (65 km²; highest point 910 m above sea level) is the remnant of a long-extinct volcano[52]. Most of the island is covered by vegetation unlike the Prince Edward Islands. Except for its upper reaches, where there is a shrinking ice cap within an extensive unvegetated area, most of Marion Island is covered in peat[h]. Extensive areas of swampy ground are found in the lowlands of the Prince Edward Islands and upper areas of Gough Island.

Climate

Although all three SANAP bases are likely to be associated in the public mind with a cold and inhospitable climate, they occupy different biogeographic zones and their climates differ markedly. The Antarctic climate is cold and dry (humidity is low due to low temperatures, with precipitation falling as snow, not as rain). During summer, the sun does not set, and in winter the sun does not rise above the horizon. Detailed climatic data at ground level for a nunatak near Vesleskarvet named Robertskollen showed winter air temperature dropping to a minimum of -33.6°C and rising in summer to a maximum of only 5.2°C[60].

The sub-Antarctic Prince Edward Islands and cool-temperate Gough Island are much warmer and wetter (with precipitation falling mainly as rain), often experiencing strong winds. Because their climate is oceanic, temperature fluctuations across the seasons are not large[61]. The effects of climate warming are now noticeable at Southern Ocean islands, however. Long-term meteorological data, collected at Marion Island since its annexation by South Africa, have shown that the island is becoming both warmer and dryer; its central ice cap is disappearing, and its surrounding seas are also warming[62, 63, 64, 65, 66].

Biodiversity

The Antarctic Continent, most especially away from exposed-rock coastline, is a barren place. Southern Ocean islands are very different: they teem with life. A few nunataks in Dronning Maud Land have colonies of breeding seabirds, such as Snow *Pagodroma nivea* and Antarctic *Thalassoica antarctica* petrels whose guano supports plants

View towards Katedraalkrans from top of Long Ridge (Marion Island). *Photography: Paul Sumner*

Boulder beach at the base station (Marion Island).
Photography: Paul Sumner

Reflections from the midnight sun in the icy waters at the ice shelf off Antarctica. *Photography: Rudi Pretorius*

Marion base under construction. *Photography: Adriaan Dreyer*

(mosses and lichens) and invertebrate (mites and smaller) life[67] (Ryan and Watkins, 1989). Vesleskarvet is especially barren, with no breeding birds, a few lichens but no identified mosses, and few mites, along with nematodes and tardigrades[57].

The Prince Edward Islands are a haven for large numbers of breeding seabirds and seals, some of which are considered globally threatened[68, 69, 70]. There are four species of penguin, the macaroni (*Eudyptes chrysolophus*) and the king (*Aptenodytes patagonicus*) being the most abundant, five species of albatross, including 44% of the world's population of wandering albatrosses (*Diomedea exulans*), and a suite of burrowing petrels of the family Procellariidae. There are three species of seals: the southern elephant seal (*Mirounga leonina*) and two species of fur seal (*Arctocephalus spp.*).

Gough Island also supports seals, penguins, albatrosses, and petrels, including two endemic land birds, a bunting and a moorhen[52]. Marion and Gough Islands have populations of house mice (*Mus musculus*) that are believed to have been introduced by visiting expeditions. Marion Island used to have an introduced population of feral domestic cats (*Felis catus*), but these have now been eradicated[71].

The vegetation of the three islands is broadly similar, although the more northerly Gough Island does have two species of trees. Woody plants are absent on the Prince Edward Islands, a defining feature of the sub-Antarctic region. Small forbs[i], grasses, ferns, and mosses make up the bulk of the vegetation[52, 72]. Alien plants exist on all the islands. The islands also support abundant invertebrate life: mites, flies, weevils, moths, earthworms, and the like[73, 74], some of which are flightless. Gough especially has many introduced species.

The inshore environments of the islands are rich in sea life. The Prince Edward Islands, for example, have extensive kelp beds, and killer whales (*Orca orca*) are regularly sited offshore.

View to the north over Katedraalkrans towards Prince Edward Island. *Photography: Paul Sumner*

ENVIRONMENTAL TRENDS

Due to the large geological, climatic, and ecological differences between the Antarctic Continent and the southern islands of the Prince Edwards and Gough, this section addresses the environmental issues pertaining to each separately.

Dronning Maud Land, Antarctic Continent

SANAE IV at Vesleskarvet is a modern base that is run in an environmentally responsible manner. Using the guidelines of the Antarctic Treaty's Committee for Environmental Protection (CEP), SANAP undertook a Comprehensive Environmental Assessment prior to its construction of the base[75]. The implementation of the environmental management plan arising from the assessment coupled with annual environmental audits of the base and its surrounds ensure stringent environmental compliance. Special attention is given to waste and pollution management. A great deal of the waste material is sorted and returned to South Africa for recycling or disposal in dedicated waste-management sites, including hazardous waste such as scientific chemicals, batteries, spent lubrication oils, plastics, metals, and glass. Reducing the risks of fuel spills into the environment forms an important part of the annual audits. At Vesleskarvet, a

small area of exposed rock has been marked off to protect its limited biota[57, 76].

South Africa follows all the requirements of the Madrid Protocol on Environmental Protection and its various annexes that cover such matters as protection of species and of areas controlling introductions, pollution, and liability. The country has yet to propose an Antarctic Specially Protected Area (ASPA) or an Antarctic Specially Managed Area (ASMA) to the Antarctic Treaty's Committee for Environmental Protection. However, the Robertskollen nunataks, as the most biologically diverse rock exposures relatively close to SANAE IV, are seen as worthy of ASPA status.

Over the years, South Africa has followed CEP protocols in decommissioning redundant bases and field stations in Dronning Maud Land. In the main, all structures that have not become buried below the ice surface have been recycled to South Africa. Notable examples include sections of the Emergency Base (or E Base as it is called) close to the site of the now buried SANAE III, and the earlier Sarie Marais field station at Grunehogna, inland from the shelf edge.

Dronning Maud Land is not seen as a prime site for ship-based tourism. Although the inland mountain ranges and nunataks might lend themselves to visits by adventure tourists, to date tourism has not impacted on South Africa's activities on the continent. In contrast, scientific activities in the region are increasing. There is significant collaboration between Antarctic-based nations concerning logistics such as the sharing of facilities aboard ships and planes, and the utilizing of a Norwegian blue-ice runway that can take wheeled aircraft. For both types of operations Cape Town is used as a gateway to Antarctica.

South Africa also complies with the MARPOL regulations concerning the dumping of wastes at sea. While at sea in the Southern Ocean, both south and north of the Antarctic Treaty Area, the SANAP research and supply vessel, the *SA Agulhas*, does not dump its waste overboard, but stores it on board for later incineration or return to South Africa.

The Prince Edward Islands

The Prince Edward Islands, South Africa's only overseas possession, have been accorded the country's highest state of formal protection, that of Special Nature Reserve, in terms of the then Environmental Conservation Act of 1989, now superseded by the national Environmental Management: Protected Areas Act, No. 57 of 2003 (NEMPA). In terms of NEMPA, entry into a Special Nature Reserve is restricted to research and conservation management activities only. One consequence of this high level of protection is that commercial tourism may not be permitted. A management plan was adopted in 1996[77] and is currently being revised.

As with other sub-Antarctic islands, one of the greatest

SA Agulhas going through pack-ice, close to the Antarctic continent. *Photography: Rudi Pretorius*

Releasing a weather balloon from the deck of the *SA Agulhas* to obtain meteorological readings. *Photography: Rudi Pretorius*

Former ice plateau view north from highest peak on Marion Island. *Photography: Paul Sumner*

Seals basking in the sun (Marion Island). *Photography: Ian Meiklejohn*

threats to the Prince Edward Islands' ecosystem is the introduction of alien animal and plant species and disease-bearing agents by visiting expeditions. The warming and drying[66] of the island due to climate change has created an environment that appears to be conducive to the introduced alien flora and fauna species establishing themselves[78]. In addition, alien species already present could become more of a problem as the islands' climate changes[79].

Some alien species that have been introduced in the past have been eradicated. The feral cat (*Felis catus*), for example, was removed from Marion Island after a long campaign[71]. The remaining alien mammal, the house mouse (*Mus musculus*), is proving harder to eradicate[80]. Introduced plants have spread so far that their removal is now considered impracticable[81]. The Prince Edward Islands Management Committee (PEIMC) now places much emphasis on activities designed to reduce the risk of introducing new alien species, with a stringent set of quarantine protocols in place that are regularly reviewed and enhanced.

Albatross on nest with young chick peeking from under the wing at the world (Marion Island). *Photography: Ian Meiklejohn*

A commercial longline fishery for Patagonian toothfish (*Dissostichus eleginoides*) around the islands and on nearby sea-rises and mounts[j] has led to large numbers of seabird deaths since the fishery's inception in the mid-1990s[82]. The adoption by South Africa of mitigation measures set out by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and its National Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries[52], following guidelines set out by the Committee on Fisheries of the Food and Agriculture Organization (FAO), is helping to reduce this bycatch to low levels. Illegal, unreported and unregulated (IUU) fishing has done much to harm the stock itself[83]. A new fisheries patrol vessel commissioned in late 2004, the *Sarah Baartman*, is capable of reaching the islands and should help to alleviate this situation.

The islands are also affected by environmental issues such as human disturbance, pollution, and litter. Regulations in the management plan, coupled with a permitting system operated by the PEIMC, appear sufficient to address these impacts, although a more codified system supported by a best-practice manual, operated by professional environmental management staff employed within SANAP, has been recommended[77, 84].

Several initiatives are under way to enhance the formal level of protection of the Prince Edward Islands. Internationally, South Africa has prepared nominations to register the islands as natural sites under the World Heritage Convention and as a wetland of international importance under the Ramsar Convention. Domestically, South Africa is working towards the proclamation of a large Marine Protected Area around the islands that will encompass territorial waters and at least parts of the Exclusive Economic Zone, which extends out to 200 nautical miles. The first stage in this process has been the declaration of territorial waters (out to 12 nautical miles) a no-fishing zone from the beginning of 2005. In addition to the above initiatives, South Africa is a founder member of the international Agreement on the Conservation of Albatrosses and Petrels (http://www.acap.aq), which offers scope for the enhanced protection of the islands' threatened albatrosses and larger petrels[85].

Gough Island

Conservation issues at the Gough Island Nature Reserve (a World Heritage Site) are broadly similar to those at the Prince Edward Islands, with the greatest attention being focused on the eradication of alien species, especially the house mouse[86, 87, 88]. South African scientists and researchers strictly follow the requirements and regulations

of the island's management plan[52], even though ultimate responsibility for its management lies with the United Kingdom. South Africa provides logistical support to a UK-funded project to eradicate the Procumbent Pearlwort Sagina procumbens believed to have been accidentally introduced with packing materials from Marion Island sometime in the 1990s. The project is currently restricted to the immediate surrounds of the base.

The *SA Agulhas* berthing close to the ice shelf to start unloading its cargo destinied for SANAE IV.

Photography: Rudi Pretorius

The helicoptor off the deck of the *SA Agulhas*. *Photography: Rudi Pretorius*

The *Sarah Baartman* patrolling the ocean to prevent illegal fishing. *Photography: Tony van Dalsen*

NOTES

a. The State of Coasts project used the 1996 National Land Cover Database to classify land use. The latest land-cover data (NLC2000) were not available at the time of this analysis.

b. The demersal trawl fishery targets deep and shallow-water hake (Merluccius paradoxus and Merluccius capensis, respectively); sole (Austroglossus pectoralis); and Cape horse mackerel (Trachurus trachurus capensis).

c. Abalone occur in shallow water, are easily removed, and thus do not require expensive fishing equipment

d. The categories of IUCN Red Listed species of concern for maintaining species diversity are: Critically Endangered, Endangered and Vulnerable.

e. In 2001, South Africa had 5 beaches with Blue Flag status; in 2005 the number had risen to 20.

f. Means small cliff in Norwegian.

g. Also known as 'cinder cones', scoria cones are the most common type of volcano. They are built from particles and blobs of congealed lava ejected from a single eruption.

h. Peat is an accumulation of partially decayed vegetation matter.

i. A broad-leaved plant, other than a grass, sedge or rush.

j. Mountain, typically an extinct volcano, rising from the ocean floor that does not reach the water's surface.

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Up and down!
Up and down!
From the base of the wave
to the billow's crown;
And amidst the flashing and
feathery foam
The Stormy Petrel finds a home,--
A home, if such a place may be,
For her who lives on the wide, wide sea,
On the craggy ice, in the frozen air,
And only seeketh her rocky lair
To warm her young and
to teach them spring
At once o'er the waves
on their stormy wing!

Barry Cornwall