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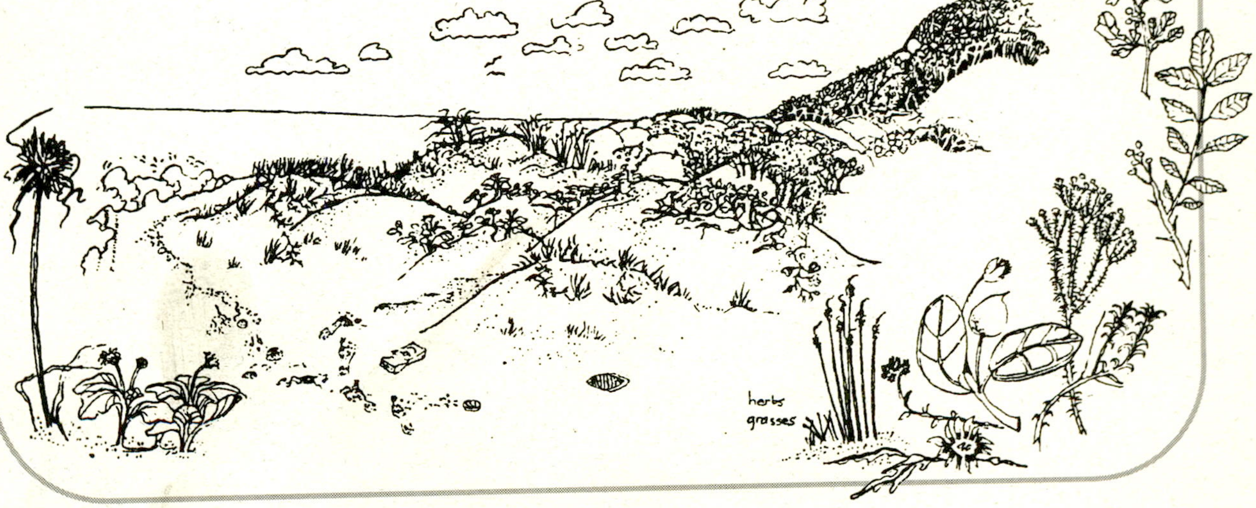

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Foreword

Dunes backing sandy beaches dominate the KwaZulu-Natal sub-tropical shoreline. These coastal dunes are highly sensitive environments which face increasing human impacts. Planning in these sensitive areas requires a sound knowledge of these human impacts, the natural ecological processes and the sensitivities of the dune systems. Over the past twenty years the Commission has funded a range of research on the coastal dunes of KwaZulu-Natal. This research has focussed on varied themes such as vegetation, shoreline changes and mining. This work needed to be taken further through the formulation of planning guidelines.

Following a national coastal dunes workshop held in 1989, at which the central KwaZulu-Natal coast was identified as a key site for dune research, Prof. A. McLachlan of the University of Port Elizabeth approached the Commission with a research proposal. Initiated in 1993, the research project aimed to provide the Commission with readily available planning guidelines for the management of KwaZulu-Natal's coastal dunes. In particular, the project aimed to co-ordinate monitoring and research related to coastal dunes, investigate human impacts and assess ecological sensitivity and identify recreational potential and suitable types of development. It also aimed to provide conservation priorities and management and planning guidelines. The two focal sites of the research were Richards Bay and Mtunzini.

This investigation into the structure and functioning of the central KwaZulu-Natal coastal dunes, so as to facilitate their sustainable use, will assist in the formulation of sound management plans. The research has provided new insight in the complex coastal dune processes, which the Commission hopes will stimulate greater interest in coastal management and conservation amongst coastal managers at both a regional and local level.

CHAIRMAN
Town and Regional Planning Commission

Executive Summary

A pilot study of the ecological dynamics of coastal dunes was conducted in the dunefield alongside the farm Twinstreams near Mtunzini on the central KwaZulu-Natal north coast. A classical pattern of vegetation succession is evident across the dunes. This study investigated the soil structure and processes contributing to the formation of the humic layer across the vegetation gradient as well as changes in the diversity of insects, small mammals and birds. The role of ecological processes, such as herbivory and ant granivory, were studied to estimate their importance in the establishment of dune vegetation and dune stabilisation. Recreational use of dunes and beaches were investigated through a questionnaire study conducted in the Umlalazi Nature Reserve and at Richards Bay. Human impacts and recreational potential in these areas were assessed during on-site inspections and through examination of 1:10 000 aerial photographs.

Trends in soil organic matter across the vegetation gradient indicated that it takes about 80 years for the process of litter production and decomposition to contribute significantly towards the production of soil humus. Meiofaunal communities were dominated by two nematode species, neither of which showed clear zonation patterns across the gradient. A Pheidole ant species was common and thought to play an important role as a seed predator in the foredunes. The small mammal community was depauperate but typical of undisturbed KwaZulu-Natal coastal forests. Sherman traps detected the presence of the red veld rat, Aethomys chrysophilis, a generalist omnivore which could play a significant role as a seed predator, the forest shrew, Mysorex varius, and the cane-rat, Thryonomys swinderianus, a specialist grass eater not likely to influence grass establishment in the sparsely vegetated areas. Birds were the most diverse vertebrates and there was a significant overlap in the communities found in the forest, thicket and transition zones; sixteen species occurred only in the forest.

The process of herbivory increased strongly from the pioneer to the forest zone, a trend that corresponded to increases in soil nutrients and plant diversity and might reflect the preferences of bushbuck, the major herbivore at the site. Granivory exhibited the opposite trend increasing from the forest to the pioneer zone. The high levels of granivory in the pioneer zone have strong implications for the establishment of plant communities as most pioneer plants have small seeds that are vulnerable to ant granivory. These preliminary findings highlight the interdependence of physical factors and biological processes, both plant and animal driven, in structuring the dune ecosystem. The dune sequence at Mtunzini represents a unique example of primary succession and has exceptional conservation and educational value.

The study of recreational patterns showed that pressure on the coastal zone occurs in pulses associated with public holidays and that the intensity of pulses in the study area has been at consistent levels for the past three years. The popularity of Umlalazi and Richards Bay showed that there is a need for a diversity in resorts to cater for different recreational experiences. Dunes backing beaches attracted a small proportion (average 5 - 6%) of beach visitors and it was only at the coastal sites of Richards Bay that the impact of trampling on the foredunes was clearly evident. The severity of trampling should be judged according to the sand depositional status of the coastline, dune vegetation cover, conditions for plant growth and the extent of human use. Off-road vehicle (ORV) tracks over foredune vegetation were noted at Five-Mile Beach. Detailed recommendations to control human impacts, in terms of trampling and ORV traffic, are given.

Factors relating to the physical and biological features, social environment, economic aspects and legal constraints that should be taken into account when assessing the potential of any coastal area to support recreation (or development) are detailed. These factors are presented as a series of questions and form the basis of criteria that were used to assess the recreational potential of six sites in the study area. Alkantstrand was identified as a 'free access' area because the coastline is already modified to accommodate urban requirements. Umlalazi and four sites north of Alkantstrand showed a moderate to low potential to support recreation; the reasons for the low potential are notably different and related chiefly to the physical stability of the shoreline.

The fundamental principles governing the management of sandy coasts are described and the ecological sensitivities are highlighted. Management strategies to maintain the natural sand budget and conserve biodiversity are outlined in detail.

Chapter 1

Introduction

1.1 The Coastal Zone - Pressures, Sensitivities and Function

Of the 3 000 km constituting South Africa's shoreline, 70% comprises sandy beaches backed by dunes. Beaches and dunes are inextricably linked through the exchange of sand into a coupled sand transport system and as a unit form an integral part of the coastal zone, a highly sensitive transition between the land and the sea. In addition to beaches and dunes, the coastal zone incorporates diverse features that include inshore waters, the intertidal zone, coastal lakes, lagoons and estuaries. Despite its sensitive nature, the coast is the most densely populated part of most maritime countries. In the Cape, 90% of the population live within 100 km of the coast (Manuel & Glazewski, 1991), and on a global scale more than half of the world's population lives within 60 km of the shoreline; over the next 30 years this figure is projected to increase to three-quarters of the world's population (Wynberg, 1993).

In South Africa the coastal zone has experienced an intensification of human population pressure induced by socio-political changes stemming from the repeal of apartheid legislation; the result has been an influx of people to coastal cities and towns. Large informal housing settlements have emerged that impact directly on coastal dunes through the encroachment of housing structures, and the use of forest vegetation for firewood and *muti* (Berry, 1992). Dam construction and resort and holiday-related property developments have altered almost all of the 365 estuaries around the coastline (Yeld, 1993), and some authorities have allowed development to encroach into dune systems, restricting the natural flow of sand and encouraging coastal erosion (McLachlan & Burns, 1992; McLachlan *et al.*, in press).

Apart from their spectacular scenic beauty, sandy beaches and dunes are important coastal features because they disperse the incoming energy of swashes, surges and waves at all tides. Frontal or foredunes backing the driftline dissipate the energy of storm waves at high tides and greatly reduce the direct impact of onshore gale force winds. They therefore act as protective buffers between resources on the land and climatic elements (Tinley, 1985). In addition, coastal dunes are discrete ecological environments that support endemic and specialised plants and animals (McLachlan, 1991). Sandy beaches and dunes are interdependent in that they function within a single sand system; altering the sand dynamics of one component directly impacts on the other. With the exception of the Mtunzini area on the central KwaZulu-Natal north coast and Dwarskersbos on the long curve of St Helena Bay on the west coast (Tinley, 1985), most of the South African coastline is stable or eroding through the combined forces of wave action, the slow rise in sea level and inappropriate coastal developments.

To retain the function and biotic characteristics of sandy coasts, it is important to maintain the process of natural shoreline adjustment. In view of the extent, importance and sensitivity of coastal dunes, this report investigates the ecology of dunes along the central KwaZulu-Natal north coast as well as human use patterns and impacts to foster the compilation of sound management guidelines that will serve to retain the biotic diversity and function of these systems.

1.2 Importance of Coastal Dunes

As significant barriers at the land-sea interface, dunes play a vital buffering role and are important for the exchange of sediment on the shore (Tinley, 1985). The constant two-way shift of sand between dunes and the beach is a self-regulating mechanism vital for the preservation and protection of the shoreline. Dunes are important for several other reasons: dune aquifers are a source of potable water, dunes represent a sand and mineral resource, and they can be afforested. As pleasure outlets, beaches are used for swimming, sunbathing and picnicking, and dunes, in some cases, for sand skiing and hang-gliding. In addition, there are beach-dune areas that incorporate national parks, wilderness areas and floral, marine and nature reserves.

It is in their economic and social value, however, that the vulnerability of sandy coasts lies. They are sites for luxury holiday homes and holiday resorts requiring roads, parking lots, sewage and rubbish disposal, and lighthouses and beacons. Larger coastal cities support industrial areas, railway systems, highways and bridges that in places encroach into dunefields. In some cases, large sections of headland bypass dunefields have made way for development or have been stabilised through a lack of understanding of the function of these systems on the part of early local authorities; severe coastal erosion has been the outcome of both situations (McLachlan & Burns, 1992). Extraction of diamonds on the west coast, heavy metals on the KwaZulu-Natal coast and demands for calcium carbonate extraction rights in eastern Cape dunes are additional large-scale disturbances threatening dunes.

Coastal dunes incorporate areas of outstanding scenic, ecological, historical and cultural value, often national assets, that warrant protection from overuse. Broad, open, transgressive dunefields, such as those on the south and south-east Cape coasts, are scenically spectacular, support unique plant and animal communities, serve as breeding sites for rare birds, e.g. Damara terns, and harbour Strandloper middens, remnants of early peoples in South Africa (Illenberger & Kerley, 1992). Vegetated dunes of the KwaZulu-Natal coast support a complex suite of biota characteristic of tropical coasts and are valuable ecological and educational resources (see Chapter 6, this volume). In addition, they harbour features of cultural and historical value, e.g. early Zulu smelting sites, Zulu graves and spiritual sites, Tonga pottery and implement deposits, Iron and Stone Age artefacts and ruins of World War II Royal Air Force bases (McGwynne *et al.*, 1993; Physical Planning Directorate, NPA, 1986).

1.3 Coastal Zone Management in South Africa

In an attempt to control development in the coastal zone, regulations amounting to an interim measure were promulgated in terms of the Environment Conservation Act, 1982 (Act 100 of 1982), which declared the strip of land 1 000 m wide landwards of the high water mark to be a 'limited area' within which permits were required for development related activities. The 1982 Act was later repealed and this restriction was lifted in the Cape and KwaZulu-Natal; the result was that environmentally insensitive development again took place (Manuel & Glazewski, 1991). Under the current Act (Act 73 of 1989) 'limited development areas' may be proclaimed by the Minister of Environment Affairs but the Act makes no provision for a legally entrenched national environment policy, including a coastal zone management policy, or any legal requirement for the implementation of Environmental Impact Assessment (EIA) procedures. These shortcomings, *ad hoc* planning and development, the recent devolution of functions to provincial and local authorities without prior formulation of policy and guidelines, the lack of co-ordination and accountability between and within administrative levels, and the lack of public accountability all hinder effective coastal management efforts (Sowman, 1991; Kapp *et al.*, 1992; Wynberg, 1993).

To accommodate increasing demands for coastal resources within a framework of ecological sustainability, a policy advocating the implementation of Integrated Environmental Management (IEM) procedures needs to be adopted. This could be achieved by consolidating and reforming all legislation applicable to the coastal zone (Rabie, 1987 from Sowman, 1991) and formulating a new Coastal Zone Management Act which would guide and regulate all development in the coastal zone (Sowman, 1991). In accordance with this, the President's Council report (1991) on a national environmental management system urged the compilation of a development plan 'to ensure orderly coastal development in harmony with the environment and causing the least impact on the natural environment and scenic features'. It recommended that guidelines in the development plan be incorporated into the structure plans of local authorities.

As a step towards the development of a policy for the coastal zone, the Council for the Environment (1989a, b, c, 1991) formulated a comprehensive strategy for the management and future sustainable utilisation of the entire coastline, emphasising the need for an integrated authority to control this dynamic interface. Efforts by the Department of Environment Affairs (DEA) to formulate an environmental policy for South Africa culminated in the publication in 1993 of a White Paper which set out the policy of the Government with respect to a national environmental management system. The White Paper declared the Government's commitment to environmental research, education, conservation and the principles of integrated environmental management to attain the sustainable utilisation of resources. This document however has no legal standing and merely outlines the Government's intention. It needs to be followed up by the development of a specific implementation strategy that should 'set priorities, highlight crucial issues and be supported by energetic management plans and statutory policy declarations' (DEA, White Paper, 1993).

IEM procedures have been set out by DEA (1992) in a six-document guideline series on the IEM procedure. In addition, DEA has initiated a Coastal Management Advisory Programme (CMAP) to facilitate the exchange of information on coastal matters between researchers, interested groups and stakeholders, and working groups to formulate goals, principles and objectives for management policy.

A policy for the control of ORVs in the coastal zone was announced by the Minister of Environment Affairs on 29 April 1994. The policy recommends that recreational vehicles should not be allowed near bathing areas, beach areas close to bathing areas, ecologically sensitive areas, such as dunes and bird and turtle nesting areas, and protected areas specifically established to preserve the coastal environment. In addition, it advocates the introduction of a permit system to regulate the use of ORVs in demarcated areas, and recommends that the number of access points to demarcated areas be limited. Vehicles should be restricted to the 'wet sand' portion of the beach between the low and high water marks and could be prohibited for a specific period preceding and following high tide. These are, however, merely recommendations. The acknowledgement of their importance and their implementation is largely the responsibility of regional or local government.

Coastal zone management impacts on many facets of the Reconstruction and Development Programme (RDP) - a policy framework by the African National Congress, specifically with respect to "Meeting basic needs" (the environment - see 2.10.2.3 and 2.10.7 of RDP document), "Developing our human resources" (sports and recreation), and "Building the economy" (tourism - see 4.5.4.7 of RDP document). "Participatory decision-making processes around environmental issues empowering communities to manage their natural environment" (2.10.3.2 of the RDP document) is one of the issues in the RDP related to coastal zone management. Such issues form part of the broader environmental, social and economic aspects surrounding dune management.

Ultimately it is imperative that an acceptable and comprehensive management policy is legally entrenched into a Coastal Zone Management Act to implement environmentally sound management plans and foster the sustainable use of the coastal zone.

1.4 The Situation in KwaZulu-Natal

In KwaZulu-Natal, particularly along the south coast, natural environments have been altered largely through insensitive developments and irresponsible farming practices, leaving in their wake environments with a reduced capacity to maintain biodiversity and thus support natural ecological processes. Major developments, like Richards Bay harbour, were undertaken before proper environmental management techniques and procedures had been introduced and have consequently resulted in unnecessary but permanent ecological damage (Yeld, 1993).

Regulations which were promulgated on 12 December 1986 in terms of the Environmental Conservation Act (No. 100 of 1982) were an attempt to ensure that controls were placed on developments or activities in sensitive areas within 1 000 m of the high water mark. Due to technical and legal problems, the regulations were withdrawn after the promulgation of the 1989 Act. Inappropriate developments have subsequently had numerous adverse impacts on sensitive parts of the coastal zone. Many of these impacts were of an irreversible nature, and arose because sufficient legislative control on unsuitable development in the coastal zone does not exist. The re-institution of an effective regulatory mechanism to replace the former coastal regulations became evident.

The vegetation along the KwaZulu-Natal north coast has been identified, mapped, and the conservation importance outlined (CSIR report to the Town & Regional Planning Commission (TRPC),1992). All developments in sensitive areas are subject to prior approval from the appropriate governing body. In addition, the TRPC has adopted the 'Green Wedge' principle which advocates that coastal development should take the form of discrete nuclei separated by areas of undeveloped land (Physical Planning Directorate, TRPC, 1986).

Some areas of the KwaZulu-Natal coast are under the jurisdiction of the Natal Parks Board. The Board's mission in managing these areas is to maintain ecological processes, preserve genetic diversity, ensure sustainable utilisation of resources, and to promote public recreation (Brownlie & Porter, Natal Parks Board, internal document, undated). The Board has adopted the Integrated Environmental Management procedure as advocated by the Council for the Environment (1989) for all their projects and those programmes and policies which have the potential to affect the natural or visitor environments (Brownlie & Porter, 1991).

1.5 Objectives of this Report

Faced with rapid population growth, an escalation in the rate and extent of development and sea level rise, there is an urgent need for controlling bodies to compile large-scale guidelines that incorporate detailed structure plans for specific coastal regions. It is also important that the perceptions and needs of the various population groups who live in or use the coastal zone be accommodated in such structure plans. With this premise, the Town and Regional Planning Commission engaged a team of coastal ecologists in the Zoology Department at the University of Port Elizabeth to conduct a pilot research project to describe the ecological dynamics of coastal dunes in the vicinity of Mtunzini on the central KwaZulu-Natal north coast; to assess human impacts on dune systems in the reserve and at Richards Bay; and ultimately to formulate management guidelines for planners that will assist in the sustainable use of coastal resources.

Chapter 2

Terms of Reference

The Zoology Department, a member of the SAB Institute for Coastal Research at the University of Port Elizabeth, (represented by Prof. Anton McLachlan) will over a period of 11 calendar months conduct a research project that will provide the Town and Regional Planning Commission with planning guidelines for the management of KwaZulu-Natal coastal dunes. The project will be supported by, and based on, basic research.

The area of research will be coastal dunes on the seaward side of the farm *Twinstreams*; the dunes form part of the Umlalazi Nature Reserve and lie about 3 km south of the town of Mtunzini. The research project will also include the area of Richards Bay from the harbour northwards to the municipal boundary, a stretch of coastline approximately 7 km long.

The aims and objectives of the research project are:

A. (i) to co-ordinate monitoring and research related to coastal dunes near Mtunzini and at Richards Bay on the central KwaZulu-Natal north coast;

(ii) to investigate human impacts and assess ecological sensitivities; and

(iii) to identify recreational potential and suitable types of development.

B. to submit a written report on conservation priorities and management and planning guidelines.

Chapter 3

Relevant Literature

Dune vegetation communities along the prograding coastline near Mtunzini were first recorded in a preliminary account by Moll (1972). Since then vegetation and patterns of succession in the coastal dunes bordering the Zululand coast north of the Tugela River have been well documented (Weisser, 1978, 1980; Weisser & Marques, 1979; Weisser *et al.*, 1982; Weisser & Backer, 1983; Weisser & Muller, 1983; Avis, 1992). Prompted by the presence of lush tropical vegetation, ecological research along the Zululand coast has focussed primarily on the dynamics of vegetation communities. The proposal to mine dunes in the area for heavy metals stimulated further botanical research (Weisser, 1987) and introduced studies on the distribution of fauna and their capacity to recolonise rehabilitated dunefields (Ferreira & Van Aarde, 1993 a-e). Coastal erosion in the Richards Bay area prompted a study by the Division of Water Technology of the CSIR (Cooper, 1991) to assess the rate of change of the KwaZulu-Natal coastline from the Umtamvuna River to Cape St Lucia and to estimate future shoreline positions so that planning decisions could accommodate these changes. Van Teylingen *et al.* (1993) outlined the conservation status of the vertebrate fauna of coastal dunes along the South African coast; this work included the fauna of the KwaZulu-Natal coast.

The ecology of the largely unvegetated Alexandria coastal dunefield lining Algoa Bay in the eastern Cape has been well studied (Van der Merwe, 1987; Young, 1987; Illenberger, 1988, 1992; Ascaray, *et al.*, 1991; McLachlan, 1991; Parker-Nance *et al.*, 1991; Illenberger & Kerley, 1993) and provides baseline information on the ecology of coastal dunefields in South Africa. Other studies in the eastern Cape include descriptions of coastal vegetation (Lubke, 1983; Lubke & De Villiers, 1991), ecophysiological investigations (Lubke & Avis, 1982a, b; Avis & Lubke, 1985), and coastal dune management (Avis, 1985, 1986, 1992).

Tinley (1985) was the first to describe the distribution, dynamic processes and erosional status of dunes along the South African coast. His definitive report provides a useful framework of data and guidelines for the management and conservation of coastal dunes. Brown and McLachlan (1990) focussed on beach-dune systems describing the ecology and dynamics and outlining management guidelines for sandy coasts in general. The basic principles of coastal zone management and guidelines for coastal land use have been published in two concise documents by the Council for the Environment (1989b, 1991); these set out the functions and sensitivities of the coastal zone and provide practical advice for developers.

Chapter 4

The Study Area

4.1 Situation, Extent and Controlling Bodies

The study area, situated about 130 km north-east of Durban, comprises vegetated coastal dunes stretching from the seaward side of the farm *Twinstreams* (lat. 28 57'S; long. 30 30'E), 4 km south of the Siyaya River mouth, northwards to the municipal boundary of Richards Bay (Figure 4.1). The area incorporates a stretch of coastline about 48 km long. The dunefields average about 1 500 m in width with a maximum width of 2 250 m; the highest dune is about 80 m above sea level (Weisser, 1987). The coastline is intersected at five places: by the Siyaya River furthest south, northwards the Mlalazi and Esikhawini Rivers, and finally the two outlets of the Richards Bay complex, the Mhlatuze Lagoon and Richards Bay Lagoon. The water bodies Mdlangu, Babane, Ncombo, Cubha and Mzingazi are associated with the western border.

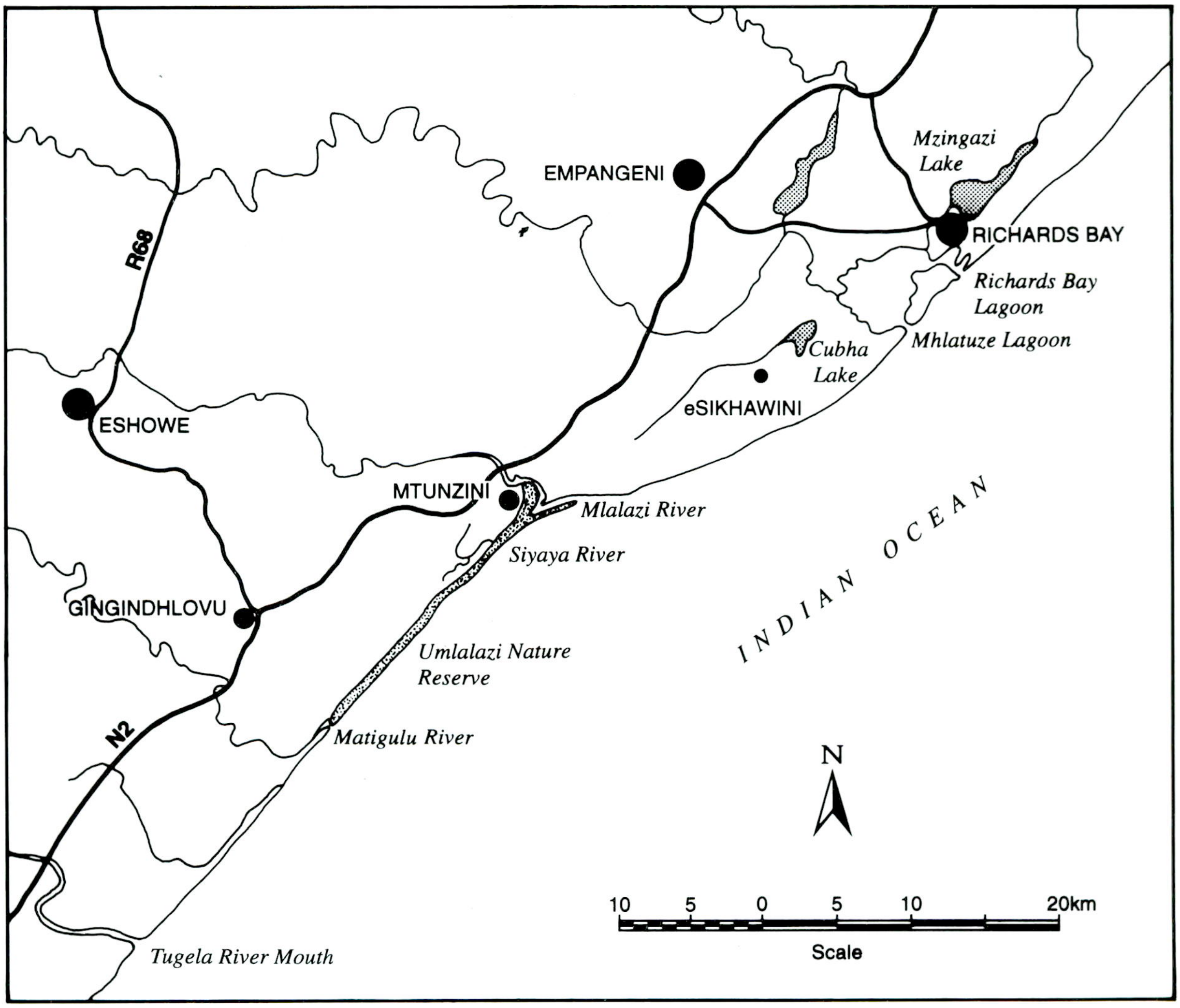

Figure 4.1 *Map of the central KwaZulu-Natal coastline showing the study area between the Umlalazi Nature Reserve and Richards Bay.*

The ecological study was conducted in the coastal dunes alongside the farm *Twinstreams*, which is owned by the timber company Mondi. The dunes form part of the Umlalazi Nature Reserve which includes the coastal zone between the Mlalazi and Matikulu Rivers. The reserve (18 km) incorporates a series of vegetated dune ridges running parallel to the shore. A classical pattern of vegetation succession is evident across the dune ridges (Weisser & Backer, 1983; Avis, 1992) with a clear gradient from pioneers closest to the beach to complex forest communities furthest from the shore. The coastal dunes alongside *Twinstreams* were declared a National Heritage Site largely through the conservation efforts of Mr I.F. Garland, past owner of the farm. Although the dune forest community is protected, the Umlalazi Nature Reserve is open to the public and the dunefields are therefore vulnerable to inappropriate use.

The questionnaire study to ascertain recreational preferences was confined to two sites: the main bathing area of the Umlalazi Nature Reserve situated about 400 m north of the Siyaya River mouth; and Newark and Alkantstrand, urban beaches of Richards Bay situated north of the channel connecting Richards Bay harbour to the sea. Newark beach is closest to the harbour and is separated from Alkantstrand by a breakwater. Human impacts on the physical features of the environment were assessed in the Umlalazi Nature Reserve, chiefly in the area north of the Siyaya River, and at Richards Bay (Newark to Five-Mile beach), a 5 km stretch of coastline. The coastal zone between the Umlalazi Nature Reserve and the municipal boundary of Richards Bay is under the jurisdiction of four controlling bodies. South of the Mlalazi River, the coast to the mouth of the Matigulu River constitutes the Umlalazi Nature Reserve which is controlled by the Natal Parks Board; the climax dune forest landwards of this strip is owned and administered by the timber company Mondi. The area north of the Mlalazi River to the Richards Bay sanctuary falls under the former KwaZulu Department of Agriculture and Forestry, and the Richards Bay Local Council controls the coastline of Richards Bay to its council boundary.

4.2 Geology and Geomorphology

This information has been adapted from Weisser and Backer (1983), Weisser (1987), Tinley (1985) and Cooper (1991). The area north of the Mlalazi River is situated on the southern end of the Mozambique coastal plane and was formerly part of the sea bed (Cretaceous to early Miocene); an extensive dune system built up on these shores during the Quaternary period. Almost all the plain is underlain by thick Cretaceous formations, exposed with a seaward dip along the river channels.

South of the Mlalazi River, the coastal plane is absent and the shoreline is actively accreting from the deposition of large quantities of sand onto the beach. The beach averages less than 80 m in width and is backed by a series of low (average height 5 m) Holocene dune ridges that formed from the merger of small isolated foredunes parallel to the shore. Offshore, the continental shelf is relatively shallow and widens to reach its maximum width of 45 km near the Tugela estuary.

Between the Mlalazi River mouth and Richards Bay, the beach is relatively narrow and is backed by a cliff cut into dunes of the Port Durnford formation. The dunes are currently eroding and large scale slumps exposing bare sand are common.

Natural dune features and processes at Richards Bay have been disturbed by the development of the harbour, the construction of a breakwater and recreational facilities to accommodate visitors. Northwards the now inactive, vegetated dunefield is fronted by a cliffed foredune ridge running parallel to the shore. The foredune ridge is interrupted at intervals by man-made structures such as car parks, caravan parks, picnic sites, lookout vantage points and wooden walkways.

4.3 Sand Accretion, Erosion and Shoreline Stability

In the Umlalazi Nature Reserve a series of 18 vegetated dune ridges have developed parallel to the shore; the most recent of these have been associated with five time intervals dating back to 1937. Dune advancement during this period was found to be highly variable, ranging from 1.25 m y^{-1} between 1937 and 1957, and 5.67 m y^{-1} between 1965 and 1977 (Weisser & Backer, 1983). Although the coastline between the Mlalazi River mouth and Richards Bay sanctuary consists of erosive scarps, Cooper (1991) found that much of the area had accreted since 1937. Sand derived from slumping and aeolian transport has been incorporated into the beaches, which have become wider.

The coastline between the Tugela River and 10 km north of the Mlalazi River is currently accreting at variable averaged net rates of up to 5 m y^{-1} , largely through the deposition of sediment from the Tugela and Matikulu Rivers and augmented by sand carried by longshore drift from areas to the north and south. Maximum accretion occurs about 5 km north of the Tugela River (Cooper, 1991). Accretion rates diminish rapidly north of the Mlalazi River, possibly as a result of a decrease in the sand carrying capacity of longshore drift and even a drift reversal north of the river. The mouth of the river acts as a minor sink for sand which accumulates at the mouth as a flood-tidal delta.

Although the study area is mostly accreting, albeit slowly in places, there are two areas of marked erosion between the Umlalazi Nature Reserve and Richards Bay sanctuary, both backed by eroding cliffs cut into sand dunes (Cooper, 1991). Episodic collapse of cliff faces causes a temporary progradation of the adjacent beach followed by a period of stability. The construction of Richards Bay harbour destroyed the sandy barrier separating Richards Bay from the Indian Ocean. The accumulation of wind-blown sand against the southern breakwater of the harbour has created a sand sink. In 1991 the coastline of Richards Bay was recorded as stable, although affected by the artificial pumping of sand from the harbour (Cooper, 1991).

4.4 Wind and Wave Climates

The dominant winds blow from the SW but a peak in frequency also occurs from the NNE (Cooper, 1991). These winds blow almost parallel to the coastline with similar frequencies and velocities (Weisser & Backer, 1983; Cooper, 1991); southwesterlies play the greater role in the formation of dunes (Avis, 1992). Gales are infrequent and winds are strongest during the day. Winds that carry salt spray blow chiefly between September and January reaching average speeds of 26 - 40 km h^{-1} and gusting up to 140 km h^{-1} (Moll, 1972).

The dominant wave approach to the shore is either SE or S and SW (Cooper, 1991). Both approaches generate a northward moving longshore drift with a reduced magnitude between the Tugela and the Siyaya Rivers and thus a reduced northward flow of sand in this area. Longshore currents close to the coastline may exceed 1 m s^{-1} whereas currents associated with the Agulhas system further offshore flow parallel to the shore with surface velocities of 0.2 - 0.8 m s^{-1} (Weisser & Backer, 1983). These coastal currents produce strong northeastwards and onshore flows that carry large volumes of sand up the coast to be deposited in the area of the Umlalazi Nature Reserve.

The average morphodynamic state of beaches in the study area is the longshore bar-trough that forms as a result of the interaction between winds, wave action, sand particle size and beach slope (Short & Wright, 1983). The longshore bar-trough has an offshore bar alongside a relatively wide, deep (2 - 3 m) trough that leads onto a shallow beach terrace. Waves break on the bar, reform in the trough and surge over the terrace and up the beach face. Weak rip currents return water to the nearshore.

4.5 Climate and Soils

The climate is subtropical and days are generally warm to hot and humid. The mean annual daily maximum temperature is 26.6°C and the minimum is 16.3°C. Maximum temperatures of up to 44°C occur in December with minimum temperatures of 5°C in June (Schultz, 1985 from Avis, 1992). Rainfall recorded at Mtunzini over a 53 year period shows the mean annual rainfall to be approximately 1 200 mm and the monthly summer rainfall (October to March) to be 130 mm whereas the mean monthly winter rainfall (April to September) is 71 mm; rain falls on at least 69 days of the year (Weather Bureau, 1954 from Moll, 1972). With temperatures warm and rainfall high, there is no soil water deficit and conditions for plant growth are optimum.

Dune soils are predominantly sand, composed chiefly of quartz minerals and calcite from shells, and are either whitish, signifying their more recent age, or reddish to brownish, indicating that they are older (Weisser, 1978). The darker coloured sands have a higher clay content and are more fertile. Soil profiles are evident in those sands supporting climax forest communities whereas no profiles are present in the pioneer vegetation zone. Heavy metals comprise about 4.5% of coastal sands in KwaZulu-Natal although the content may reach as high as 10% or 17% (Fromme, 1980 from Tinley, 1985).

Chapter 5

Ecological Research on Coastal Dunes of the Central KwaZulu-Natal North Coast

5.1 Introduction

Coastal dunes in South Africa form a linear, discontinuous eosystem covering approximately 70% of the coastline, being broken only by rocky shores, cliffs and river mouths (Tinley, 1985). While the adjacent beach ecosystem is largely marine and wave-driven, dune systems tend to be terrestrial and wind-controlled. Following the geographical and climatic gradient around the coast from the arid west to the warm subtropical east coast is a gradient of distinctly different dune systems. As the coastline sweeps through a multitude of biomes, dune plant communities mirror elements of the dominant vegetation of each region. Thus, desert and sub-desert elements on the west coast give way to heath/fynbos vegetation on the southern coast and species from subtropical forests, thickets and savannas on the east coast. Canopy height tends to increase from the west coast, which supports dwarf scrub thicket (0.5 - 1.5 m); to the moist east coast with tall mature subtropical forests (> 15m).

On coasts where the shoreline is stable and rainfall moderately high, dunes tend to be colonised by four zones of vegetation (Tinley, 1985), although it is seldom that all four zones are found in a single dunefield. Closest to the sea is a *pioneer zone* comprising creeping grasses and succulent herbs with stoloniferous and rhizomatous growth forms. Plants in this zone are adapted for survival in stressful conditions (e.g. sand burial, swash erosion, salt loading, high temperatures, high light intensities and moisture and nutrient deficits) and play an important role in creating embryonic dunes by securing sand, thus facilitating the establishment of less hardy species. The pioneer zone gives way to a zone with moderate sand movement supporting a community of low shrubs and clumped bushes. With increasing distance from the sea, dunes are dominated by terrestrial processes, the influence of sea breezes and salt spray becoming minimal. In this relatively benign habitat, a *scrub-thicket zone* of dense dwarf trees with a distinct layer of plant litter establishes itself. In areas with particularly high rainfall (> 700 mm per year) and mature soils, large tree species and an understorey of creepers and herbaceous shrubs form a *climax forest zone*. An excellent representation of the entire classical successional gradient occurs on the prograding shoreline at Mtunzini on the Zululand coastline. These east coast dunes support a greater diversity of fauna (van Teylingen, *et al.* 1993) and flora than other dunes in South Africa. The tourist potential and thus need to conserve these vegetated coastal dunes has been recognised for several years.

Much scientific interest has been focused on the dunes at Richards Bay where extensive rehabilitation programmes have followed mining activities. This work has largely involved monitoring the recovery of plant (Weisser, 1987), mammal (Ferreira & van Aarde, 1993a-e) and ant (Majer & de Kock, 1992) communities. Ant communities are often regarded as bioindicators of the general 'health' and rehabilitation success of the dune ecosystem following disturbance. There are however major gaps in our understanding of the ecology of KwaZulu-Natal dunes, particularly regarding the ecological processes responsible for the patterns of dune faunal and floral diversity.

In order to manage dunes on a sound basis, a fundamental understanding of their ecology is necessary. To date research on South African dunes has focused on systems on the semi-arid south coast, with fewer studies in the KwaZulu-Natal dunes. This study therefore aims to investigate the structure and function of coastal dunes on the central KwaZulu-Natal north coast with a view to generating scientific information that can form the basis for sound management guidelines for these dunes. The research approach has been to investigate the successional pattern produced by the prograding shoreline between the Matigulu and Mlalazi Rivers. The study has focussed on the changes in a range of faunal communities and ecological processes across the successional gradient represented by the first 13 dunes from the beach inland to the climax forest, and complements previous vegetation studies at this site. This report presents the findings of two field trips (April and August 1993) to the dunefield in the Umlalazi Nature Reserve; studies of many of the components are still in progress.

5.2 Study Area

The study area is the section of coastal dunes lying seawards of the farm *Twinstreams*, about 3 km south-west of Mtunzini; the dunes form part of the Umlalazi Nature Reserve under the jurisdiction of the Natal Parks Board. The stretch of dune forest in the coastal zone between the Matigulu and Mlalazi Rivers represents the only pristine dune forest in the area. Much of the remaining land comprises eucalyptus and sugar plantations. Mean annual rainfall is approximately 1 200 mm and temperatures are relatively mild throughout the year.

5.2.1 VEGETATION

The vegetation covering the prograding dune series approaches the classical Clementsian pattern of succession with pioneer species in the foredunes being serially replaced by progressively more complex communities landwards over a series of 18 dune ridges running parallel to the coastline. Vegetation surveys have been conducted in the area since 1972 (Moll, 1972; Weisser & Marques, 1979; Weisser & Müller, 1983; Weisser, 1987; Avis, 1992). Sand is actively deposited on the shore and new dunes form continuously, being stabilised over periods of approximately 10 years, mainly by the pioneer species *Scaevola thunbergii*. This plant has the ability to thrive in areas of shifting sand and high salt loads. Other pioneer species which are found immediately behind the first dune include *Launnaea sarmentosa* and *Arctotheca populofolia*.

For the purpose of this study, the first three dunes (closest to the shore) were classified as the **pioneer** zone. A **transition zone** comprising shrubs, such as *Passerina rigida*, *Gazania regens*, and grasses (e.g. *Stipagrostis zeyheri*) occur in dunes 4 to 6. This corresponds to Tinley's (1985) shrub zone or zone II. Further inland (dunes 7 - 9), dune scrub species form a dense **thicket** with a canopy approximately 3.5 m tall. This thicket gives way to climax **forest** (dunes 10 - 13). The tree species *Mimusops caffra*, *Eugenia capensis*, *Maytenus nemorosa* and *Euclea natalensis* form the 7 to 15 m tall closed canopy, while the fern, *Phymatodes scolopendria*, and the leafy herbaceous shrub, *Isoglossa woodii*, form a dense field layer. Moll (1972) found that the fern species dominated in soil with pH 7.4, whereas *Isoglossa* occurs in older soils with pH 7.2. Lianas (e.g. *Dalbergia armata*, *Acacia kraussiana* and *Scutia myrtina*) are common in the forest where tree falls have created gaps in the canopy.

5.3 Soil Structure

Coastal dune sands are generally alkaline and described as juvenile weakly developed soils of recent deposits, being composed chiefly of the lighter quartz minerals and calcite from shell fragments (Tinley, 1985). West coast sands tend to be of the sand-over-calcrete type, whereas those on the east coast are of the higher rainfall group of fersiallitic sand (Tinley, 1985). The high calcium content of the sands induces deficiencies in nine elements (most notably Al, Cu, Fe, Mn, P and K). Heavy minerals, such as zircon, augite and magnetite, are characteristic elements in KwaZulu-Natal sands.

Stabilisation of dunes by pioneer plants initiates pedogenesis (soil formation), typified by the accumulation of humus. The presence of a nutrient-rich humic layer in older dunes creates a favourable climate for colonisation by less hardy plant species. The development of soil across the dune gradient is thus one of the most fundamental processes allowing plant and animal communities to colonise the dunefield. Plants with a high salt and calcium tolerance tend to colonise recently formed foredunes which are light-coloured, have a relatively simple soil structure, pH of approximately 7.8 and no humic layer (Moll, 1972). Further inland, the soils supporting climax forests are dark in colour, less alkaline (pH 7.2 - 7.4) and have a well developed humic layer. To investigate the processes contributing to the formation of the nutrient-rich humic layer, soil structure, rates of litter decomposition and the structure of meiofaunal communities instrumental in breaking down plant litter in the sand were studied.

5.3.1 METHODS

Soil samples were collected from the trough, crest and midway up the slope on both the north- and south-facing slopes of each of the 13 dunes in the study area. Each sample comprised three subsamples taken from different depths (0 - 10 cm, 10 - 20 cm and 20 - 30 cm). These samples were used to assess the physical (e.g. soil particle size) and chemical (organic components) changes across the dune gradient. Soil moisture profiles and a topographical profile of the area were determined.

5.3.2 RESULTS

The organic content of the soil in the surface 10 cm layer increased across the gradient with the highest content evident in the thicket zone (Figure 5.1). At lower soil depths however soil organics only started to show significant increases in the forest zone.

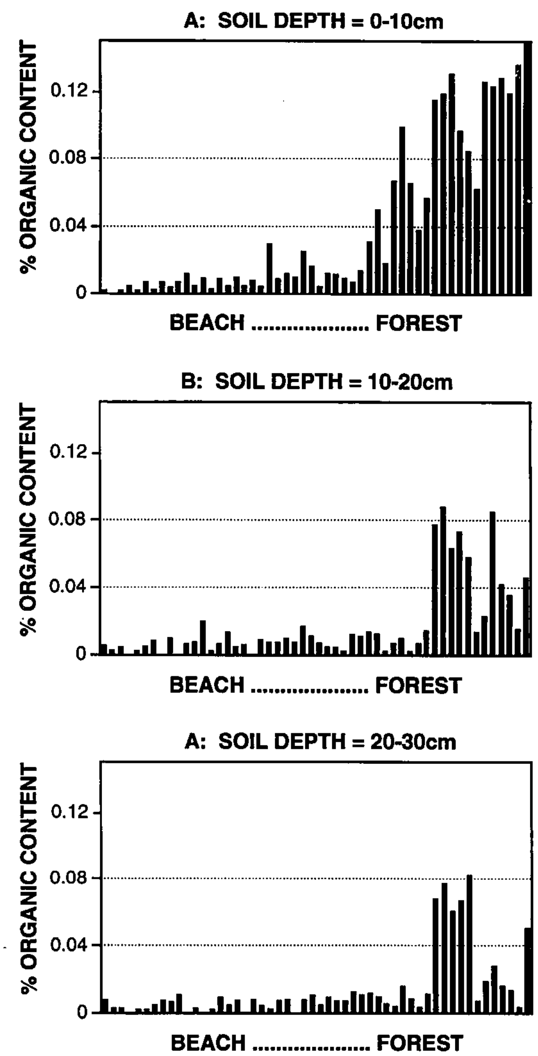

Figure 5.1 *Soil organic content at three depth intervals measured at the slopes, crest and trough of the first 13 dunes (dune 1 is closest to the sea).*

Surface soil moisture remained relatively low in the pioneer and transition zones (Figure 5.2), but increased in the thicket and forests zones. This trend was however reversed for soil moisture at deeper levels (i.e. from 10-20 cm and 20-30 cm).

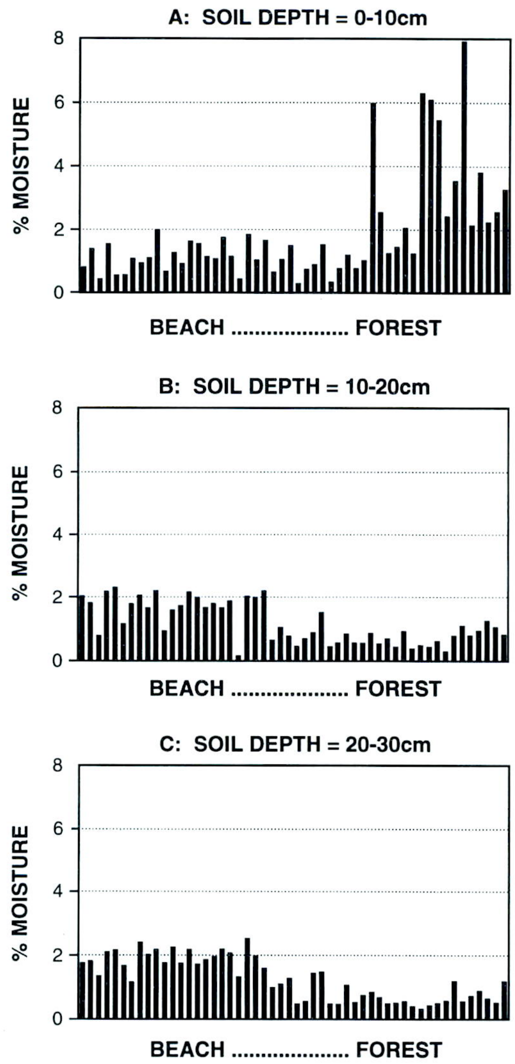

Figure 5.2 *Soil moisture content at three depth intervals measured at the slopes, crest and trough of the first 13 dunes (dune 1 is closest to the sea).*

5.3.3 DISCUSSION

The trends in soil organic matter measured across the gradient indicates that it takes about 80 years (assuming average dune formation takes 10 years) for the process of litter production and decomposition to contribute significantly towards the production of soil humus. This corresponds with the closing of the vegetation canopy in the thicket zone. The increase in surface soil moisture reflects the increase in organic matter in the soil. The observation of relative dryness in the deeper soils in the thicket and forest zones (both in relation to the surface soils and those in the pioneer and transition zones) may be attributed to the high moisture retention properties of the organic material in the surface soils in these zones and/or tree roots pumping moisture out of these layers. In contrast, in the pioneer and transition zones, there is little organic material to retain any precipitation at the suface; water would therefore percolate rapidly through the sand.

5.4 Vegetation Structure

Concomittant with the successional pattern exhibited by plant communities from the primary zone through to the climax forest, faunal communities may also expected to exhibit successional patterns across these zones. A number of studies have shown that animal groups respond to vegetation architecture rather than composition (e.g. MacArthur & MacArthur, 1961). It was therefore necessary to quantify changes in vegetation architecture across the successional gradient to relate them to changes in animal communities.

5.4.1 METHODS

Vegetation architecture was quantified in terms of plant growth form and horizontal vegetation density. Plant growth form was measured over two 30 m transects randomly located within each zone, and characterised as grass, forbs, shrubs, lianas, trees (Mueller-Dombois & Ellenberg, 1974). Horizontal vegetation density was determined using a density board with four replicates in each zone (MacArthur & MacArthur, 1961).

5.4.2 RESULTS AND DISCUSSION

Shrubs dominated the pioneer zone, with increasing grass cover in the transition zone. The thicket zone was dominated by trees and shrubs, with trees and lianas dominant in the forest zone. Horizontal vegetation density at low levels as well as vegetation height increased from the pioneer through to the forest zone (Figure 5.3). In the forest zone, vegetation density was moderate at intermediate heights, with a well-developed canopy at about 6 m. The observed trends in vegetation structure across the successional gradient conformed to expectations. These data will be related to the faunal communities where appropriate.

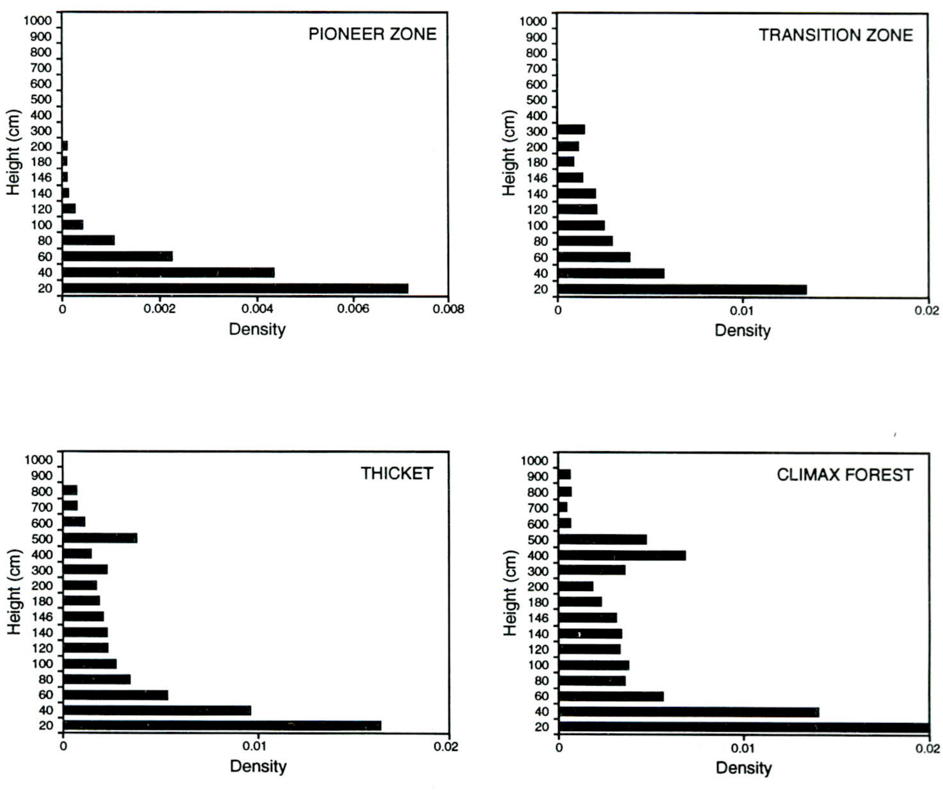

Figure 5.3 *Horizontal vegetation density in the pioneer, transition, thicket and forest zones.*

5.5 Meiofauna

Invertebrate fauna inhabiting the soil and litter layers decompose litter and therefore recycle nutrients back into the soil. The meiofaunal communities were therefore investigated as indicators of soil development.

5.5.1 METHODS

Meiofauna samples were extracted from the soil samples, preserved in 70% alcohol, stained with rose-bengal and counted using dissecting and light microscopes.

5.5.2 RESULTS AND DISCUSSION

Meiofaunal communities were dominated by two nematode species across the gradient; these species are still to be identified. Neither showed a clear zonation across the gradient, a surprising result considering the clear zonation of vegetation and changes in soil structure. Overall nematode abundance was, however, positively correlated with soil moisture. Further work on feeding guilds will hopefully elucidate clearer patterns.

5.6 Faunal Diversity

5.6.1 INVERTEBRATE DIVERSITY

Insects are the most diverse and abundant organisms in dune systems, but have been poorly studied (McLachlan, 1991). Few dune endemics are predicted to occur in coastal dunes, but insect assemblages may be unique to dunes, or zones within dunefields (McLachlan, 1991). The insect comunities were sampled to assess changes in biodiversity across the dune gradient.

5.6.1.1 Methods

Insects were sampled over 24 hours during the April and August field trips using pitfall traps placed on each dune ridge (four per crest and trough) across the gradient. The four samples from each crest and trough respectively were pooled, and stored in 70% alcohol for identification in the laboratory. Samples were identified to the level of Family.

5.6.1.2 Results and Discussion

Invertebrates with marine affinities, e.g. the ghost crab, *Ocypode ceratophthalmus*, were recorded in the pioneer zone but not further inland. Invertebrate fauna increased in diversity from the pioneer zone through to the forest zone. However, as greater definition is required, insects from prominent Orders will be identified down to the level of species with the aid of expert taxonomists. The results of the granivory trials during April 1993 identified ants as an important insect group, and more effort was concentrated on their sampling during the August field trip (see below).

5.6.2 ANT DIVERSITY

Ants belong to a variety of different feeding guilds. Some are solitary whereas others form social groups. Together, the different species in a community perform vital roles as seed dispersers, scavengers and even pollinators. While little is known about the ant fauna occupying the dunes near Mtunzini, the community colonising rehabilitated dunes at Richards Bay is diverse with up to 76 species recorded in the area (Majer & de Kock, 1992). The oldest rehabilitated dune forests (13 years old) in this disturbed area share some, though fewer, species with pristine dune forest (Majer & de Kock, 1992).

5.6.2.1 *Methods*

Ant diversity was sampled by collecting a range of specimens from trays baited with honey, fish and seed (millet and *Eragrostis* combination) placed in the four zones. Specimens were also collected opportunistically. The samples were stored in 70% alcohol for identification by Hamish Robertson (South African Museum, Cape Town).

5.6.2.2 *Results*

Ten ant species from three subfamilies were found across the four zones (Table 5.1). Six species were collected in each of the pioneer and transition zones, whereas in the thicket and forest zones respectively, three and one species were collected. One small black-coloured species, *Monomorium* sp. (*opacum*-complex), which was found only in the pioneer zone, may be an undescribed species (Hamish Robertson, pers.comm.).

Table 5.1 ANT SPECIES DIVERSITY ACROSS FOUR DUNE ZONES

Species	Pioneer zone	Transition zone	Thicket zone	Forest zone
Monomorium sp._*opacum* complex [Sub-family: Myrmicinae]	X			
Monomorium sp._*monomorium* group [Sub-family: Myrmicinae]	X			
Crematogaster castanea [Sub-family: Myrmicinae]	X	X		
Tetramorium sericeiventre [Sub-family: Myrmicinae]	X	X		
Pheidole sp. 1 [Sub-family: Myrmicinae]	X	X		
Pheidole sp. 2 [Sub-family: Myrmicinae]		X		
Polyrachis gagates [Sub-family: Formicinae]		X		
Pheidole megacephala [Sub-family: Myrmicinae]		X	X	X
Pheidole sp. 3 [Sub-family: Myrmicinae]			X	
Odontomachus troglodytes [Sub-family: Ponerinae]			X	

5.6.2.3 *Discussion*

In the pioneer zone, *Pheidole* sp. 1 was common, found in 11 of a total of 15 seed trays. This species may be particularly important as a seed predator in the foredunes, and, as such, may play a significant role in limiting the process of vegetation establishment and subsequent stabilisation of the dunes. Hamish Robertson (pers. comm.) suggested that a greater variety of baits and different sampling techniques may have yielded additional species, particularly cryptic and solitary species, which are less common and not as easily seen as colony-forming, social species.

5.6.3 SMALL MAMMAL DIVERSITY

Small mammals are important components of dune ecosystems, particularly as seed predators (Castley, 1992). Furthermore, the only mammals recorded as being endemic in coastal dunefields are small mammals, such as the hairy footed gerbil, *Gerbillurus paeba paeba*, (McLachlan, 1991). The small mammal community was therefore surveyed across the gradient to identify the species present and the potential key species.

5.6.3.1 Methods

A total of 150 (April) and 200 (August) Sherman traps were laid out in the dunes at Mtunzini and monitored over a period of 96 hours. The traps were set out along the crests and in the troughs of 13 dunes within the four zones, and checked at dawn and dusk for nocturnal and diurnal small mammal captures. Capture individuals were identified, weighed, sexed and marked (fur clipping) before being released.

5.6.3.2 Results

All captures occurred at night, the nocturnal, red veld rat, *Aethomys chrysophilis*, being the only small mammal species caught during both sampling periods. A single forest shrew (Mysorex varius) was trapped in the forest zone during the August sampling trip, and cane-rat, *Thryonomys swinderianus*, activities were evident in the transition zone during April. During April, there were eight *Aethomys* captures (five individuals) i.e. a trap rate of 1.78 captures per 100 trap nights. In contrast, a trapping rate of 3.13 (25 captures, 14 individuals) was obtained during August.

5.6.3.3 Discussion

The small mammal community appears to be depauperate, but typical of undisturbed KwaZulu-Natal coastal forests. Ferreira & van Aarde (in prep. a-e) noted that *A. chrysophilis* also tends to dominate in mature unmined dune forests at Richards Bay. There were no dune specialists or endemics at Mtunzini. The lower trapping success during the first field trip may have been due to the extremely dry conditions experienced during April which could have resulted in depressed small mammal populations. *A. chrysophilus* is a generalist omnivore whereas *T. swinderianus* is a specialist grass eater. *Thryonomys* would be unlikely to influence grass establishment in the transition zone since it is limited to areas of high grass cover (De Graaff, 1981) and would not colonise a site until grass had been established.

5.6.4 AVIFAUNAL DIVERSITY

Birds are useful indicator species for disturbance because they are easy to census, they respond strongly to variations in vegetation structure (MacArthur & MacArthur, 1961) and because they are highly mobile, changes in bird communities occur over short distances. Furthermore birds may play an important role in succession through the dispersal of seeds. This component of the study therefore aimed to identify the bird communities in the different zones.

5.6.4.1 Methods

During the April and August 1993 field trips, the avifaunal community in the dunes was sampled in the early morning and late afternoon over five consecutive days. Birds foraging, roosting or nesting in each of the four zones were identified by sight and/or call, while birds flying overhead were ignored. The time taken to efficiently sample each zone was determined during preliminary surveys, such that progressively more effort was spent in each zone as visibility decreased due to density of the vegetation (10, 20, 30 and 40 minutes in the pioneer, transition, thicket and forest zones respectively). Sampling was conducted for 100 minutes after sunrise and for 100 minutes before sunset.

5.6.4.2 Results

Twenty-eight bird species were recorded across the 13 dunes in April and 38 species in August (Table 5.2) with a total number of 47 species. The weather during the April field trip was calm and warm, and during August was windy and cooler. Generally bird diversity increased towards the forest zone and the pioneer zone harboured the most distinctive community, i.e. fewest species in common with other zones.

Table 5.2 AVIFAUNA COMMUNITY COMPOSITION IN THE PIONEER, TRANSITION, THICKET AND FOREST ZONES RECORDED DURING APRIL AND AUGUST 1993

BIRD SPECIES	ZONE			
	Pioneer	Transition	Thicket	Forest
Cape Wagtail	X			
Palmnut Vulture	X			
African Fish Eagle	X			
Whitefronted Plover	X			
Stonechat	X			
Water Dikkop	X			
Redeyed Dove	X	X		
Spottedbacked Weaver		X		
Cape Canary		X		
House Sparrow		X		
Rattling Cisticola		X	X	
Black Sparrowhawk		X	X	
Collared Sunbird		X		X
Yellowbilled Kite	X	X	X	X
Redfaced Mousebird		X		X
Blackcrowned Tchagra		X	X	X
Yellowbellied Bulbul		X	X	X
Sombre Bulbul		X	X	X
White-eared Barbet		X	X	X
Goldenrumped Tinker Barbet		X	X	X
Blackbellied Starling		X	X	X
Blackeyed Bulbul			X	X
Paradise Flycatcher			X	X
Black Flycatcher			X	X
Bleating Warbler			X	X
Greenspotted Dove			X	X
Cape White-eye			X	X
African Goshawk			X	X
Yellowbreasted Apalis			X	X
Hadada Ibis			X	X
Forktailed Drongo			X	X
Southern Boubou				X
Puffback				X
Greyheaded Bush Shrike				X
Wood Owl				X
Purplecrested Loerie				X
Square-tailed Drongo				X
Terrestrial Bulbul				X
Natal Robin				X

Table 5.2 Continued				
BIRD SPECIES	ZONE			
	Pioneer	Transition	Thicket	Forest
Forest Weaver				X
Orangebreasted Bush Shrike				X
Spotted Thrush				X
Longcrested Eagle				X
African Fish Eagle				X
Trumpeter Hornbill				X
Tambourine Dove				X
Grey Sunbird				X

5.6.4.3 Discussion

Birds were the most diverse vertebrates found in the dunes, and diversity for this taxon was highest in the forest and lowest in the pioneer zone. There was significant overlap in bird community composition between the forest, thicket and transition zones, but limited overlap in the pioneer and other zones. Despite the high overlap between birds recorded in the forest and transition and thicket zones, the forest supported 16 species not seen in the other three zones. Birds recorded in the transition zone were often in large feeding parties and included three species not recorded in the other zones, whereas no birds were found only in the thicket zone.

5.7 Ecological Processes

5.7.1 HERBIVORY

A range of mammalian (e.g. bushbuck, duikers, hares) and insect (e.g. caterpillars, beetles) herbivores occur in dunes (van Teylingen *et al.*, 1993). These herbivores have different dietary requirements and so forage selectively for specific plants growing in the different zones of the dunes. However, the distribution of vegetation in the four zones is not uniform; certain palatable species occur in some areas but not in others. Consequently, levels of herbivory could be expected to differ between the zones and hence the impact that herbivores may have on plant communities may also differ. An index of herbivory was obtained based on the visible evidence (grazed leaves) of herbivory in each zone.

5.7.1.1 Methods

Herbivory of randomly selected dicotyledonous plants was measured in the four zones. Each plant was divided into four height classes up to a maximum of 1 m. The first five leaves on a randomly selected stalk within each height class were assessed for signs of herbivory. If there were no leaves within the height class, the class was ignored. An index of herbivory that incoporates both the proportion of leaves eaten as well as the proportion removed from each leaf was developed. Leaves with zero herbivory were given a zero score, while those with 25%, 50%, 75% or 100% herbivory were scored 1, 2, 3 or 4 respectively. Stalks or stems that had been completely eaten scored 5. The scores were summed for all the height classes within each zone and the resulting index compared using chi-squared analysis. A minimum of 1 000 leaves were inspected in each zone.

5.7.1.2 Results

A trend of increasing herbivory from the pioneer to the forest zone was evident (Table 5.3), with a clear increase in the proportion of leaves showing signs of herbivory. Chi-squared analysis ($X^2 = 402.65$; d.f. = 3, $p < 0.00001$) showed a significant increase in the index of herbivory from the pioneer to the forest zone.

Table 5.3 LEVELS OF HERBIVORY EXPRESSED AS THE PROPORTION OF LEAVES SHOWING SIGNS OF HAVING BEEN EATEN, AS WELL AS THE INDEX OF HERBIVORY (SEE TEXT FOR DETAILS), IN THE FOUR DUNE ZONES

IMPACT	Pioneer	Transition	Thicket	Forest
Proportion leaves eaten	14.5 %	26.4 %	34.3 %	53.9 %
Index of herbivory	243	382	566	1 111

5.7.1.3 Discussion

It is apparent that herbivory, one of the fundamental processes affecting plant communities, increased stongly from the pioneer to the forest zone. Herbivory is dependant on a number of different factors, including the species of the plant, its nutrient status, age of the leaf, season, species of herbivore, habitat of herbage and the availability of alternate herbage. The observed trends in herbivory correspond to increases in soil nutrients and plant diversity, and may also reflect the habitat preferences of the major vertebrate herbivore at this site (bushbuck *Tragelaphus scriptus* - see MacLeod, 1992).

5.7.2 ANT GRANIVORY

Plant seeds are key elements in any ecosystem, their fate following dispersal from the parent plant influencing the distribution of plants in that environment. Granivorous animals (birds, ants and rodents) depend on seeds as their primary food resource and so have a profound effect on vegetation establishment. Kerley (1991) compared the seed removal rates of ants, small mammals and birds in the semi-arid Karoo environment and found that ants removed significantly more seed than the other two groups, thus highlighting this group of insects as important agents of seed predation. Seed removal in the dunes by ant granivores could represent a significant reduction in the seed bank. Conversely, translocation and storage of seeds into below-ground ant burrows may improve their chances of germination. This has important implications for the establishment of dune vegetation and stabilisation.

5.7.2.1 Methods

During the two sampling trips (April and August), removal of seeds was measured at 12 - 15 feeding stations set out in each of the four zones of the dunefield. Each feeding station comprised a seed tray (plastic petri-dish) containing a pre-weighed seed mixture (10g commercial millet, *Panicum miliaceum*, and 10g *Eragrostis curvula*). The trays were placed flush with the soil surface and covered with an inverted, slatted pot-plant cover. The 6 mm slats in the covers allowed access to ants but excluded other seed predators (e.g. rodents). The trays were checked for seed removals each morning and evening and, where necessary, additional pre-weighed amounts of seed were added. The seed trays were sealed and removed after 72 hours. Specimens of ants found at seed trays were collected and stored in 70% alcohol for identification. Seed remaining in the trays was dried (60°C, 24 h), equilibrated to atmospheric humidity, sorted and weighed to the nearest 0.01 g to determine the amount of seed removed by ant granivores in each of the four zones. ANOVAs were used to test for differences in the amount of seed removed per zone.

5.7.2.2 *Results and Discussion*

The amount and rate of seed removal in the four zones did not differ significantly between the two sampling trips, hence the two data sets were pooled for subsequent analyses. Ant granivory was highest in the pioneer zone with a decrease towards the forest (Table 5.4). Seed removal rates (millet and *Eragrostis* seed combined) differed significantly between the four zones ($F = 8.459$, $p < 0.0001$, d.f. = 3,102).

Table 5.4 ANT GRANIVORY TRENDS IN THE DUNES

	Pioneer n=27	Transition n=26	Thicket n=26	Forest n=28
% of trays with > 2g removed	81.48	57.69	26.92	28.57
mass of seed removed (g/zone/day)	163.75	65.71	20.30	19.68
removal rate (g/tray/day)	6.06	2.92	1.75	0.73

The pioneer zone was most heavily utilised by ant granivores (mean removal rate = 6.06 g/tray/day). While the amounts of millet and *Eragrostis* seed removed did not differ significantly between the transition, thicket and forest zones, significantly more *Eragrostis* seed (313.72 g) than millet (177.53 g) was removed from the pioneer zone ($F = 4.917$, $p = 0.0310$, d.f. = 1,26). This apparent preference for the smaller *Eragrostis* seed may be a result of the small body size of the dominant ant species (*Pheidole* sp. - see section on ant species diversity) in the pioneer zone. It is however possible that *Eragrostis* seed is an energetically more rewarding food resource.

Selective foraging influences the suite of plant species which grow in the dunes and it is therefore important to maintain the present natural community of ant species in the Mtunzini dunes. Changing this balance e.g. through the removal or disturbance of existing species, or introduction of alien species could ultimately disrupt the state of equilibrium in the dunes.

5.8 General Discussion

The coastal dune system at Mtunzini has important geological significance, and provides a unique opportunity to study the processes responsible for dune formation, colonisation and stabilisation. Further, these dunes support a classical example of plant succession from pioneer vegetation on newly formed foredunes through to a climax community of forest on older landward dunes. This successional pattern reflects the development of soils on the dune sands and should be conserved.

The successional pattern also reflects high vegetation diversity in the dunefield, with the full range of plants from pioneer through to climax species represented. In addition, the present study has demonstrated that these dunes support a high diversity of animals representing a number of taxonomic groups. The dunes should therefore be managed to maintain this biodiversity.

The strong zonation of the different animal groups across the dunefield indicates that the whole successional sequence should be managed as a unit and not as a series of isolated units. Using the bird community as an example, if only the forest zone was conserved, it would indeed support a high diversity of birds (but not of ants). However, this would not provide for those bird species unique to the pioneer zone. Similarly, conserving only the pioneer zone would place the forest zone species at risk. The contrasting trends between ant and bird diversity also indicate that conservation of all zones as an integral unit would provide for the highest diversity of all taxa.

It is generally accepted that there are regular trends in the relative importance of abiotic (e.g. wind, salt spray, etc.) and biotic (e.g. seed dispersal, litter breakdown, etc.) factors across coastal dunefields, with the importance of abiotic factors decreasing from the beach landwards, where biotic factors become more important (McLachlan, 1991). This trend was confirmed in the present study for the process of herbivory which increased from the pioneer zone through to the forest zone. However, another biotic process, granivory exhibited the opposite trend, increasing from the forest through to the pioneer zone. This indicates a need to quantify the relative importance of such processes in dunefields rather than simply assume a particular trend. The high levels of ant granivory observed in the pioneer zone have strong implications for the establishment of plant communities in this zone. Most pioneer plants have small seeds that are vulnerable to ant granivory, and it is interesting to note that the prime species responsible for colonising the pioneer zone, *Scaevola thunbergii*, has large seeds that tend to be dispersed by gravity and water, and are therefore not vulnerable to ant predation. The mechanisms whereby the seeds of those grass species which establish in the transition zone avoid ant predation need to be identified.

It is concluded that the coastal dune sequence at Mtunzini represents a unique example of primary succession and thus has exceptional conservation and educational value: it is an exciting biological mesocosm in which to test ecological theory under pristine conditions. Further, since this sequence is almost unique in South Africa in covering adequately all four zones, it harbours the entire spectrum of plant and animal species found in this region. Finally, preliminary findings have highlighted the interdependence of physical factors and biological processes, both plant and animal driven, in structuring dune ecosystems.

Chapter 6

Recreational use of Beaches and Dunes at Umlalazi and Richards Bay

6.1 Recreational Patterns on Beaches

6.1.1 INTRODUCTION

Dunes and beaches are inextricably linked into a single sediment system by the flow of sand. Because of their close ecological association, human impacts on one can directly affect the other. Sandy beaches are becoming increasingly popular as recreational resources and, with most beaches along the coastline backed by dunes, recreational activities associated with beaches inevitably impact on the adjacent dunes. Access to beaches is usually by means of roads or paths built through or sometimes over the dunes. Accessibility is a strong factor controlling beach popularity (Mijic *et al.*, 1981) and to cater for the needs of beach users, parking lots and entertainment and ablution facilities are often conveniently established in the backbeach or dune areas.

Dunes act as reservoirs for sand, storing it during times of accretion, and releasing it during times of erosion (Tinley, 1985). The growth of vegetation on dunes imparts a stability to the shore which can be disturbed when the tenuous plant cover is uprooted, or when sand dunes are destroyed to make way for the construction of facilities. To accommodate the increasing recreational use of sandy beaches, and at the same time maintain the function of beach-dune systems as buffers between the land and the sea, it is clearly important to study the recreational patterns of beach users.

The aim of this study was to investigate current recreational patterns and preferences of beach users at Newark and Alkantstrand, two urban beaches at Richards Bay, and at Umlalazi, a wilderness beach 400 m north of the Siyaya River mouth. This included an idea of the use by off-road vehicles (ORVs) at Umlalazi and at Five-Mile Beach which is situated 5 km north of Richards Bay harbour. Newark and Alkantstrand are under the jurisdiction of the Richards Bay Local Council whereas Umlalazi is located in a nature reserve administered by the Natal Parks Board.

6.1.2 THE STUDY AREA

Umlalazi Beach extends for 18 km between the Mlalazi and Matigulu Rivers. The Umlalazi Nature Reserve borders on the Mlalazi River estuary and supports two caravan parks with 24 and 14 camp sites respectively and 22 chalets, each with 6 beds; these facilities are situated within 750 m of the beach. The beach is relatively undeveloped, except for a parking lot for approximately 500 cars, two ablution blocks and two ORV access points about 1 km apart. No shark nets or lifeguards are provided and no ORVs are permitted on the beach between the two access points although they are allowed north and south of the restricted zone.

The two urban beaches at Richards Bay, Newark and Alkantstrand, are well developed whereas Five-Mile Beach to the north is undeveloped. Alkantstrand and Newark are situated side-by-side immediately north of Richards Bay harbour mouth and are separated by a breakwater. For the purpose of this report, the two beaches are regarded as one and collectively termed Alkantstrand. This is the only beach of those sampled that is protected by shark nets. It also has lifeguard facilities and shady picnic spots on landscaped lawns, a permanent restaurant, kiosk, toilets and showers 200 m landwards of the beach, as well as temporary cabins housing additional kiosks, facilities for renting surfboards and beach umbrellas, and temporary toilets and showers directly on the backbeach. Five-Mile Beach to the north has no facilities except a small parking lot for about 20 cars and an access point for ORVs to travel to Mapelane, approximately 35 km further north. No ORVs are allowed between Alkantstrand and Five-Mile Beach, as the area is reserved for pedestrians.

6.1.3 METHODS

Questionnaire surveys were conducted at Umlalazi and Alkantstrand Beaches over Easter (9 - 12 April) and on 31 December 1993 and 1 January 1994. The Easter survey attempted to determine the origin of beach users, group size and age composition, types of accommodation and transport used, preferences and opinions regarding beach recreation, and reasons for visiting a particular beach. The survey on 31 December 1993 and 1 January 1994 concentrated on recreation patterns and public awareness of dunes.

Recreation patterns were studied by conducting hourly counts of visitors on the beach and in the dunes. ORV use was studied at Umlalazi and Five-Mile Beach by hourly counts of vehicles on the beach and by recording the origin of the vehicles. Information on the numbers of visitors to Umlalazi and Alkantstrand Beaches were obtained from Mr John Maltby, the manager of the Umlalazi Nature Reserve, and Mr James Spiers, chief lifesaver for Alkantstrand in Richards Bay.

Statistical analyses were performed on the data. Chi-square tests were used to determine the significance of differences in the number of respondents between the two beaches and between ethnic groups. ANOVA was used to test for differences in numbers and origin of ORVs between the beaches and between the different public holidays. A regression was performed to find the relationship between beach visitor abundance and number of people observed in the dunes.

6.1.4 RESULTS

6.1.4.1 Visitor frequencies and trends

Numbers of visitors to Alkantstrand and Umlalazi over popular holiday periods fluctuated considerably between 1990 and 1994 (Figure 6.1). Peak numbers each year were largely associated with the period 26 December (Boxing Day) until 1 January (New Year's Day). At Umlalazi the peak for this period increased between 1991 and 1992, but declined notably in 1993 whereas at Alkantstrand, peaks remained largely constant. Visitor numbers over the Easter holiday period were also consistent over the three years

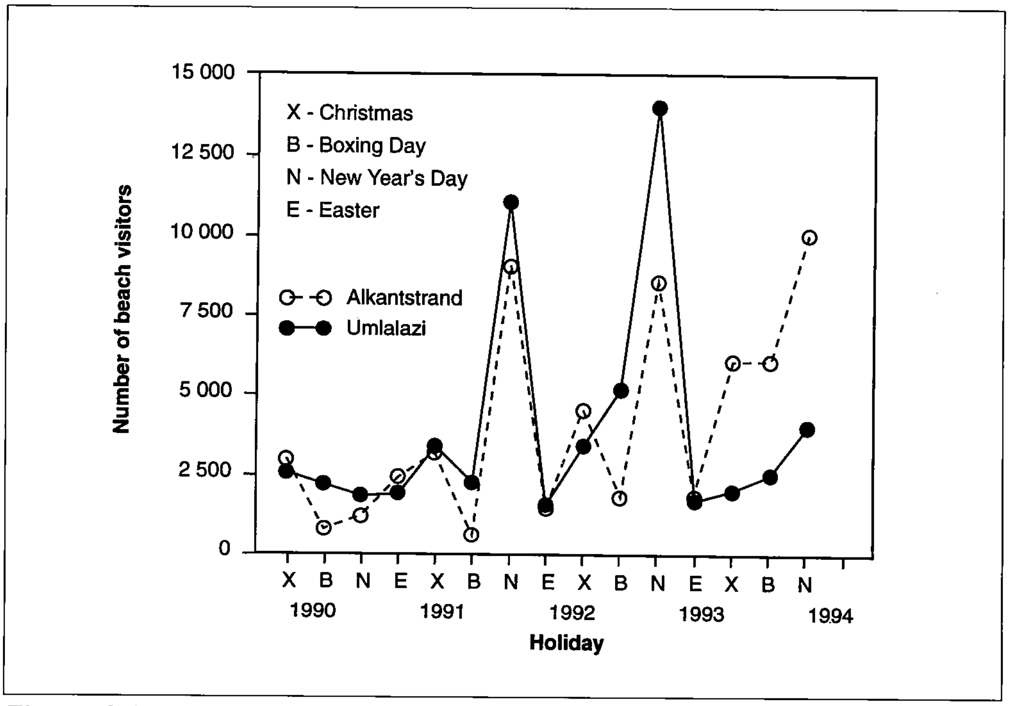

Figure 6.1 *Frequency of visitors to Alkantstrand and Umlalazi Beaches during the main holiday periods (Christmas Day (25 December), Boxing Day (26 December), New Year's Day (1 January) and Easter (early April) during the years 1990 to 1994.*

monitored by staff at the Umlalazi Nature Reserve. Overall, annual visitor patterns and the intensity of visits did not appear to show any notable increase.

Comparing hourly visitor numbers at Easter and on New Year's Day, Alkantstrand received considerably more visitors than Umlalazi (by an order of magnitude) (Figures 6.2 & 6.3(a) and (b)). At Easter, peaks in abundance were reached at 12h00 at Umlalazi and 13h00 at Alkantstrand, whereas on New Year's Day peak abundances occurred at 16h00 at Umlalazi and between 17h00 and 18h00 at Alkantstrand.

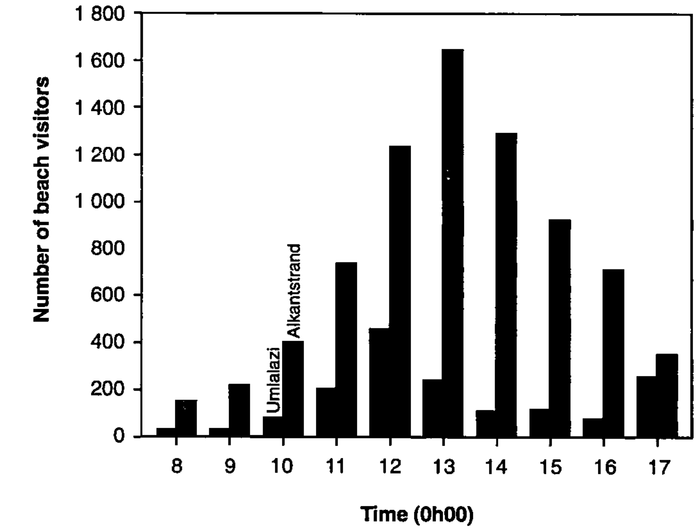

Figure 6.2 *Number of visitors to Umlalazi and Alkantstrand Beaches throughout the day on a single day over the Easter holiday 1993.*

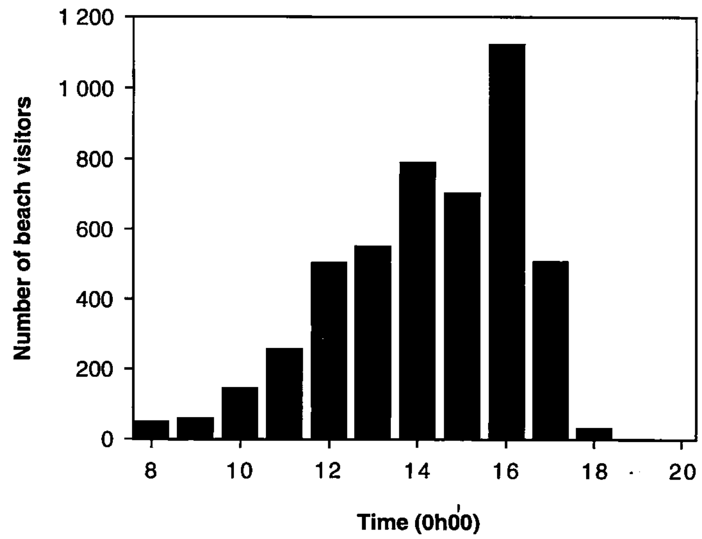

Figure 6.3(a) *Numbers of visitors at Umlalazi Beach throughout the day of 1 January 1994.*

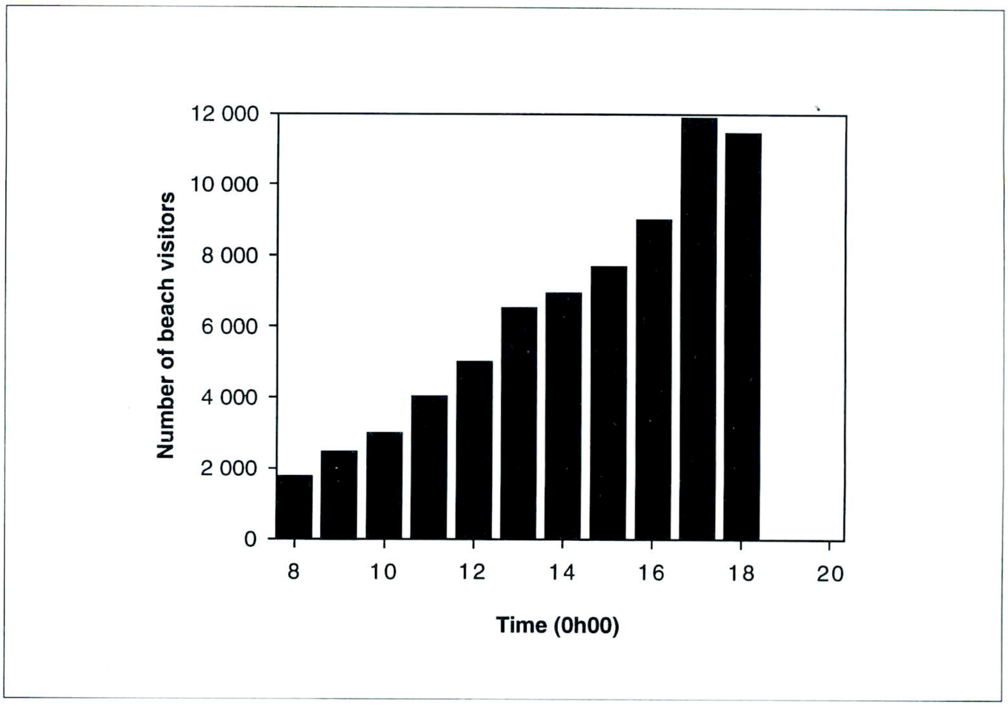

Figure 6.3(b) *Numbers of visitors at Alkantstrand Beach throughout the day of 1 January 1994.*

6.1.4.2 Use of ORVs

More ORVs used Five-Mile Beach than Umlalazi over Easter; the opposite trend was noted on New Year's Day (Figures 6.4 & 6.5). The peak numbers of ORVs on Five-Mile Beach over Easter and on New Year's Day were 58 and 78 vehicles respectively. At Umlalazi ORV numbers peaked at 32 and 45 for Easter and New Year's Day

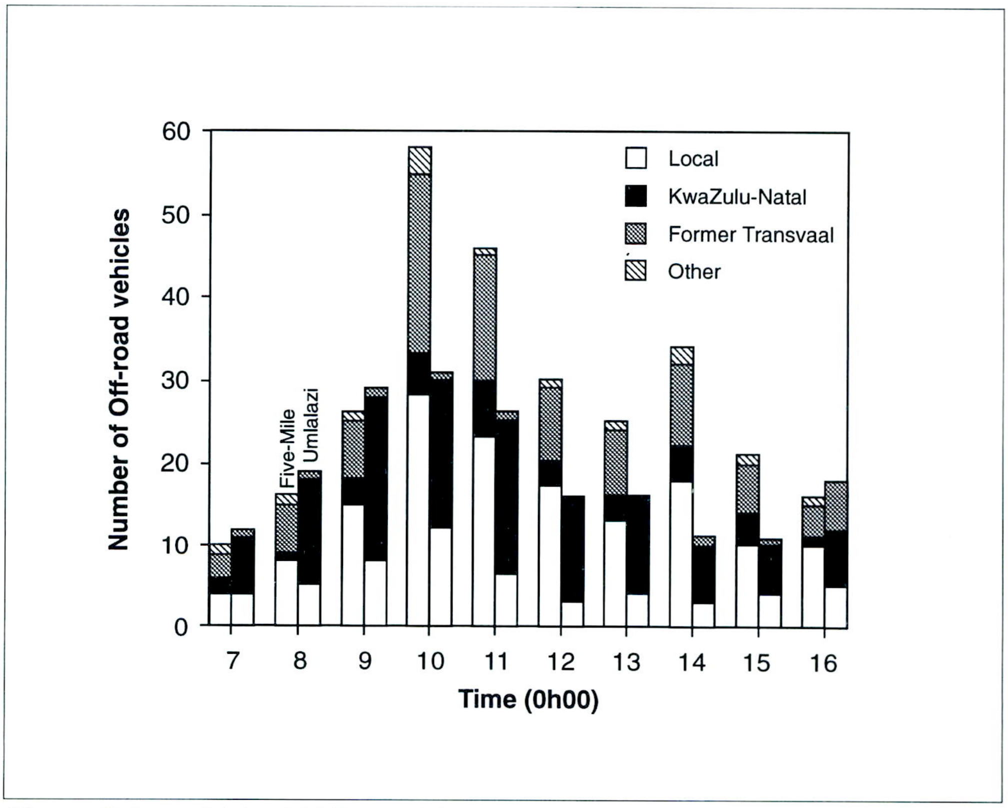

Figure 6.4 *Origin of ORVs and their occurrence on Umlalazi and Five-Mile Beaches during a single day over the Easter 1993 weekend.*

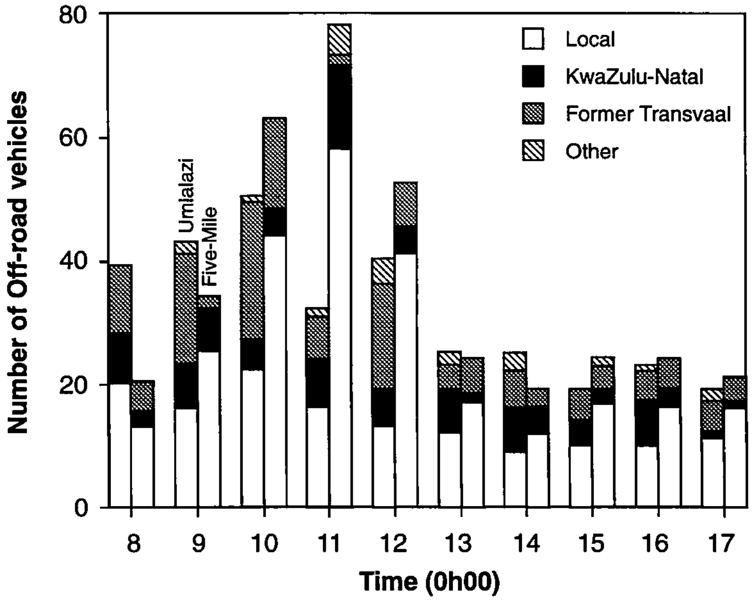

Figure 6.5 *Origin of ORVs and their occurrence on Umlalazi and Five-Mile Beaches throughout the day of 1 January 1994.*

respectively. On both occasions and on both beaches ORV peaks were reached at 10h00 - 11h00. More than half the ORVs accessing the beach at Umlalazi were 'foreign' (76% over Easter and 55% on New Year's Day). Over Easter, most of these originated from other parts of KwaZulu-Natal whereas on New Year's Day most originated from the former Transvaal. At Five-Mile Beach, more than half the ORVs were local (57% over Easter and 71% on New Year's Day); the largest proportion of 'foreign' ORVs originated from the former Transvaal on both occasions. Local vehicles were more common at Five-Mile Beach than at Umlalazi.

6.1.4.3 *Questionnaires*

For the study of recreational patterns on beaches, a total of 219 questionnaires (see Appendix A, Part 1) (118 at Umlalazi and 101 at Alkantstrand) were completed over Easter 1993.

A second questionnaire survey concentrating on recreation patterns and public attitudes towards dunes was conducted from 31 December 1993 to 1 January 1994 (hereafter combined and called New Year unless otherwise stated). A total of 107 questionnaires (see Appendix A, Part 2) (55 at Umlalazi and 52 at Alkantstrand) were completed.

6.1.4.4 *Origin of visitors*

Most respondents (40%) interviewed at Umlalazi came from the former Transvaal whereas at Alkantstrand similar proportions (35% and 37% respectively) came from the former Transvaal and KwaZulu-Natal. Of the whites interviewed on both beaches, most (mean 51%) were from the former Transvaal with KwaZulu-Natalians constituting a mean of 42%. Of the non-white respondents, most (79%) at Umlalazi were local whereas at Alkantstrand, most (55%) came from other parts of KwaZulu-Natal; 21% came from the former Transvaal and 23% were local.

6.1.4.5 Group size

At Umlalazi and Alkantstrand mean visitor group size (± standard deviation) was similar: 5.6 ± 1.8 persons and 5.3 ± 2.1 persons respectively. Variation in group size was generally high.

6.1.4.6 Age composition

Of respondents at Umlalazi and Alkantstrand 50% and 66% respectively were in the age-group 11 - 30. At Umlalazi 35% were older than 30 years in contrast to only 23% in this age category at Alkantstrand.

6.1.4.7 Accommodation

At Umlalazi and Alkantstrand respectively 41% and 57% of respondents lived at home. Of the respondents not living at home, most stayed with family and friends (mean 17%) and in the caravan park (mean 19%). Of the rest, few (5%) stayed in hotels and chalets.

6.1.4.8 Mode of transport

Mode of transport was included only in the Easter questionnaire. Most respondents (81% at Umlalazi and 70% at Alkantstrand) used private transport. At Alkantstrand, 4% used the public bus service, 21% used taxis and 1% walked to the beach. At Umlalazi, 17% went there on foot. A count of cars on New Year's Day at Umlalazi showed that 41 taxis were used for transport on that day (R. Shepherd, Natal Parks Board, pers. comm.).

6.1.4.9 Beach activities

Swimming was the most popular activity on both beaches (mean 87%) with sunbathing and picnicking similar in popularity (mean 40%); walking was also popular (mean 33%). Surfing was a keen activity among younger visitors and was equally popular at both beaches (mean 13%). Fishing was more popular at Umlalazi (35 %) than at Alkantstrand (23%).

6.1.4.10 Duration of visit

Most visitors to Umlalazi (42%) stayed 3 - 4h whereas at Alkantstrand most (40%) stayed for the entire day. A small proportion on both beaches (mean 8%) stayed for less than 2 h and most (mean 86%) stayed longer than 3 h.

6.1.4.11 Beach preferences

The most important reason why respondents (36% at Umlalazi and 29% at Alkantstrand) on both beaches visited a particular beach was its proximity to home. At Alkantstrand the presence of lifeguards and shark nets, in contrast to the absence of these facilities at Umlalazi, was an important factor. At Umlalazi 23% simply enjoyed the beach and 14% at Alkantstrand felt likewise. At Umlalazi 11% enjoyed its uncrowded and peaceful nature; no-one at Alkantstrand remarked on the importance of peace and quiet. Beach activities attracted a small proportion (15%) to Alkantstrand and an even smaller proportion (4%) to Umlalazi.

6.1.4.12 Popular visiting times

Most respondents interviewed on both beaches during Easter visited the beach most often at that particular time of the year (mean 45%), a response similar to that of respondents on New Year's Day who visited the beach most often on New Year's Day mean 66%). Comparing the proportions of Easter and New Year's Day respondents who visited beaches on different public holidays, Christmas (mean 22%), Boxing Day (mean 7%) and New Year's Day (mean 15%) were less popular with Easter than with

New Year's Day respondents, who visited the beach less often during Easter (mean 14%). Greater proportions of respondents at Alkantstrand than at Umlalazi visited these beaches on public and school holidays as well as during weekends. This applied both to Easter and New Year's Day respondents. No New Year's Day respondents visited the beaches during winter holidays in contrast to 4% and 15% of Easter respondents at Umlalazi and Alkantstrand respectively who did.

6.1.4.13 Visits to alternative beaches

Of the Umlalazi respondents, 35% also visited Richards Bay beaches whereas 27% at Alkantstrand visited other beaches in the Richards Bay area and Umlalazi (18%). St Lucia, about 35 km north-east of Richards Bay, seemed to be popular and was visited by 7% of Umlalazi and 32% of Alkantstrand respondents. Other beaches visited by respondents at both sites were eSikhaweni (4%), Port Durnford (2%), Mapelane (2%), Sodwana (4%), Cape Vidal (3%) and Durban (6%).

6.1.4.14 Attitudes towards beach-related issues

At Umlalazi 55% of respondents were in favour of ORVs on the beach in contrast to 37% at Alkantstrand; 27% and 15% of respondents respectively used ORVs on the beach. At these two beaches, 80% and 24% respectively said that they would swim without shark nets. Only 3 - 4% of respondents on both beaches felt overcrowded during Easter although 17% and 32% of respondents at Umlalazi and Alkantstrand respectively had felt overcrowded some time in the past, mainly on New Year's Day. Only 37% and 31% of respondents at Umlalazi and Alkantstrand respectively were in favour of limiting the number of visitors to the beaches; 62% and 47% respectively were willing to pay an entrance fee to gain access to the beach.

6.2 Recreational Use of Dunes adjacent to Umlalazi and Alkantstrand Beaches

6.2.1 PERIODICITY

The maximum numbers of persons observed using the dunes at Umlalazi were 28 (12.1% of the total beach visitors) at 14h00 on 31 December 1993, and 27 (2% of beach visitors) at 16h00 on New Year's Day (Table 6.1). At Alkantstrand visitors using the dunes peaked at 10 persons (0.7%) around 14h00 on 31 December 1993 and 50 persons (0.4%) around 17h00 on New Year's Day. Despite the high visitor abundance on New Year's Day, no persons were observed using the dunes at Alkantstrand for most of the day, except during the times of peak beach abundance (17h00 - 18h00). In contrast, public use of the dunes at Umlalazi continued throughout the day, albeit in low numbers. There was a broad relationship (linear regression $r=0.75$) between the abundance of visitors using the dunes and the number of visitors on the beach, especially at Alkantstrand; i.e. more visitors on the beach usually signified more using the dunes although this was not always the case.

6.2.2 DURATION OF STAY

There was no difference between the proportion of respondents at Umlalazi (47%) and Alkantstrand (42%) who entered the dunes occasionally. Most of those entering the dunes at Umlalazi (65%) and half of those at Alkantstrand stayed for > 1 hour, only 35% and 50% respectively remaining for < 1 hour.

6.2.3 DUNE ACTIVITIES

At Umlalazi viewing the scenery from elevated dunes, finding peace and quiet, and sunbathing were the activities pursued by about 16% of those using the dunes; most users (54%) enjoyed walking in the dunes. With Umlalazi Beach situated in a nature reserve, these activities were more

Table 6.1 HOURLY VISITOR NUMBERS ON THE BEACH AND IN THE DUNES AT UMLALAZI AND ALKANTSTRAND BEACHES

31 December 1993

	UMLALAZI			ALKANTSTRAND		
Time	Number on Beach	Number in Dunes	% in Dunes	Number on Beach	Number in Dunes	% in Dunes
08h00	170	2	1.2	64	0	0
09h00	200	8	4.0	350	2	0.6
10h00	370	12	3.2	650	7	1
11h00	204	15	7.4	1 000	8	0.8
12h00	251	18	7.2	1 500	8	0.5
13h00	231	28	12.1	1 500	8	0.5
14h00	175	22	12.6	1 500	10	0.7
15h00	104	5	4.8	800	1	0.1
16h00	70	3	4.3	400	3	0.8
17h00	45	6	13.3	250	0	0
18h00	15	0	0	200	0	0

New Year's Day 1994

	UMLALAZI			ALKANTSTRAND		
Time	Number on Beach	Number in Dunes	% in Dunes	Number on Beach	Number in Dunes	% in Dunes
08h00	50	10	20	1 800	0	0
09h00	60	7	12	2 500	1	0
10h00	146	7	5	3 000	0	0
11h00	256	5	2	4 000	0	0
12h00	500	5	1	5 000	0	0
13h00	550	4	0.7	6 500	2	0
14h00	786	11	1	6 900	0	0
15h00	700	17	2	7 600	0	0
16h00	1 118	27	2	8 900	0	0
17h00	500	16	3	11 900	50	0.4
18h00	22	0	0	11 400	45	0.4

popular than in the low-lying dunes lining the urban Alkantstrand Beach where viewing (55%) and walking (27%) were the chief dune activities. It is noteworthy that only two respondents at Umlalazi and one at Alkantstrand admitted to using their own path and not an official route to gain access to the beach.

6.2.4 DUNES AS COASTAL ASSETS

Although the dunes at Umlalazi are almost pristine whereas those at Alkantstrand have been grossly modified to make way for various recreational facilities, 91% of respondents on both beaches felt that dunes were scenically attractive and a valuable asset to the beach. When asked whether dunes played a functional role on sandy coasts, 87% thought that they did and 12% answered in the negative or did not know. Of those who thought that dunes were functional coastal features, most (58%) at Umlalazi ascribed an ecological (29%) and storm protection (29%) function to dunes with 11% unaware of the function of dunes; in contrast 23% at Alkantstrand had no idea of the function. Similar proportions of respondents at Alkantstrand mentioned ecological (23%), storm protection (25%) and creating beautiful scenery (23%) as functions of dunes.

6.3 Discussion

6.3.1 VISITOR TRENDS AND PREFERENCES

During the years 1990 to 1993, Umlalazi and Richards Bay Beaches experienced variable peaks in visitor abundance over the main holiday periods; the gross trends suggest that pressure on the coastal zone occurs in pulses associated with public holidays, and that after 1990 the intensity of the pulses has in fact been at consistent levels. Both Umlalazi and Richards Bay are situated in close proximity to the residential areas of Empangeni, Felixton, KwaMbonambi, Mtunzini, Eshowe, Amatikulu, Gingindlovu, eSikhawini, Ngwelezana and Nseleni and serve as the closest seaside recreation outlets for these centres. In addition, the coast attracts a large proportion of its annual visitors from other parts of KwaZulu-Natal and from the former Transvaal. With the current political changes in the country destined to increase social stability and promote economic resurgence, the demand for leisure outlets is likely to rise accordingly. Umlalazi and Richards Bay could therefore face the prospect of becoming popular venues for local year-round recreational activities and as holiday resorts attracting visitors from further afield during specific holiday periods.

This study showed Alkantstrand to currently be more popular than Umlalazi probably because of its proximity to Richards Bay with its 30 000 inhabitants. Umlalazi is 40 km from Richards Bay, 32 km from Empangeni and 44 km from Eshowe and thus presents a formidable drive from the major centres for a day's visit. Furthermore Umlalazi might also be situated too close to Richards Bay and nearby towns to represent a holiday venue for local residents; longer holiday periods probably encourage holidaymakers to travel longer distances. Umlalazi appeared to attract visitors from a wider area than Richards Bay particularly those who enjoyed camping or caravaning in the nature reserve or those who had friends in the area. The presence of shark nets and lifeguards at Alkantstrand may have been a drawcard although the absence of these features were apparently no deterrent to visitors at Umlalazi. The two beaches are however notably different in what they offer the visitor. Alkantstrand is an urban beach geared towards the needs of an urban population. It is usually well populated, supports well developed facilities and focusses on short-term entertainment; the natural features have largely been sacrificed. There is a caravan park and picnic sites on the stretch of coast a few kilometres north of Alkantstrand; these are within the metropolitan area of Richards Bay and thus have a semi-urban flavour. Umlalazi on the other hand is a wilderness beach and supports an unspoilt and minimally modified landscape featuring a broad beach backed by lushly vegetated dunes. Although there is a caravan park alongside that forms part of the Umlalazi Nature Reserve, the facilities are minimal and the beach is usually sparsely populated. There is ample space for walking and the beach offers visitors a stimulating wilderness experience. The popularity of both Alkantstrand and Umlalazi highlights the need for diverse coastal resorts to cater for different recreational experiences.

The extremely high visitor numbers (> 7 000) experienced annually at Alkantstrand and Richards Bay on New Year's Day reflect a long-standing tradition in South Africa that has also been recorded on beaches in the eastern Cape (De Ruyck *et al.* submitted). With the changing social scenario in the country, it is likely that the future will bring changes in traditional and economic factors which will probably result in changes in recreation patterns.

6.3.2 USE OF ORVS

The use of ORVs was more common at Five-Mile Beach than at Umlalazi with the Chrstmas/New Year period the most popular. The maximum number of ORVs recorded at Five-Mile Beach (i.e. 79), a stretch of 2 km to the municipal boundary of Richards Bay, on New Year's Day 1994 and even the maximum (i.e. 50) at Umlalazi, an 18 km stretch, are indicative of the popular use of these vehicles to access the more remote fishing spots along the coast. Probably because of the expense involved in using four-wheel-drive vehicles over long distances, ORV use was associated more with the longer holiday periods. Angling is a rapidly growing sport and with many areas of the coast already over-fished, keen anglers need to venture further to maintain good catches.

At Umlalazi, ORV access to beaches is controlled and channelled to specific points, drivers are issued with an instruction pamphlet and their behaviour is monitored by staff of the Natal Parks Board. At Five-Mile Beach, however, there appears to be little if any control over ORVs. The survey conducted for this study revealed that many of those accessing the beach at the Five-Mile point ignored prominent signs prohibiting access to the beach south of the access road. In addition vehicle tracks through pioneer vegetation stabilising the foredunes immediately north of the access road were clearly visible, further evidence of the absence of control and either ignorance or defiance on the part of the drivers. Avis (1992) has shown that two to three ORV passes per month are sufficient to significantly reduce the height of pioneer plants. With the use of ORVs on beaches likely to increase, and in the face of marketing campaigns by ORV manufacturers who continually introduce new and more adaptable models into the market, the threat of unscrupulous use of these vehicles on beaches poses a real threat to plant communities that stabilise shifting dune sand and thus facilitate the protective function of the coastline. In a bid to protect the coastal zone, a policy for the control of vehicles on beaches was announced by the Minister of Environment Affairs on 29 April 1994. The policy made provision for the introduction of a permit system to facilitate law enforcement and for the prohibition of ORVs above the high water mark.

6.3.3 USE OF DUNES

The elevated yellow mounds of sand backing most sandy beaches are attractive to beach visitors because the sand is usually warm and moves readily underfoot with the result that walking in dunes presents an exciting and unusual experience. Some dunes, particularly those along the south east Cape coast, are unvegetated, several metres high and are ideal venues for sand skiing. The dunes backing the wilderness beach at Umlalazi were more attractive to visitors than those at Alkantstrand, with 4 - 6% of visitors using the dunes and a maximum of 28 persons in the dune area at any one time over the holiday periods monitored. They were used as viewing points and places to walk, sunbathe, picnic and find peace and quiet. The foredunes at Umlalazi reach up to 4 m high and are stabilised at the seaward edge by a sparse covering of pioneer plants. Despite their low intensity use by beach visitors, the dunes at Umlalazi showed no signs of deterioration.

Although it has been documented that common dune pioneer plant species can only withstand low levels of human trampling (2 - 10 passes per month) (Avis, 1992), the impact of trampling at Umlalazi should be seen in perspective. Visitor abundance is sporadic, concentrated into four main holiday periods, and the proportion of visitors who use the dunes is generally low. In addition, because the dunes cover an extensive area, there is a reduced chance that one particular area would be exposed to continual trampling. From an ecological perspective, the entire 55 km of coastline between the Tugela River mouth and 10 km north of the Mlalazi River mouth is accreting at a rate of 1 - 5 m per year, i.e. sand is accumulating on the beach at a considerable rate (Cooper, 1991). Also, the area experiences high rainfall which promotes rapid plant growth and thus rapid recovery in the event of disturbance. Seen in the light of these factors, if access to the beach is restricted to one or two major paths built through the dunes or else a few minor paths that employ wooden boardwalks to cross over the dunes, and if using the dunes for recreational purposes is maintained at moderate levels, trampling should not pose a threat to the Umlalazi beach-dune system or the coastline in the vicinity. Despite this, it would be advantageous to inform visitors of the dangers associated with the destruction of dune vegetation. This could be effectively achieved through simply designed but informative signboards strategically placed at entrance points.

ORV use at Umlalazi could however pose a problem. ORVs traverse large areas, they are heavy vehicles and when driving at speed are insensitive to what lies in their path. At high tide, they are compelled to use the foredune area, and with many vehicles using the same track (50 were recorded on Umlalazi Beach on New Year's Day 1994), the damage to foredune plants could be extensive. For this reason, the policy (Government Gazette, 29 April 1994) restricting ORVs to below the high water mark and even prohibiting access for specific periods preceding and following high tide should be strictly enforced.

At Alkantstrand, a few low-lying (about 0.5 m high) dunes covered by a sparse growth of pioneer plants occur adjacent to Newark Beach. The dunes do not constitute a significant natural or scenic asset to the beach and they play little or no part in the sediment dynamics of the area. Although a few visitors use the dunes, probably because they are slightly elevated, they do not appear to constitute a popular recreational resource in this urban-orientated environment. With the backbeach area of Newark/Alkantstrand already grossly modified, use of these dunes should be freely allowed.

Although the study of recreation patterns did not extend to the four Richards Bay Beaches north of Alkantstrand (Soetwater, Two-Mile, Kleiklipklofie and Five-Mile), these beaches are also visited extensively by the general public throughout the year. The coastal zone along this stretch features a relatively narrow beach adjacent to a high foredune ridge running parallel to the shore on which car parks and picnic facilities have been built. The coastline is eroding markedly in places, cutting into the foredune ridge which is tenuously stabilised by a complex and highly sensitive vegetation community. The impact of human trampling to access the facilities atop the ridge is clearly evident and has exacerbated the erosion. With the beach narrow and sand continually eroded to the sea, the ridge vegetation can withstand no human impact whatsoever. It is therefore important that access to the beach from facilities on the ridge be strictly confined to the boardwalks and that further development be restricted to at least 100 m from the seaward face of the foredune ridge.

6.4 Conclusion

Beaches along the central KwaZulu-Natal north coast are popular recreation and holiday venues. The frequency of visits is sporadic and varies according to season. The highest numbers of visitors occur at and around the new year. Alkantstrand is an urban beach where the natural features have been largely modified to accommodate the development of the town of Richards Bay and the harbour; the beach caters for an urban beach experience. Umlalazi Beach is situated in a nature reserve and the environment has experienced little alteration; it caters for a wilderness experience. ORV use appears to be uncontrolled in the northern Richards Bay area, the foredune environment clearly showing the signs of ORV impacts, whereas at Umlalazi ORV use is successfully controlled by Natal Parks Board wardens.

Beaches are ideal environments for human recreation and can withstand even fairly high levels of both human trampling and ORV traffic (Van der Merwe & Van der Merwe, 1991). This is however not the case with the adjacent dunes where the growth of pioneer plants stabilises the flow of sand. Recreation should therefore be encouraged on beaches but controlled in dunes. However, with the composition of the coastline, extent of plant communities and the gross movement of sand highly variable along the central KwaZulu-Natal northern coastline, management plans to promote the sustainable use of the coastal zone should be designed to accommodate local circumstances.

Chapter 7

Human Impacts: Umlalazi and Richards Bay

7.1 Introduction

Sandy coasts are malleable, readily moulded by forces associated with wind, waves and tides. It is through this malleability that they can function as efficient and self-regulating buffers between the land and the sea, protecting the land from storm surf and gale force winds. But, it is also in this malleability that their considerable vulnerability to human disturbance lies. With the flow of sand the chief agent of malleability, any factor that disrupts the natural sand flow patterns between the dunes, beach and surf zone, whether it be through reduction, constriction or restriction, will decrease the capacity of sandy coasts to act as protective buffers, with the onset of coastal erosion the likely consequence.

Along the South African coast there are many examples of poorly planned and inappropriate developments that have interrupted the natural sand balance, with the coastline and often the development suffering the inevitable outcome. Two examples of the impact of man's tampering with littoral sand sources are worth mentioning (see McLachlan *et al.*, in press). On the south-east Cape coast, until the early 1960s there were few holiday cottages in the St Francis Bay region. Since 1964 the foredunes behind the beach, the downwind nose of the Oyster Bay dune system and the smaller northern flank of the Santereme dunefield were stabilised to develop the St Francis Bay resort. More recently the larger southern flank of the Santereme dunefield was stabilised to develop Santereme, a new resort. As a consequence, the beaches of St Francis Bay south of the Krom River are eroding and require costly artificial restoration to preserve them and to protect threatened houses built on foredunes that normally act as sand buffers.

The beaches of Waenhuiskrans, 40 km east of Cape Agulhas, experienced considerable erosion because of the artificial stabilisation in the 1960s of the bypass dunefield on the Struis Point headland. In 1987 and 1988, after 10 years of continual beach erosion, efforts to destabilise the dunefield through successive burning programmes have proved successful and the beaches are slowly accreting. These examples are evidence that sandy coasts are fragile, delicately balanced systems in which beaches and dunes comprise interdependent components. For the preservation of the physical and biological integrity of the coastal environment, the coastal zone should be managed as a unit (McLachlan *et al.*, in press).

7.2 Human Impacts

When assessing the impacts of human activity on the coastal zone, it is important to judge their severity in relation to the patterns of sand movement and the sand depositional status of the coastline. Within the relatively short (50 km) stretch of coastline between Umlalazi and Richards Bay, the shoreline experiences accretion (Tugela River to about 10 km north of the Mlalazi River), erosion (intermittent intervals 4 - 7 km in length between the Mlalazi River and the outlet of the Mhlatuze Lagoon) and stability/erosion (5 - 6 km north of Richards Bay harbour) (Cooper, 1991). Although the manifestations of human activity might be similar along this shoreline, e.g. paths, cars parks, roads, etc., the degree to which these disrupt natural sediment cycles or threaten biotic communities that lend stability to the coastal zone differ accordingly.

The impacts of human activities in the Umlalazi Nature Reserve south of the Siyaya River and at Richards Bay were assessed visually during two field trips and by examination of a series of 1:10 000 aerial photographs (with permission of EMATEK) taken in April 1990.

7.2.1 UMLALAZI NATURE RESERVE

7.2.1.1 Human trampling

With human activity in the Umlalazi Nature Reserve controlled by Natal Parks Board wardens, evidence of human trampling was limited to the foredunes in the vicinity of the main access point from the car park, and a few footpaths established by repeated passages through the scrub-thicket vegetation to reach the beach from the road running parallel to the shore. Foredune trampling was localised and its impact appeared to be small and of local significance.

Although the footpaths are narrow, increased trampling could destabilise vegetation alongside broadening the paths and pave the way for the formation of blowouts (broad sandy gaps in coastal vegetation from and through which sand is channelled onto adjacent land). Blowouts have long been considered to represent sites of human disturbance but are also natural phenomena caused by strong onshore winds together with an abundant supply of sand (Ferguson, 1994). From aerial photographs, and noting the direction of the sand tongue, it appears that natural blowouts have formed in a few places close to the Mlalazi River mouth (Plate 7.1). To limit the extent of vegetation destruction, footpaths should be carefully selected, run at 90° angles to the predominant wind, zig-zag instead of following straight lines and should be fenced. They should also be reduced to as few as conveniently possible; visitors should be strictly discouraged from making their own paths.

7.2.1.2 ORV activity

ORVs access the beach at two points: one enters directly from the main car park and the other from a point about 1 km further north. Destabilisation of vegetation at the access points is limited to the immediate vicinity. No tracks were noted in the foredunes during the field observations (limited to the area surrounding the main access points) and they were not evident from the aerial photographs. About 200 m south of the northernmost access point is a broad (100-150 m) triangle of sand encroaching into the foredunes that appears to have been caused by the formation of a road. If this is the case, this road should be closed and traffic restricted to the two recognised access points.

7.2.1.3 General human impact

The condition of coastal vegetation in the Umlalazi Nature Reserve shows the impact of human activity to be limited to small areas surrounding access points. The main car park is situated about 130 m landwards of the foredunes and thus landwards of the littoral active zone (i.e. zone where sand is actively blown by the wind); the caravan and camping facilities are located about 450 m from the backbeach in the landward extremity of the climax dune forest. Both facilities are thus situated where they do not pose any threat to the natural sediment dynamics of the area and destruction of indigenous and unique coastal forest has been minimal. With the shoreline continually accreting and with human activities in the reserve monitored, the potential for negative human impacts on this coastline under current circumstances is low.

7.2.2 RICHARDS BAY

7.2.2.1 Human trampling

The impacts of human trampling are clearly visible at three semi-urban beaches north of Richards Bay harbour and alongside the caravan park situated about 1 km north of Alkantstrand. Soetwater, Two-Mile and Kleiklipklofie Beaches all have wooden boardwalks constructed over the dune vegetation to the beach; the boardwalks are either directly attached to or are located within 100 m of the car parks on the foredune ridge. Regardless of their presence or position, destruction of vegetation creating open

Plate 7.1 Aerial photo of the Umlalazi Nature Reserve north of the Siyaya River (S) mouth. The car park (C) with the ORV and pedestrian access points leading from it are clearly visible; the second ORV access point (A2) can be seen on the seaward side of the curve in the Mlalazi River (M).

(Photo used with the permission of EMATEK, CSIR, Stellenbosch)

channels of sand is evident immediately alongside the boardwalks; visitors tramp through the vegetation next to the boardwalk, bypassing it instead of using it to cross the foredune (Plate 7.2). Where a boardwalk is situated a short distance from a car park, direct paths have been made to the beach resulting in destruction to strips of vegetation on the ridge (Plate 7.3). At Kleiklipklofie, where the boardwalk is prominently featured, almost all the vegetation on the seaward side of the car park has been destroyed by the impact of numerous individual paths to the beach (Plate 7.4). In addition, the vegetation on the northern dune ridge above the car park has experienced the same fate. Access

Plate 7.2 Destruction of vegetation alongside this boardwalk at Soetwater has created channels of mobile sand.

Plate 7.3 Paths trampled through the foredune vegetation to reach the car park at Two-Mile Beach.

Plate 7.4 Continual trampling through the vegetation to reach the beach in front of the car park at Kleiklipklofie has created a band of readily mobile sand. Note that the destruction of vegetation behind the car park has caused the formation of a blowout.

to the beach from the caravan park appears to be random in places and has created gaps in the vegetation. The dune ridge is lower than that further north although the beach is fairly narrow.

The formation of paths through vegetated dunes inevitably destroys the vegetation underfoot with continual use of the same path widening the gap of mobile sand. During strong winds this sand is free to blow into the backdunes encouraging greater instability and causing blowouts which facilitate the passage of sand inland. The Richards Bay coastline is stabilised by a foredune ridge covered by scrub-thicket-forest vegetation. With erosion occuring at intervals along the shore, the beach is variable in width with the result that during high tide waves lap against the vegetation in some places; storm surf readily scours into the ridge and large scars in sections of the ridge are evidence of these forces. Vegetation destabilisation, caused by the creation of paths, exacerbates the erosion of the foredune as the fixing action of plant cover is lost facilitating the tidal removal of sand. Education of visitors through the erection of simple but informative signboards outlining the dangers plus regular patrols by a law enforcement officer are ways to combat the destruction of the ridge vegetation.

7.2.2.2 *ORV activity*

ORV activity in Richards Bay is officially confined to the 2 km stretch north of Five-Mile Beach to the council boundary; vehicles are prohibited from using the beaches to the south of the access road. However, during the field trip for this survey, several ORVs were noted on the southern beaches despite a prominent sign at Five-Mile Beach prohibiting access. To the north of the Five-Mile access point, low lying foredunes stabilised by a sparse covering of pioneer plants have become established seawards of the foredune ridge. Distinct ORV tracks were evident over the foredunes destroying the vegetation in their path (Plate 7.5). As in the impact of trampling, continual ORV passage reduces plant cover. With the Richards Bay coast experiencing variable intervals of erosion and accretion, the impact of ORVs in the area should be carefully monitored.

Plate 7.5 ORV passages have created tracks through the foredunes at Five-Mile Beach destroying the vegetation in their path.

7.2.2.3 *General human impact*

Large scale natural erosion in places, the establishment of paths through dune ridge vegetation, gaps of mobile sand created alongside wooden boardwalks, and the establishment of ORV tracks through foredune vegetation are the most noticeable human impacts on the coastal dunes in this area. However, a prominent feature of the coastal zone of Richards Bay is the presence of large areas of relatively pristine coastal dune forest (Plate 7.6). Disturbance to the forest has been confined largely to the access roads leading to, and the area covered by, recreation facilities that include the caravan park, Soetwater, Two-Mile, Kleiklipklofie and Five-Mile Beaches. Between Two-Mile and Kleiklipklofie Beaches, the general absence of trees suggests a past disturbance in this area. Until recently, Meerensee township had maintained a distance of at least 450 m from the backbeach; this ecologically prudent planning had in effect preserved large tracts of the forest, which had acted as a buffer between the land and the sea. However, development brochures published by the Richards Bay Local Council indicate that the Meerensee township is to be expanded into the forest 1 km north of Kleiklipklofie reaching right up to the foredune ridge. This development will inevitably destroy a large section of local indigenous forest, a decreasing natural resource and a source of a wilderness experience for the residents of Richards Bay. In addition the houses built close to the foredune ridge could become exposed to the impacts associated with coastal erosion in the long term.

7.3 Human Impacts - Prevention and Control

Human impacts observed at Umlalazi and Richards Bay are not peculiar to those areas but are common along most sandy coasts that experience human activity. Research on dune vegetation in the eastern Cape by Avis (1992) has shown that common dune species are able to withstand very low levels of human trampling (2 - 10 passages per month), i.e. incidental and accidental use. Shrub species such as *Passerina rigida* are completely intolerant of any disturbance, and certain forest communities are also highly susceptible. Coastal grasslands are however more tolerant. Two or three ORV passes per month are sufficient to significantly reduce the height of sand stabilising pioneer plants, such as *Scaevola plumieri* and *Sporobolus virginicus*, and prevent recovery. To conserve the physical integrity and biotic diversity of the shoreline, human activity should be controlled and channelled into less sensitive areas.

Plate 7.6 Aerial photo of the coastline at Richards Bay showing the caravan park (CP) and Soetwater (S), Two-Mile (T) and Kleiklipklofie (K) Beaches. Note the presence of indigenous coastal forest between the resorts.

(Photo used with the permission of EMATEK, CSIR, Stellenbosch)

The recommendations indicated below to control these impacts are applicable to all soft coasts.

HUMAN TRAMPLING

- Access through foredune vegetation should be by means of *elevated wooden boardwalks* constructed to allow natural processes to continue. Pathways need not be elevated over more resilient vegetation, such as coastal grassland, but the substrate should be reinforced to prevent erosion (Avis, 1992).

- Access points should be constructed at a 90° angle to the predominant wind to trap sand and discourage the formation of blowouts. They should follow zig-zag paths and not straight lines.

- On popular beaches *aesthetically acceptable* fencing should be used to protect foredune vegetation from trampling.

- In high use areas access to beaches through the dunes should be *channelled* through a few (number will depend on the size of the beach and the car park) well signposted and well constructed paths whether they be wooden boardwalks or reinforced paths. Paths should be attached to the car park at the most convenient points (additional paths can be constructed from secondary roads if necessary) and take the shortest route to the beach with due consideration for ecological factors.

- Access points should be used to focus attention on the function and sensitivities of the coastal zone through the erection of *simple, colourful and informative signs*. Chief languages of the region should be included and diagrams could be used to reach the illiterate.

- In more remote areas where trampling is infrequent, i.e. < 5 passages per month (Avis, 1992), and does not exceed the natural resilience levels of the pioneer vegetation, the impact of disturbance through random trampling is minimal. Therefore in low use areas, the use of specific paths should be discouraged as these promote continuous disturbance to specific areas where the chances of exceeding natural recovery levels would be greater.

ORV TRAFFIC

- The published policy (Government Gazette, 29 April 1994) for the control of ORV traffic in the coastal zone incorporates the most important recommendations and these should be noted and implemented (see also Schneier, 1986; Council for the Environment, 1991; Avis, 1992).

- On ecologically sensitive beaches (i.e. those backed by vegetated and unvegetated foredunes) a *permit system* should be introduced to limit ORV access and control their activities.

- ORVs should keep to the 'wet sand' i.e between the low and high water marks; vehicles should not at any time encroach into the foredunes.

- If during high tide, encroachment into the foredunes cannot be prevented, sections of the beach should be closed to ORV traffic for 2 hours preceding and following high tide.

- ORVs should not encroach into *turtle or bird nesting areas*; if necessary, beaches should be closed to ORVs during certain times of the year, e.g. breeding seasons of vulnerable species.

- Access points should be *minimised and carefully planned*, taking convenience and ecological sensitivities into account. They should be angled at 90° to the predominant wind to prevent the formation of blowouts and should avoid sharp turns and steep inclines.

- Access roads should be *reinforced* through surfacing with gravel, wooden board or chain and should be maintained.

- Simple, informative and colourful *signs* should be erected at access points to highlight the function and sensitivities of sandy coasts and the consequences of irresponsible practices.

- The coastline could be *zoned* into no access, limited access and free access areas to protect sensitive elements where necessary and to accommodate recreational requirements.

Chapter 8

Recreational Potential

8.1 Introduction

Population growth, increased affluence and more leisure time lead to a greater demand for new recreational resources and greater pressure on those already established. With the almost disproportionately large number of people living in close proximity to the coast, much of the focus for recreational outlets is directed towards the coastal zone. Frequent use and indeed over-use of sensitive areas, such as dunes and estuaries, increase the risk of degradation of these resources and could lead to a deterioration in the quality of recreational experiences. Accommodating growing demands for access to coastal resources and simultaneously protecting the natural features that form an integral part of both the human experience and ecological function of the coastal zone, is the primary goal of coastal planning and management.

The conflict between increased access and resource protection is basically a problem of resource allocation (Vogt, 1979). Solution of the problem does not require an all-or-none approach but one which either allows or prohibits free access or strives to strike a balance between use and the maintenance of biophysical integrity, i.e. advocates areas of no development, unrestricted development, or limited development (with conditions). The critical decisions as to where to place the emphasis and what management principles to adopt in areas under consideration depend on the ecological sensitivity, socio-economic priorities, and the attitudes of interested and affected parties. These factors considered in parallel will govern the extent of human use of coastal resources and therefore their recreational (and economic) potential.

Management decisions relating to the use of the coastal zone are the responsibility of local authorities. It is therefore important that these authorities act within the framework of a management policy based on sound ecological principles but also take into account the needs and opinions of local communities. Although the Council for the Environment (1989a-c, 1991) has produced guidelines outlining the principles and objectives of coastal zone management and coastal land use, there is currently no legal requirement to comply with these guidelines. With a national coastal zone management policy still to be formulated and incorporated into a Coastal Zone Management Act, local authorities have the task of both devising and implementing policies applicable to local conditions.

Coastal dunes form an integral and sensitive part of the coastal zone and should be managed as a unit within the framework of a management policy designed to promote sustainability. Instead of focussing on the recreational potential of coastal dunes only, this chapter highlights the general principles governing the assessment of recreational (and indeed development) potential of the coastal zone, thereby including principles relating to dune management.

8.2 Assessing Recreational Potential

Recreational potential should be assessed for each section of the coastline under scrutiny, even if the area is relatively small. Ecological characteristics and sensitivities, human population densities and needs, and land use allocations may vary considerably within short distances and therefore management strategies should be designed to accommodate each set of circumstances. With the greater part of the KwaZulu-Natal coast lined with vegetated dunefields, most coastal recreational assessments are likely to include an evaluation of dune areas.

8.2.1 THE 'GREEN WEDGE' PRINCIPLE

Before any management decision is taken on development in any area along the coast, the local authority or prospective developer should refer to the sub-regional and local level plans along the KwaZulu-Natal north and south coasts. Some of these plans incorporate the 'Green Wedge' principle which advocates that coastal development should take the form of discrete nuclei separated by areas of undeveloped land (Physical Planning Directorate, NPA, 1986). There are three advantages to this pattern of development:

- it allows a stimulating contrast between the severe skyline of clustered buildings and the natural landscape of coastal vegetation;
- dune forest could be conserved in some areas whereas in other areas agricultural or forestry activities could be accommodated; and
- ribbon development (i.e. the elongated spread of resorts along the coast) would be restrained and alternative development strategies (e.g. expanding landwards or increasing the density of dwellings) would be encouraged.

The 'Green Wedge' principle recommends that permanent uses, e.g. industry, flats, houses and shops, should not be allowed to occupy potential green wedges. Depending on the environmental characteristics of each wedge, only agriculture (or silviculture), conservation and low-impact, low-cost resort development should be allowed. In addition, certain wedges should be preserved for 'the enhancement of the total coastal environment' (Physical Planning Directorate, NPA, 1986).

8.2.2 ACCESS OR PROTECTION - GAUGING PRIORITIES

In areas under consideration that may be privately owned, under local authority control or even in green wedges where limited specific development is allowed, the first decision to be taken is whether the management emphasis should be placed on protection, access, or a balance between the two (Vogt, 1979). This decision would determine the degree of protection each area should be afforded and consequently the degree to which recreational (or economic) activities should be accommodated; the decision would depend on the biophysical environment, social and economic priorities and legal constraints of the area.

It would be advantageous and would facilitate the decision-making process if the coastal zone manager had a clear idea of the type of development envisaged, the spatial extent it required and the kind of activities that would stem from it. Below is a list of questions relevant to biophysical, social, economic and legal issues that should be considered during the assessment. The questions are designed to give decision-makers a guide to the diversity of factors that need to be considered in deciding the fate of a particular environment.

(i) Biophysical environment

Physical features

- What is the composition of the shoreline under consideration, in particular the position and extent of rocky outcrops, sandy beaches, dunes and estuaries?
- What is the condition of the environment? Is the area pristine? To what extent are the impact of man's activities evident? Is the damage reparable?
- How much shoreline is available for development? What are the current uses of the shoreline? Is there enough room for expansion?
- Are the natural features unique? Is the area the only of its kind in the country (national asset) or the province (regional asset) or are its features common along the coast?

- What is the proximity of cities and towns? How accessible is the area?

- Is the shoreline stable, eroding or accreting?

- What is the modal state of the beach-surf zone in the area? (Modal state reflects the average state of the beach-surf zone and is related to the degree of exposure of the beach to wave energy. Six states have been identified (Short & Wright, 1983) and a bathing hazard rating has been associated with each one (see Appendix B, Part 1)).

- Does the area include 'Designated areas or features' (DEA, 1992) (see Appendix B, Part 2), i.e. any area or feature already declared in terms of an Act of Parliament or by agreement between land-owners and the State President or the Minister of Environment Affairs?

- Does the area include 'Demarcated areas or features' (DEA , 1992) (see Appendix B, Part 3), i.e. any area or feature demarcated by a central, regional or local authority?

- Does the area have any educational value with regard to its physical features?

Biological features

- Are the dunes backing the beach vegetated? Is the vegetation lush or sparse? Is the area one of high or low rainfall?

- Does the dune vegetation consist mainly of indigenous plants? To what extent, if any, has the vegetation been invaded by exotic species? Are there any threatened species present? (The vegetation lining the KwaZulu-Natal coast has been mapped and its sensitivities identified (CSIR report to TRPC, 1992); relevant information can be obtained from the TRPC).

- Do any bird species use the dunes as breeding or roosting grounds? What is the conservation status of these species? (The conservation status of the vertebrate fauna of coastal dunes in South Africa has been described by Van Teylingen *et al.* (1993)).

- Do the beach or dune areas harbour endemic or threatened animals? (Red Data Books outlining threatened species are available for birds (Brooke, 1984), mammals (Smithers, 1986), and reptiles and amphibians (Branch, 1988); information on dune vertebrates is summarised in Van Teylingen *et al.*, 1993).

- Does the beach serve as a breeding ground for turtles or a primary habitat for intertidal crustaceans such as ghost crabs?

- Does the area have any educational value with regard to its biological features?

- Is the area unique in that it harbours the only habitat for a particular plant or animal species in South Africa (national asset) or this province (regional asset)?

(ii) Social environment

- Is the area of any outstanding scenic value? Is the scenic beauty of national, regional or local significance?

- If the area is of high scenic value on a local level, what value does the local public attach to the scenic attributes? (The same question is relevant if the scenic value is regarded to be of either regional or national significance. Areas of outstanding natural beauty are listed as 'Demarcated areas or features' (DEA, 1992; see Appendix B, Part 3)).

- Does the area harbour any sites of historical or cultural value? Are these national assets? (Areas of religious, spiritual, social, cultural or historical interest are listed as 'Demarcated areas or features' (DEA, 1992; see Appendix B, Part 3)).
- What are the recreational preferences of the public in the area?
- What is the attitude of the public towards facilities currently available? How widely are these facilities used?
- How much variety in recreational experiences does the area offer, e.g. windsurfing, surfing, boating, diving, wilderness experience?
- What is the attitude of the local public towards development in the area?

(iii) Economic aspects

- Is the project proposal included in the list of Project Proposals classified by the Department of Environment Affairs (1992) (see Appendix B, Part 5)?
- Does the scenic beauty of the area contribute significantly to the local or regional economy?
- Does the area harbour minerals of economic value?
- Does the area include valuable agricultural or silvicultural land?
- Is the area close to nuclear or arms testing sites? Is it envisaged that ventures of national economic importance will be developed in the vicinity?
- Does the area have international or national ecotourism value?

(iv) Legal constraints

- Is the project proposal included in the list of Policy and Planning Proposals classified by the Department of Environment Affairs (1992) (see Appendix B, Part 4)?
- Are there any legal restraints on development in the area in terms of:
  - (i) Regional Structure Plans adopted at provincial government level?
  - (ii) Land Use Ordinances at local government level?
  - (iii) a Coastal Zone Management policy that has been incorporated into an Act of Parliament?

8.2.3 MAKING THE DECISION

Decisions relating to the development of the coastal zone are complex. For a decision to be acceptable to local and national authorities, conservationists and the general public, and lead to successful management of coastal resources, a broad consensus of both scientific and general public opinion needs to be achieved and incorporated into the decision. It is important that the coastal zone manager or local authority has a well defined proposal of the intended development, irrespective of whether it is the construction of simple ablution facilities, an access road or a large scale housing complex.

The questions outlined in Section 8.2.2 illustrate the most important issues that should be addressed to facilitate a well balanced and informed decision-making process. By noting the natural features, condition of the environment, current recreational uses, and the amount of shoreline available for recreation, the coastal manager should be able to obtain an indication of whether protection, increased access or even rehabilitation should be optimised (Vogt, 1979). Additional information required to build the body of the case can be obtained from sources indicated alongside the questions. Local wildlife and conservation societies as well as governmental nature conservation officers and provincial planners can be consulted for assistance in compiling inventories for plants and animals as well as information on their sensitivities. In areas regarded as local or regional assets, public attitudes could be ascertained through questionnaires, public meetings and meetings with specific interested and affected groups. On a national scale, attitudes towards unique coastal assets would be more difficult to determine but could be pursued through informing conservation-orientated government and non-government organisations of the proposed activities.

The manager should note that within the coastal zone of *highly* developed urban areas, i.e. those where the seafronts support concrete structures, such as promenades, roads, shops, houses, hotels, recreational facilities, or artificial landscapes featuring lawns and gardens, recreational preferences of the general public tend to take priority over ecological issues. Because the natural features of these areas are *already irretrievably modified*, they can be regarded as 'sacrifice areas'. However, in less developed areas where the natural features are intact although damaged through over-use or inappropriate use, every effort should be made to repair the damage and restore the natural character of the environment. In these areas, it would be advisable to introduce measures to control human activity.

Should a proposed development involve a 'Policy and Planning Proposal' or 'Project Proposal' listed by the Department of Environment Affairs (1992), or be likely to encroach into areas listed as 'Designated' or 'Demarcated' according to the same authority (DEA, 1992) (see Appendix B, Parts 2 - 5), the possible impact of the development should be assessed by a team of professional coastal ecologists through the implementation of an Environmental Impact Assessment or an Integrated Environmental Management Plan. These procedures are rigorous tools designed to ensure that the environmental consequences of development proposals are understood by decision-makers and are adequately considered in planning processes. The procedures also resolve or mitigate any negative impacts and enhance positive aspects of development proposals (DEA, 1992).

In gathering information for a decision by a higher authority, or for his own decision-making, a manager should aim towards an open, democratic and participatory approach to planning and development. Decisions to restrict or limit access are part of the costs to be borne to protect the resource for the present as well as for future generations, and should lean towards protection or conservation of resources (Vogt, 1979).

8.3 Initial Assessment of Recreational Potential at Umlalazi and Richards Bay

As part of the larger project on the ecological dynamics and human impacts on KwaZulu-Natal coastal dunes, initial assessments of recreational potential were made at the Umlalazi Nature Reserve and along the Richards Bay coastline during two field trips to each area. At Umlalazi, the coastal environment (i.e. beach and dune areas) in the vicinity of the main access point to the beach was assessed, i.e. the area north of the Siyaya River. In the Richards Bay area, the two main metropolitan beaches, Newark and Alkantstrand, were assessed as well as four coastal sites (beach and dune areas) to the north up to Five-Mile Beach, 2 km south of the Richards Bay council boundary.

The assessment was based on a rating system that assigns values to the most important natural characteristics and the main recreational features (see Tables 8.1 - 8.6). Natural characteristics were selected from the set of questions posed in Section 8.2.2; additional or alternative characteristics may be included, if considered appropriate. Assessing most natural characteristics (e.g. *educational value*, *biodiversity*, and *ecological and physical sensitivity*) requires some expertise and a suitably qualified scientific officer with experience in coastal ecology should be given the task. A detailed account of how to assess each characteristic/feature is given in Appendix C. Recreational features (with the exception of *modal beach-surf zone state*) require no expertise to assess.

Only aspects that could be assessed on site were addressed; no account was taken of public attitudes or preferences, nor economic or legal perspectives. Each characteristic/feature was allocated a score between 0 and 10. For natural characteristics, a high score (~10) indicates the need for a high degree of protection. *Conservation merit* (or worthiness) of an area is reflected as the mean of the natural characteristics numbered 1 - 6. The characteristic, *physical sensitivity*, requires an assessment of the net sand movement of the shoreline, i.e. the degree to which the shore is erosional, stable or accretionary. A shoreline experiencing active sand accumulation is relatively insensitive (low score) and requires a lower degree of protection than an eroding shoreline, which is relatively sensitive (high score).

Conservation merit and *physical sensitivity* are both important factors to be taken into account when considering the potential of a particular environment to ecologically sustain human impact. In development *suitability* (mean of ratings for conservation *merit* and *physical sensitivity*), conservation and development are assumed to be incompatible as use modifies the natural features to varying degrees and, unless rigidly controlled, can lead to environmental degradation.

For recreational features, a high score indicates a high degree of suitability for recreation given the current complement and condition of facilities. The mean of ratings for recreational features is represented in the factor *recreational suitability*. An *index of recreational potential* was estimated from the mean of the scores for *development suitability* and *recreational suitability* and thus reflects the potential of a site to accommodate recreational activities and yet maintain the natural features, biodiversity and ecological processes characteristic of the environment.

The initial assessments of six sites, Umlalazi, Newark and Alkantstrand, Soetwater, Two-Mile, Kleiklipklofie and Five-Mile Beaches, are illustrated in Tables 8.1 - 8.6. It should be noted, however, that the recreational suitability rating is based on an assessment of the diversity and condition of recreational facilities at the time of the assessment, and not on the suitability should the facilities be refurbished.

Table 8.1 Initial assessment of recreational potential at a site in the UMLALAZI NATURE RESERVE north of the Siyaya River mouth. The maximum rating for each score is 10 (see Appendix C for details on points allocations).

CRITERION	SCORE
NATURAL CHARACTERISTIC[1]	
1. Pristine nature	8
2. Scenic quality (rel. to wilderness beaches)[2]	7
3. Educational value	9
4. Unique features (national asset)	9
5. Biodiversity	9
6. Ecological sensitivity[3]	8
Conservation merit [4]	***8.3***
Physical sensitivity (accreting)[5]	***2***
Development suitability[6]	**4.8**
RECREATIONAL FEATURE	
1. Shark nets	0
2. Lifeguards	0
3. Modal beach-surf zone state Beach-surf bathing hazard rating[7] Bathing safety rating	Intermediate (7-8) 2-3
4. Off-road vehicle (ORV) access (2 roads, 1 incoming & 1 outgoing)	8
5. Footpaths to the beach from main car park	9
6. Cafeteria & entertainment facilities	0
7. Footpaths through dune forest (spaced every 200 - 300m	7
8. Toilet facilities (2 blocks at car park & 1 at second ORV access point)	8
9. Showers (1 block)	6
10. Rubbish bins (2 *en route* to beach & 3 on beach)	7
11. Car park capacity (approx. 500 cars)	7
Recreational suitability[8]	**5**
RECREATIONAL POTENTIAL INDEX[9]	**4.9**

1 Criteria assessed relative to the suitability for development

2 Highly subjective rating, should be assessed relative to the type of shore (urban/semi-urban/wilderness)

3 See Appendix C

4 Calculated as the mean of scores for natural characteristics 1 - 6

5 Reflects the degree and direction of sand movement onto or from the shore i.e. accreting/stable/eroding

6 Development suitability reflected as the antithesis of the mean of physical sensitivity and conservation merit

7 Classified according to modal beach-surf zone state by Short & Wright (1983) (see Appendix B, Part 1); score of 10 is most dangerous bathing conditions, therefore hazard rating of 7-8 indicates a safety rating of 2-3

8 Calculated from the mean of the scores for recreational features and is based on an assessment of the recreational facilities that are **already established**

9 Recreational Potential Index is the mean score of development suitability and recreational suitability

Additional comments

Umlalazi beach is a *wilderness* beach situated in the Umlalazi Nature Reserve which is managed by the Natal Parks Board. Access to the reserve is controlled by admitting a maximum of 500 vehicles per day (including off-road vehicles) and access to the beach controlled by channelling visitors into marked and sometimes fenced footpaths; activities of ORV drivers, beach visitors and picnickers are monitored by managers and trained guards. The provision of shelters along the road through the dune forest landwards of the back dunes would improve the recreational suitability of the reserve during windy days when conditions on the beach are unpleasant. A small wooden platform built over the dunes at the backbeach would provide a viewing point for the area and could also serve as an avenue to educate the public on the ecology and sensitivities of coastal dunes.

Table 8.2 Initial assessment of recreational potential at NEWARK AND ALKANTSTRAND Beaches in the Richards Bay metropolitan area. Maximum rating for each score is 10 (see Appendix C for details on points allocations).	
CRITERION	**SCORE**
NATURAL CHARACTERISTIC[1]	
1. Pristine nature	1
2. Scenic quality[2] (relative to urban beaches)	4
3. Educational value	1
4. Unique features (local asset)	0
5. Biodiversity	2
6. Ecological sensitivity[3]	2
Conservation merit [4]	***1.7***
Physical sensitivity (stable)[5]	***3***
Development suitability[6]	**7.7**
RECREATIONAL FEATURE	
1. Shark nets	10
2. Lifeguards	10
3. Modal surf zone state Surf zone hazard rating[7] Bathing safety rating (in surf zone) Beach state Beach hazard rating Bathing safety rating (close to beach) General bathing safety rating	Intermediate (7-8) 2-3 Reflective (3-4) 6-7 2-7
4. Off-road vehicle (ORV) access points	N/A
5. Footpaths to the beach from main car park	10
6. Cafeteria & entertainment facilities	7
7. Toilet facilities (permanent & temporary)	9
8. Showers (2 sets)	8
9. Rubbish bins	10
10 Car park capacity (approx. 400 cars)	7
Recreational suitability[8]	**8.4**
RECREATIONAL POTENTIAL INDEX[9]	**8**

1 Criteria assessed relative to the suitability for development

2 Highly subjective rating, should be assessed relative to the type of shore (urban/semi-urban/wilderness)

3 See Appendix C

4 Calculated as the mean of scores for natural characteristics 1 - 6

5 Reflects the degree and direction of sand movement onto or from the shore i.e. accreting/stable/eroding

6 Development suitability reflected as the antithesis of the mean of physical sensitivity and conservation merit

7 Classified according to modal beach-surf zone state by Short & Wright (1983) (see Appendix B, Part 1); score of 10 is most dangerous bathing conditions, therefore hazard rating of 7-8 indicates a safety rating of 2-3

8 Calculated from the mean of the scores for recreational features and is based on an assessment of the recreational facilities that are **already established**

9 Recreational Potential Index is the mean score of development suitability and recreational suitability

Additional comments

Newark and Alkantstrand are well developed *urban* beaches under the jurisdiction of the Richards Bay Local Council. The beaches and the recreational facilities backing the beaches are diverse and well maintained. There are both permanent ablution facilities, situated about 300 m landwards of the backbeach, and temporary ones constructed immediately adjacent to the backbeach. The natural features have largely made way for the development of lawns, sun shelters, shops and ablution facilities. Backing Newark beach, there are a few low-lying foredunes covered by a sparse spread of pioneer plants; a thin stand of casuarina trees lends some natural character to the modified landscape.

Table 8.3	**Initial assessment of recreational potential at SOETWATER 3 km north of Richards Bay harbour. Maximum rating for each score is 10 (see Appendix C for details on points allocations).**
CRITERION	**SCORE**
NATURAL CHARACTERISTIC[1]	
1. Pristine nature	5
2. Scenic quality (rel. to semi-urban beaches)[2]	7
3. Educational value	6
4. Unique features (local asset)	6
5. Biodiversity	6
6. Ecological sensitivity[3]	6
Conservation merit[4]	***6***
Physical sensitivity (eroding)[5]	***6***
Development suitability[6]	**4**
RECREATIONAL FEATURE	
1. Shark nets (no swimming allowed)	0
2. Lifeguards	N/A
3. Modal beach-surf zone state Beach-surf bathing hazard rating7 Bathing safety rating	Intermediate (8) 2
4. Off-road vehicle (ORV) access points	N/A
5. Footpaths to the beach from main car park	7
6. Cafeteria & entertainment facilities	7
7. Toilet facilities (permanent)	8
8. Showers (2 sets)	N/A
9. Rubbish bins	5
10 Car park capacity (approx. 80-90 cars)	7
Recreational suitability[8]	**5.1**
RECREATIONAL POTENTIAL INDEX[9]	**4.6**

1 Criteria assessed relative to the suitability for development

2 Highly subjective rating, should be assessed relative to the type of shore (urban/semi-urban/wilderness)

3 See Appendix C

4 Calculated as the mean of scores for natural characteristics 1 - 6

5 Reflects the degree and direction of sand movement onto or from the shore i.e. accreting/stable/eroding

6 Development suitability reflected as the antithesis of the mean of physical sensitivity and conservation merit

7 Classified according to modal beach-surf zone state by Short & Wright (1983) (see Appendix B, Part 1); score of 10 is most dangerous bathing conditions, therefore hazard rating of 8 indicates a safety rating of 2

8 Calculated from the mean of the scores for recreational features and is based on an assessment of the recreational facilities that are **already established**

9 Recreational Potential Index is the mean score of development suitability and recreational suitability

Additional comments

Soetwater is a *semi-urban* beach developed and controlled by the Richards Bay Local Council. There are 'no swimming' signs prominently displayed and use of the beach area is limited because of the dangerous surf conditions. The beach was a bathing beach up until 1989 and the two sets of showers are remnants of this era. The foredunes are showing signs of erosion which appears to be part of a natural erosion-accretion cycle. Beach walking and picnicking on the dune ridge that runs parallel to the coast of Richards Bay appear to be the most popular forms of recreation in this area.

Soetwater together with Two-Mile and Kleiklipklofie Beaches have been zoned as Public Open Space by the Richards Bay Local Council (Richards Bay local authority brochure, undated) and therefore will be protected from the development of housing estates but not from upgrading or extentions to present recreational facilities or from the establishment of additional ones. The indigenous coastal dune forest north and south of Soetwater stretching landwards for 700 m to 1 km appears to be largely pristine and relatively undisturbed. A concerted effort should be made to conserve the forest through maintaining the existing roads and confining facilities to those already established.

Table 8.4 Initial assessment of recreational potential at TWO-MILE BEACh, 4 km north of Richards Bay harbour. Maximum rating for each score is 10 (see Appendix C for details on the points allocations).	
CRITERION	**SCORE**
NATURAL CHARACTERISTIC[1]	
1. Pristine nature	
2. Scenic quality[2] (relative to semi-urban beaches)	
3. Educational value	
4. Unique features (local asset)	
5. Biodiversity	
6. Ecological sensitivity[3]	
Conservation merit [4]	***1.7***
Physical sensitivity (eroding)[5]	***3***
Development suitability[6]	**7.7**
RECREATIONAL FEATURE	
1. Shark nets (no swimming allowed)	
2. Lifeguards	
3. Modal beach-surf zone state Beach-surf bathing hazard rating7 Bathing safety rating	Intermediate (8) 2
4. Off-road vehicle (ORV) access points	N/A
5. Footpaths to the beach from main car park Access to beach from a point away from car park (wooden boardwalk)	
6. Cafeteria & entertainment facilities	
7. Toilet facilities (permanent)	
8. Showers	
9. Rubbish bins	
10 Car park capacity (approx. 50 cars)	7
Recreational suitability[8]	**8.4**
RECREATIONAL POTENTIAL INDEX[9]	**8**

1 Criteria assessed relative to the suitability for development

2 Highly subjective rating, should be assessed relative to the type of shore (urban/semi-urban/wilderness)

3 See Appendix C

4 Calculated as the mean of scores for natural characteristics 1 - 6

5 Reflects the degree and direction of sand movement onto or from the shore i.e. accreting/stable/eroding

6 Development suitability reflected as the antithesis of the mean of physical sensitivity and conservation merit

7 Classified according to modal beach-surf zone state by Short & Wright (1983) (see Appendix B, Part 1); score of 10 is most dangerous bathing conditions, therefore hazard rating of 8 indicates a safety rating of 2

8 Calculated from the mean of the scores for recreational features and is based on an assessment of the recreational facilities that are **already established**

9 Recreational Potential Index is the mean score of development suitability and recreational suitability

Additional comments

Two-Mile beach is *semi-urban*. Picnic sites are situated along the secondary road leading to the area. There is one main car park situated on the foredune ridge overlooking the beach where swimming is prohibited. The urban design of the facilities at the site was regarded to be tatty (G. McLachlan, pers. comm.). A road has been constructed for a short distance moving southwards along the dune ridge probably to allow for a sea view. South of Two-Mile Beach, there is a broad (stretching 700 m inland) band of indigenous dune forest which should be conserved as a matter of priority. Between Two-Mile Beach and Kleiklipklofie large sections of the forest have been removed and the area appears to be generally disturbed.

Table 8.5 Initial assessment of recreational potential at KLEIKLIPKLOFIE 5 km north of Richards Bay harbour. Maximum rating for each score is 10 (see Appendix C for details on the points allocations).

CRITERION	SCORE
NATURAL CHARACTERISTIC[1]	
1. Pristine nature	4
2. Scenic quality (rel. to semi-urban beaches)[2]	3
3. Educational value	6
4. Unique features (local asset)	6
5. Biodiversity	6
6. Ecological sensitivity[3]	7
Conservation merit[4]	***5.3***
Physical sensitivity (eroding)[5]	***7***
Development suitability[6]	**3.9**
RECREATIONAL FEATURE	
1. Shark nets (no swimming allowed)	0
2. Lifeguards	N/A
3. Modal beach-surf zone state Beach-surf bathing hazard rating[7] Bathing safety rating	Intermediate (8) 2
4. Off-road vehicle (ORV) access points	N/A
5. Footpaths to the beach from main car park	8
6. Cafeteria & entertainment facilities	4
7. Toilet facilities (permanent)	5
8. Showers	N/A
9. Rubbish bins	3
10 Car park capacity (approx. 50 cars)	5
Recreational suitability[8]	**3.9**
RECREATIONAL POTENTIAL INDEX[9]	**3.9**

1 Criteria assessed relative to the suitability for development

2 Highly subjective rating, should be assessed relative to the type of shore (urban/semi-urban/wilderness)

3 See Appendix C

4 Calculated as the mean of scores for natural characteristics 1 - 6

5 Reflects the degree and direction of sand movement onto or from the shore i.e. accreting/stable/eroding

6 Development suitability reflected as the antithesis of the mean of physical sensitivity and conservation merit

7 Classified according to modal beach-surf zone state by Short & Wright (1983) (see Appendix B, Part 1); score of 10 is most dangerous bathing conditions, therefore hazard rating of 8 indicates a safety rating of 2

8 Calculated from the mean of the scores for recreational features and is based on an assessment of the recreational facilities that are **already established**

9 Recreational Potential Index is the mean score of development suitability and recreational suitability

Additional comments

Kleiklipklofie is a *semi-urban* beach. There are two car parks, one is situated on the foredune ridge immediately behind the backbeach and the other is 80 - 100 m landwards of the first. There is a well contructed boardwalk from the car park on the ridge to enable access to the beach. The area is fairly developed with a children's playground, picnic spots and braai sites. Because of the impact of erosion of the shoreline, the beach area has limited aesthetic appeal. However, the area stretching north-northeast of Kleiklipklofie supports about 1 km^2 of relatively undisturbed indigenous dune forest. More than half of this area has been zoned for residential use and if residential development goes ahead it will undoubtedly destroy a significant proportion of the forest (see Table 8.6, Additional comments: Five-Mile Beach).

Table 8.6 Initial assessment of recreational potential at FIVE-MILE BEACH 5 km north of Richards Bay harbour. Maximum rating for each score is 10 (see Appendix C for details on the points allocations).	
CRITERION	**SCORE**
NATURAL CHARACTERISTIC[1]	
1. Pristine nature	7
2. Scenic quality (rel. to semi-urban beaches)[2]	6
3. Educational value	6
4. Unique features (local asset)	7
5. Biodiversity	6
6. Ecological sensitivity[3]	6
***Conservation merit*[4]**	***6.3***
Physical sensitivity (stable)[5]	***5***
Development suitability[6]	**4.4**
RECREATIONAL FEATURE	
1. Shark nets (no swimming allowed)	0
2. Lifeguards	N/A
3. Modal beach-surf zone state Beach-surf bathing hazard rating[7] Bathing safety rating	Intermediate (8) 2
4. Off-road vehicle (ORV) access points (a single road)	7
5. Access to beach from the single road	6
6. Cafeteria & entertainment facilities	0
7. Toilet facilities (permanent)	0
8. Showers	N/A
9. Rubbish bins	1
10 Car park capacity (approx. 10 cars)	3
Recreational suitability[8]	**2.4**
RECREATIONAL POTENTIAL INDEX[9]	**3.4**

1 Criteria assessed relative to the suitability for development

2 Highly subjective rating, should be assessed relative to the type of shore (urban/semi-urban/wilderness)

3 See Appendix C

4 Calculated as the mean of scores for natural characteristics 1 - 6

5 Reflects the degree and direction of sand movement onto or from the shore i.e. accreting/stable/eroding

6 Development suitability reflected as the antithesis of the mean of physical sensitivity and conservation merit

7 Classified according to modal beach-surf zone state by Short & Wright (1983) (see Appendix B, Part 1); score of 10 is most dangerous bathing conditions, therefore hazard rating of 8 indicates a safety rating of 2

8 Calculated from the mean of the scores for recreational features and is based on an assessment of the recreational facilities that are **already established**

9 Recreational Potential Index is the mean score of development suitability and recreational suitability

Additional comments

Five-Mile Beach is a *semi-wilderness* beach used mainly by anglers; swimming and recreational activities are not encouraged by the local authority. The aesthetic appeal to the north of the beach is high but to the south the impacts of beach erosion are visible and detract from the appeal of the Richards Bay harbour wall and lighthouse in the distance. The road to Five-Mile Beach runs through a narrow stretch of near pristine indigenous coastal forest that appears to be confined to bands alongside the road.

It is important to note that the coastal area a short distance north-east of Kleiklipklofie, up to the Richards Bay council boundary (including the lighthouse and Five-Mile Beach but excluding a stretch of about 500 m), has been zoned as a future residential area (Richards Bay local authority brochure, undated), probably an extention of the Meerensee township. Extensive development of the area, particularly to the south of Five-Mile Beach would undoubtedly destroy large sections of the coastal forest, a diminishing natural resource.

Climax Dune Forest is considered to be of intermediate conservation priority (CSIR, 1992) and, where appropriate, could support limited development if the proposal to develop was supported by a comprehensive vegetation study and environmental assessment. However communities of Climax Dune Forest and Swamp Forest, Climax Dune Forest and Dwarf Shrubland, and Climax Dune Forest and the mosaic of Dwarf Shrubland and Hyphaene Palmland, are of high conservation priority (*op. cit.*) and are vulnerable to disturbance; human impact on these communities should be kept to a minimum.

In areas where developments are planned (such as the Kleiklipklofie/Five-Mile Beach area), the vegetation and its conservation worthiness should be assessed prior to any development implementation. High conservation priority areas should be avoided, and if a development planned in an area of negligible conservation importance lies alongside one of high importance, a suitable buffer should be retained in between to protect the sensitive area as a viable ecological unit (CSIR, 1992).

8.4 Recreational Potential Index - Interpretation and Application

Comparing the RPIs and scores for the major characteristics and features incorporated into the index (Table 8.7) suggests that the urban beaches of Newark and Alkantstrand (RPI 8) are clearly suited to recreation, largely because the natural features of the area are already irreversibly modified to accommodate the construction of Richards Bay harbour and to maximise the provision of facilities to satisfy the needs of a generally entertainment-orientated urban population.

Table 8.7 Conservation merit, development suitability, recreational suitability and RPIs for the study sites.

Beach	Physical Sensitivity[1]	Conservation Merit	Development Suitability	Recreational Suitability	Recreational Potential Index (RPI)[2]
Umlalazi	2	8.4	4.8	5	4.9
Newark/Alkantstrand	3	1.6	7.7	8.4	8
Soetwater	6	6.2	3.9	5.1	4.5
Two-Mile	6	5.4	4.3	2	3.2
Kleiklipklofie	7	5.3	3.9	3.9	3.9
Five-Mile	5	6.3	4.4	2.4	3.4

1 Note that physical sensitivity is a measure of the sand depositional status or physical stability of the shoreline

2 RPI is the mean of development suitability and recreational suitability

Maintaining a pristine environment with its natural biophysical components intact is often incompatible with high density development, and nature conservation thus receives a low priority. Aesthetic qualities instead are a chief concern and, from an ecological perspective, urban coastal areas can be regarded as 'sacrifice' areas. Proposals to expand existing facilities laterally along the coast should be assessed in the same manner as those to establish new ones in undeveloped areas, and should be judged against projections for population growth and needs within the context of an urban or regional structure plan designed to promote ecological sustainability.

At Umlalazi Beach, in the Umlalazi Nature Reserve, development has been minimal and restricted to a car park, ablution facilities, paths, and access and connecting roads situated well behind the foredunes. The series of closely associated beaches north of Richards Bay harbour (Soetwater to Five-Mile) generally support intermediate to low levels of development with car parks, ablution facilities, picnic sites, cafeterias and children's playgrounds (although not all these facilities are present at all sites). These facilities are established either at the landward edge of the steep vegetated foredune ridge running parallel to the coastline or in the dune forest immediately behind.

The RPI for Umlalazi (4.9) and the series of beaches north of Richards Bay harbour (mean 3.8) indicate that the capacity to support increased recreational activities in both areas is low. The reasons are however notably different, a difference that can be explained by comparing the conservation merit (and thus development suitability) ratings between sites. Umlalazi is in a near pristine state and supports a series of parallel dune ridges that harbour a classical pattern of plant zonation, one of two in the country. These features render it highly worthy of conservation but, because it is situated on an accreting shore in a warm, high rainfall area, it experiences no threat of erosion and the conditions for plant growth are optimum. The area could therefore withstand a limited degree of development that was sensitive to its unique ecological features.

The coastline of Richards Bay is stable in some places but severely eroding in others. The development of recreation facilities on the foredune ridge has eliminated sections of the dune forest and natural erosive forces have caused scarping of the foredune, undercutting boardwalks built to access the beach. The impact of the erosion has left in its wake a beach environment with limited aesthetic appeal. Because the coastline shows clear signs of active erosion, only limited development should be undertaken and this should be restricted to carefully selected areas at least 100 m landwards of the foredune ridge. Efforts should be made to destroy as little of the indigenous dune forest as possible by restricting the size and number of facilities (the extent of the forest is particularly noteworthy in the Soetwater area and north-east of Kleiklipklofie; see also Additional Comments, Table 8.6). Thus, because of natural shoreline erosion and the presence of indigenous dune forest, the coastline north of Alkantstrand can withstand limited recreation and development pressure without negatively impacting on the ecology of the area.

RPI can thus be used to obtain an *initial* indication of the conservation worthiness of an area and, together with an assessment of existing facilities, the potential of an area to blend the conservation of natural features and processes with human activities. The index is influenced fairly strongly by the physical stability of the shoreline with the result that a stable or accreting area that warrants a high degree of protection of its biological features can generate a similar RPI to an area that is eroding and harbours a biotic community with a considerably lower conservation status. It is recommended that development proposals in areas that generate an RPI 3 be considered with caution and followed by a closer investigation of the ecological, social and aesthetic priorities with a view towards prohibiting development and even restricting access. An RPI ranging 4 - 7 requires the compilation and implementation of an ecologically sound management plan to *actively control* man's activities and thus impacts. A professional team of coastal ecologists might be consulted to conduct an Environmental Impact Assessment or compile an Integrated Environmental Management Plan to highlight the factors at stake and any mitigatory actions that could be employed. Indices > 8 indicate potentially free access areas although the final decision should be taken after all factors are taken into account. It should be remembered however that public opinion is a crucial factor in coastal zone management and public support is vital for the success of any management policy.

8.5 Conclusion

Recreational potential (or development potential) should be assessed for each area of coast considered for any kind of development. There are numerous and diverse factors that need to be taken into consideration to allow a well balanced decision-making process and to gain the support of the public, crucial for the success of any management policy. The Recreational Potential Index (RPI) can be used as a preliminary tool to assist managers in the *initial* phase of deciding the fate of a particular environment. An idea of the potential for future development within the framework of ecological sustainability can be derived from the development suitability rating, a factor incorporated into the estimation of RPI. Although some factors incorporated into the rating of conservation merit, and therefore development suitability, are subjective, the index does provide the manager with a reasonably balanced estimate of the potential of an area to maintain the natural features and simultaneously serve as a recreational outlet, given the current complement and condition of facilities.

Chapter 9

Sandy Coast Management and Planning Guidelines

9.1 Principles of Sandy Coast Management

9.1.1 THE LITTORAL ACTIVE ZONE

One of the most fundamental principles governing the management of sandy coasts centres on the paramount importance of maintaining the integrity of the *littoral active zone* (LAZ), i.e. the area on the shore *where sand is mobile* (Tinley, 1985). On any sandy shore, the dunes, beach and surf zone are inextricably linked into a *single sediment system* or sand budget by the interchange of sand. The seaward limit of the LAZ coincides with the deepest point where sand transport is driven by waves (i.e. usually between 5 and 15 m water depth) and the landward border is at the limit of wind-driven sand transport (i.e. the landward edge of the active dunes)(Figure 9.1). Ecologically the LAZ consists of two distinct systems: a *marine beach-surf zone ecosystem* comprising marine biota and controlled by wave energy, and a *terrestrial dune ecosystem* inhabited by terrestrial organisms and controlled by wind energy.

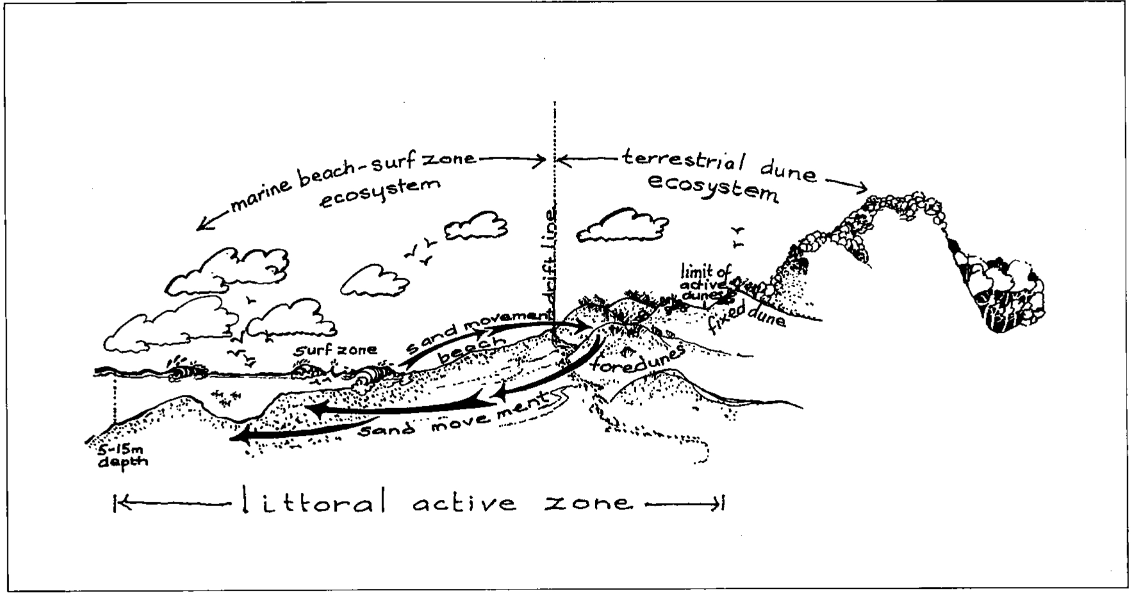

Figure 9.1 *The position and extent of the littoral active zone.*

Dunes, beaches and surf zones are closely interdependent and continually adjust their profiles according to the wave climate. During periods of calm, sand builds up on the beach and becomes stored in the dunes; rough turbulent seas erode sand from the dunes and beach and return it back into circulation. Some of this sand is deposited in the surf zone, some is carried offshore, and some moves downdrift by longshore currents to be deposited on beaches further along the coastline. The exchange of sand on any stretch of shore therefore affects the stability of the broader coastline. Dunes therefore inhibit coastal erosion by supplying sand to the beach.

The constant flow of sand within the borders of the LAZ is a self-regulating mechanism of coastal protection and preservation. The resultant malleability allows sandy coasts to act as protective buffers between the land and the sea. Frontal dunes dissipate storm wave energy at high tides and greatly reduce the impact of onshore gale force winds. Beaches dissipate waves, swashes and surges at all tides, and sand bars in the surf zone dissipate the main wave energy especially at low tides (Tinley, 1985). The LAZ is efficient and resilient as long as it remains free to fluctuate within its natural boundaries, both onshore-offshore and alongshore. The maintenance of natural patterns of sand flow, both in magnitude and direction, is vital for the efficient functioning of the shoreline.

9.1.2 ECOLOGICAL SENSITIVITIES OF SANDY COASTS

With the efficient functioning of sandy coasts dependent on the free flow of sand between the dunes, beach and surf zone, any factor that inhibits or alters the natural sand flow reduces the buffering efficiency of the coastline. The LAZ is intrinsically highly vulnerable. Storage of sand in the backbeach and frontal dunes often depends on the sand fixing action of delicately poised pioneer plants. Unrestrained trampling and ORV traffic uproot the plants and threaten their sand stabilising capacity. The construction of permanent structures on foredunes or backdunes where the plant cover is incomplete and the sand mobile, interferes with the established sand balance. In addition to affecting the physical sand dynamics, human factors also threaten plant and animal communities, many of which are unique to coastal dunefields (McLachlan, 1991).

In contrast to the highly sensitive nature of dunes, beaches regularly experience vigorous swash and wave action that mobilise large volumes of sand. The beach face becomes reshaped, its profile changing with the tides and wave climate. Beaches are thus physically malleable and are not readily impacted by even high levels of trampling and ORV activity. In addition, beach fauna largely live beneath the sand surface; they are adapted to large scale sand movement and can withstand trampling and vehicle traffic (Van der Merwe & Van der Merwe, 1991). Beaches are therefore ideally suited to recreational activities but dunes are usually highly sensitive and need to be protected.

9.2 Management of Sandy Coasts

9.2.1 SAND BUDGETS & BIODIVERSITY

Managing sandy coasts in effect means *managing the sand budget* of the littoral active zone (Brown & McLachlan, 1990). Effective management therefore requires that managers understand the vital role played by the close coupling of dune and beach systems and the importance of maintaining the natural patterns of sand movement. Managers need to recognise the factors that influence the flow of sand and develop mechanisms to conserve the natural exchange between dunes, beaches and the nearshore.

Although managing sand budgets is the primary concern on sandy coasts, vegetated dunes often support high plant and animal diversities. There are three discrete food chains in dune ecosystems; these centre on grazing organisms, detritus producers and consumers, and interstitial organisms. In addition, terrestrial and marine birds, particularly the rare Damara tern in the eastern Cape (Watson, 1992), feed and breed in dunes. Although few animals are unique to dune systems, biodiversity can be high depending on the extent of vegetation cover. Coastal zone managers should therefore also develop their understanding of dune ecosystems to appreciate their sensitivities and conserve biodiversity.

9.2.2 MANAGEMENT STRATEGIES

The questions posed in Section 8.2.2 can be used to assist the coastal zone manager to decide on a management strategy for areas under his jurisdiction. After evaluating a particular area, and even using the Recreational Potential Index (see Sections 8.3 & 8.4) as a guide to the assessment, the manager should have a clear idea of the level of human activity or resource protection that would be optimum for that environment.

9.2.2.1 *Classifying areas*

Depending on the priorities of the area under consideration, the manager can classify an area as one of the three alternatives below and adopt the appropriate management strategy.

(a) *'Sacrifice' or 'free use'* areas are areas where the coast is already *highly developed* and the natural features have been *irretrievably modified* through the products of development (i.e. within urban environments). In these areas, conservation priorities are usually low because human needs are foremost. Definite and well marked boundaries should be allocated to highly developed areas so that uncontrolled human activities do not spill over into sensitive areas that may lie alongside. Where a sensitive area has been identified adjacent to a developed area, a buffer zone should be demarcated between the two that would facilitate the protection of sensitive elements.

(b) *'Integrated'* areas are those where both conservation priorities and recreation activities can be accommodated and integrated without degradation of the environment or a deterioration in the quality of the human experience. Where there is prior evidence of degradation through excessive human use, the environment should be restored as far as possible and human activities strictly controlled.

(c) *'Protected'* areas are areas where the environment is of such a quality and/or sensitivity that even low levels of human activity can adversely affect the natural features and/or ecological processes.

The management strategies for the two extremes, i.e. 'free use' and 'protected' areas, are clear: either allow recreational activities ('free use') or restrict them to an absolute minimum ('protected' area). It is in 'integrated' areas where coastal zone managers need to actively implement a management policy that balances the demands of recreational activities and environmental conservation within a framework of ecological sustainability.

9.2.2.2 *General management guidelines*

The steadily mounting development pressure on coastal dunes and adjacent areas emphasises the urgency of conserving the physical and biological diversity and ecological processes that characterise the coastline and are responsible for its natural beauty and its role as a protective buffer between the land and the sea. Because of the extreme sensitivity of the coastal zone, sets of basic guidelines have been outlined by Tinley (1985), the Council for the Environment (1991), and McGwynne and McLachlan (1992). The most important of these are highlighted below.

(i) There should be **no development whatsoever in the littoral active zone** (see Section 9.4.1). The landward boundary of the LAZ is generally indicated by dunes *completely covered* with dune thicket/forest vegetation (Tinley, 1985). In addition, because these covered, and apparently stable, dunes are immediately adjacent to a highly unstable zone, they can revert to mobile structures should they experience natural or man-induced disturbances. Therefore, early in development planning stages, two **set-back lines should be identified**.

(a) The **erosion set-back line** is a line that coincides with the *landward extremity of the LAZ*; and

(b) **The development set-back line** is a boundary some distance landwards of the erosion set-back line and demarcates a *buffer zone* designed to restrict development to back dune areas where there is no danger of destabilising the dune. The width of the buffer zone varies according to natural characteristics such as soil type, wave climate, vegetation type and local topography. Determination of its width should take into account progressive long-term erosion or deposition patterns that cause periodic (i.e. 1: 50 year or 1:100 year) but severe fluctuations in beach width. Based on physical factors, this boundary may not be adequate to protect the habitats of some plants and animals. Where this is the case, the buffer zone should be adjusted to include threatened habitats and/or biota (Council for the Environment, 1991).

Roads, railways, bridges, powerlines, parking lots, houses or any other permanent structure should not be located on the seaward side of the development set-back line. Major roads, railways and powerlines should be kept more than 4 - 5 km landwards of the coastline (Tinley, 1985).

Since the precision of demarcating both set-back lines is crucially important to protect the ecological integrity and function of the coastal zone, it is advisable that planners *consult specialists* in the field of coastal dynamics to identify these limits.

(ii) Guidelines for specific dune types that occur along the KwaZulu-Natal coastline have been outlined by Tinley (1985). These are presented below.

- Where the shore is accreting and a series of dune ridges run parallel to the shoreline, as at Mtunzini on the central KwaZulu-Natal north coast, development should only be permitted where the oldest landward ridges are covered in vegetation. Only camping and caravaning should be permitted in the first trough behind the first definite dune ridge.
- Where the beach is backed by a well vegetated foredune ridge, e.g. part of the Richards Bay coast, or where the dunes are poorly developed or only a gradual rise occurs from the backbeach zone, development should be restricted to at least 50 m from the seaward edge of the ridge or the seaward edge of the completely vegetated sands.
- In areas where small vegetated dunes occur only as a single or double ridge, or where dunes present as steep, broad vegetated dune cordons, all development should be confined to the landward base of the dunes.

(iii) A detailed procedure for assessing the **recreational carrying capacity** of coastal areas identified as suitable for residential and associated recreational development has been described by Sowman (1987). Recreational carrying capacity is defined as the level of recreational use an area can sustain without an unacceptable degree of deterioration of the character and quality of the resource or of the recreational experience (Pigram, 1983 from Sowman & Fuggle, 1987). The procedure evaluates the range of capabilities of the environment for recreation and related human activities by assessing current recreational activities in terms of the spatial requirements of the activity, the resilience of the ecosystem to different kinds of activity, and the attitudes of the recreationists to different levels of crowding.

The procedure therefore takes into account three factors: (a) *the physical carrying capacity* of an environment i.e. the maximum number of 'use units' (people, vehicles, boats etc.) that can be physically accommodated in an area, (b) the *ecological carrying capacity* i.e. the maximum level of recreational use in terms of numbers and activities that can be accommodated before irreversible decline in ecological values, and (c) *the social carrying capacity* i.e. the level of recreational use above which there is a decline in the quality of the recreation experience (Pigram, 1983 from Sowman, 1987).

Recreational carrying capacity has been successfully assessed in a study undertaken to determine the carrying capacity of the Krom River estuary in the eastern Cape for recreational craft (Sowman & Fuggle, 1987). The procedure presents a systematic, structured and practical approach to making decisions that will govern the sustainable use of coastal resources.

(iv) Areas should accommodate a **diversity of recreational activities** so that the pressure of human activities can be dissipated. The availability of a range of activities can reduce the impact on one area in particular and thus the impact on the environment associated with that activity. Restrictions may need to be imposed on those activities that may threaten the realisation of others (Vogt, 1979).

(v) **Zones** may be established to accommodate different uses and to avoid interaction between activities that are incompatible, e.g. ORV use, fishing and surfing on beaches enjoyed by bathers.

(vi) **Limits** could be set to the numbers of visitors to certain areas or the activities allowed although this may decrease the popularity of the area.

(vii) The use of **boardwalks** to protect the dunes from trampling or the establishment of **reinforced paths** that reduce the loss of sand can be used to protect the environment and, at the same time, support human activity. Boardwalks and footpaths should be orientated at right angles to the predominant and gale force wind directions. The same applies to vehicle access routes (see also Section 7.4).

(viii) Efforts should be made to **educate users** of coastal resources through public lectures and talks, articles in local newspapers and informative but simple signs warning visitors of the sensitive nature of the coastal zone.

9.3 Other Coastal Zone Management Issues

This report has focussed on the management of coastal dunes within the coastal zone. It has highlighted ecological processes in dunes, social use patterns and impacts, mechanisms to evaluate their recreational potential, and strategies to facilitate their conservation. The coastal zone however includes inshore waters, the intertidal zone, coastal lakes, lagoons and estuaries, and coastal zone management issues that are diverse and complex. Many issues facing the conservation and use of the coastal zone as a whole were not tackled in this report. To keep these issues in the minds of policy makers, a number of important aspects that require policy decisions to be included in future coastal zone management policies are listed below:

- management of the coastal zone in the public interest;
- public access to coastal resources;
- coastal resource utilisation (e.g. development of informal settlements in coastal areas and the use of plants and animals for domestic purposes);
- conservation of cultural resources in coastal areas;

- conservation of representative coastal and marine ecosystems;
- coastal tourism and recreation;
- environmental considerations in planning and managing the use of coastal resources;
- the assessment and management of environmental impact;
- public participation in planning and managing the use of coastal resources;
- control of coastal development;
- coastal pollution;
- legal and administrative problems in coastal zone management; and
- coastal education and awareness.

9.4 Conclusion

Through the continual exchange of sand, dunes, beaches and surf zones function together as integral parts of a single sediment system known as the littoral active zone (LAZ). The LAZ is highly malleable and continually changes its profile in response to the prevailing wave climate. It is efficient and resilient as long as it remains free to fluctuate within its natural boundaries. Through the malleability of the LAZ, sandy coasts have the capacity to act as protective buffers between the land and the sea. In addition, dunefields lining most beaches constitute discrete ecological environments that harbour endemic and specialised plants and animals.

Whereas beaches can withstand human impact, dunes, particularly vegetated foredunes, are highly sensitive to all forms of disturbance. Therefore to maintain the integrity of the LAZ, to retain the natural patterns of sand movement that facilitate the buffering action of sandy coasts, and to conserve biodiversity, dunes should be protected and human activity confined to the beach below the driftline.

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References

ASCARAY, C.M., PERRIN, M.R., McLACHLAN, A., ELS, S. 1991. Population ecology of the hairy-footed gerbil, *Gerbillurus paeba paeba*, in a coastal dunefield. *Z. Saugetierk.*, 56, 296-305.

AFRICAN NATIONAL CONGRESS. 1994. Reconstruction and Development Programme - a Policy Framework. Umanyano Publications, Johannesburg.

AVIS, A.M. 1985. Coastal management and dune stabilisation. *Veld & Flora*, 2, 34-37.

AVIS, A.M. 1986. Some basic guidelines for managing and preserving our coastline. *Veld & Flora*, 72(2), 52-55.

AVIS, A.M., 1992. Coastal dune ecology and management in the eastern Cape. Ph.D. thesis. Rhodes University. 300pp.

AVIS, A.M., LUBKE, R.A. 1985. The effect of wind borne sand and salt spray on the growth of *Scirpus nodosus* in a mobile dune system. *S. Afr. J. Bot.*, 1(2), 100-110.

BERRY, M.G. 1993. Impacts associated with informal settlements on coastal vegetation in the eastern Cape. M.Sc. thesis. University of Port Elizabeth, 141pp.

BRANCH, W.R. (Ed). 1988. South African Red Data Book - Reptiles and Amphibians. *S. Afr. Nat. Sci. Progm. Rep.*, 151, 241p.

BROOKE, R.K. (Ed). 1984. South African Red Data Book - Birds. *S. Afr. Nat. Sci. Progm. Rep.*, 97, 213p.

BROWN A.C., McLACHLAN, A. 1990. *Ecology of sandy shores*. Elsevier Press.

BROWNLIE, S., PORTER, R. (undated). Planning with biotic diversity, for ecotourism diversity. Natal Parks Board, internal document. 12pp.

BROWNLIE, S.F., PORTER, R.N. 1991. A guide to integrated environmental management and the assessment of environmental impacts of proposed developments in Natal Parks Board areas. Natal Parks Board, internal document. 14pp.

CASTLEY, J.G. 1992. Role of mammals in seed dispersal in the Alexandria dunefield. M.Sc. thesis, University of Port Elizabeth. 80pp.

COOPER, J.A.G. 1991. Shoreline changes on the Natal coast -Tugela River mouth to Cape St Lucia. Town and Regional Planning Commission report. Volume 76. 57pp.

COUNCIL FOR THE ENVIRONMENT, 1989a. *Integrated Environmental Management in South Africa.* Joan Lotter. Pretoria.

COUNCIL FOR THE ENVIRONMENT, 1989b. *A policy for coastal zone management in the Republic of South Africa. Part 1. Principles and objectives.* Joan Lotter. Pretoria.

COUNCIL FOR THE ENVIRONMENT, 1989c. *An approach to a national environmental policy and strategy for South Africa.* Joan Lotter. Pretoria.

COUNCIL FOR THE ENVIRONMENT, 1991. *A policy for coastal zone management in the Republic of South Africa. Part 2. Guidelines for coastal land use.* Joan Lotter. Pretoria.

CSIR, 1992. The mapping and conservation importance rating of the Natal north coast vegetation as an aid to development planning. CSIR report to the Town and Regional Planning Commission, EMAS-C 92020.

DE RUYCK, A.M.C., McLACHLAN, A. & GLASSOM, D. 1992. Recreational use of three South African beaches before and after their opening to all races (submitted to *Ocean & Shoreline Management*).

DE GRAAFF, G. 1981. *The rodents of southern Africa*. Butterworths, Durban.

DEPARTMENT OF ENVIRONMENT AFFAIRS, 1992. *The Integrated Environmental Management Procedure*. Volumes 1-6.

DEPARTMENT OF ENVIRONMENT AFFAIRS, 1993. White Paper. Policy on a National Environmental Management System for South Arica.

FERGUSON, M.V. 1994. A detailed analysis of blow-outs in coastal foredunes. M.Sc. thesis, University of Port Elizabeth, 159pp.

FERREIRA, S.M. & VAN AARDE, R.J. In prep. a. Niche breadth and overlap of small mammals in rehabilitated dune forests.

FERREIRA, S.M. & VAN AARDE, R.J. In prep. b. Seasonal changes in small mammal density and biomass in rehabilitated coastal woodland.

FERREIRA, S.M. & VAN AARDE, R.J. In prep. c. Small mammal community structure in rehabilitated coastal woodland of different ecological time scales.

FERREIRA, S.M. & VAN AARDE, R.J. In prep. d. Small mammal species replacement in rehabilitated dune forests at Richards Bay, South Africa.

FERREIRA, S.M. & VAN AARDE, R.J. In prep. e. The influence of coastal dune woodland habitat productivity and complexity on small mammal density and diversity.

ILLENBERGER, W.K. 1988. The dunes of the Alexandria coastal dunefield, Algoa Bay, South Africa. *S. Afr. J. Geol.*, 91, 381-390.

ILLENBERGER, W.K. 1992. Sediment dynamics of the Sundays River mouth area, Algoa Bay. Ph.D. thesis, University of Port Elizabeth.

ILLENBERGER, W.K., KERLEY, G.I.H. 1993. Management and conservation of the Alexandria coastal dunefield. Institute for Coastal Research, Report No. 35, 43pp.

KAPP, PRESTEDGE & RETIEF. 1992. Towards a policy for coastal zone management in South Africa. Report to the Department of Environment Affairs.

KERLEY, G.I.K. 1991. Seed removal by rodents, birds and ants in the semi-arid Karoo, South Africa. *J. Arid Envir.*, 20: 63-69.

LUBKE, R.A. 1983. A survey of the coastal vegetation near Port Alfred, eastern Cape. *Bothalia*, 14, 725-738.

LUBKE, R.A., AVIS, A.M. 1982a. Factors affecting the distribution of *Scirpus nodosus* plants in a dune slack community. *S. Afr. J. Bot.*, 1, 97-103.

LUBKE, R.A., AVIS, A.M. 1982b. The effect of salt spray on the growth of *Scirpus nodosus*. *S. Afr. J. Bot.*, 1, 163-164.

LUBKE, R.A., DE VILLIERS, G. 1991. The vegetation of the Joan Muirhead Nature Reserve, Kenton-on-Sea. *The Naturalist*, 35, 21-30.

MACARTHUR, R.M., MACARTHUR, J.W. 1961. On bird species diversity. *Ecology*, 42, 594-598.

MACLEOD, S.B. 1992. Habitat use and diet of bushbuck in the Alexandria coastal reserve. M.Sc. thesis, University of Port Elizabeth.

MAJER, J.D. & DE KOCK, A.E. 1992. Ant recolonization of sand mines near Richards Bay, South Africa: an evaluation of progress with rehabilitation. *S. Afr. J. Sc.*, 88: 31-36.

MANUEL, F., GLAZEWSKI, J. 1991. The oceans - our common heritage. In: Cock, J., Koch, E. (Eds), *Going green - people, politics and the environment in South Africa.* Oxford University Press.

McGWYNNE, L.E., VAN TEYLINGEN, K., McLACHLAN, A. 1993. Coastal dune conservation - perceptions and needs of management authorities. Institute for Coastal Research, report number 32.

McGWYNNE, L.E., McLACHLAN, A. 1992. Ecology and management of sandy coasts. Institute for Coastal Research, University of Port Elizabeth, report number 30.

McLACHLAN, A. 1991. Ecology of coastal dune fauna. *J. Arid Environ.*, 21, 229-243.

McLACHLAN, A., BURNS, M. 1992. Headland bypass dunes on the South African coast: 100 years of (mis)management. In: Carter, R.W.G., Curtis, T.G.F., Sheehy-Skeffington, M.J. (Eds), *Coastal dunes: geomorphology, ecology and management for conservation.* Proceedings of the third European Dune Congress, Galway, Ireland, 17-21 June, 1992.

McLACHLAN, A., ILLENBERGER, W.K., BURKINSHAW, J.R., BURNS, M.E.R. (In press). Management implications of tampering with littoral sand sources. *J. Cstl. Res.*

MIJIC, S., GHAZANSHAHI, J., HUCHEL, T. & DEVINNY, J.S. 1981. Factors determining recreational use intensity at beaches. Coastal Society, 7th Conference, Galveston, October 11-14, 1981.

MOLL, E.J. 1972. A preliminary account of the dune communities at Pennington Park, Mtunzini, Natal. *Bothalia* 10(4): 615-626.

MUELLER-DOMBOIS, D., ELLENBERG, H. 1974. *Aims and methods of vegetation ecology.* John Wiley & sons, New York.

PHYSICAL PLANNING DIRECTORATE, NATAL PROVINCIAL ADMINISTRATION. 1986. Towards a policy for undeveloped land on the Natal south coast.

NATAL PROVINCIAL ADMINISTRATION, 1990. Coastal zone management along the Natal coast - guidelines. Published by the Physical Planning Directorate, Community Services Branch.

PARKER-NANCE, T., TALBOT, M.M.B., BATE, G.C. Vegetation and geomorphic age in the Alexandria coastal dunefield, eastern Cape, South Africa. *S. Afr. J. Sci.*, 87, 252-258.

PRESIDENT'S COUNCIL, 1991. Report of the three committees of the President's Council on a national environmental management system. Published by Authority, Republic of South Africa.

SCHNEIER, S.M. 1986. Report on off-road vehicles (Third draft) working committee for the coastal zone: Council for the Environment. Unpublished.

SHORT, A.D., WRIGHT, L.D. 1983. Physical variability in sandy beaches. In: McLachlan, A., Erasmus, T. (Eds), *Sandy beaches as ecosystems.* pp 727-732. W. Junk Publishers.

SMITHERS, R.H.N. 1986. South African Red Data Book - Terrestrial mammals. *S. Afr. Nat. Sci. Progm. Rep.*, 125, 216p.

SOWMAN, M.R. 1987. A procedure for assessing recreational carrying capacity of coastal resort areas. *Landscape & Urban Planning*, 14, 331-344.

SOWMAN, M.R. 1991. Impact of resort development in the coastal zone. *Veld & Flora*, 77, 120-123.

SOWMAN, M.R., FUGGLE, R.F. 1987. Assessing recreational carrying capacity: a case study of the Kromme River Estuary, South Africa. *J. Shoreline Manage.*, 3(1), 53-75.

TINLEY, K.L. 1985. Coastal dunes of South Africa. *S. Afr. Nat. Sci. Progm. Rep.* 109: 1-297.

VAN DER MERWE, D. 1987. The ecology of white-fronted sandplovers, *Charadrius marginatus*, in an eastern Cape dunefield. M.Sc. thesis, University of Port Elizabeth.

VAN DER MERWE, D, VAN DER MERWE, D. 1991. Effects of off-road vehicles on the macrofauna of a sandy beach. *S. Afr. J. Sci.*, 87, 210-213.

VAN TEYLINGEN, K., RICKARD, C.A., MCLACHLAN, A. & KERLEY, G.I.H. 1993. Conservation status of the vertebrate fauna of coastal dunes in South Africa. *Department of Environment Affairs, Biodiversity Series Rep.* 1:1-71.

VOGT, G. 1979. Adverse effects of recreation on sand dunes: a problem for coastal zone management. *Coastal Zone Management Journal*, vol. 6(1), 37-67.

WATSON, J. 1992. Dune breeding birds and off-road vehicles. *The Naturalist*, 36(3), 8-12.

WEISSER, P.J. 1978. A vegetation study of the Zululand dune areas. Town and Regional Planning Commission Report. Volume 38. 64pp.

WEISSER, P.J. 1980. The dune forest of Maputaland. In: Bruton, M.W., Cooper, K.H. (Eds). *Studies on the ecology of Maputaland.* Published by Rhodes University, Grahamstown and the Wildlife Society, Durban. 78-90pp.

WEISSER, P.J. 1987. Dune vegetation between Richards Bay and Mlalazi Lagoon and its conservation priorities in relation to dune mining. Natal Town and Regional Planning Supplementary Report. Volume 19. 71pp.

WEISSER, P.J., GARLAND, I.F., DREWS, B.K. 1982. Dune advancement 1937-1977 at the Mlalazi Nature Reserve, Mtunzini, Natal, South Africa, and a preliminary vegetation-succession chronology. *Bothalia* 14, 127-130.

WEISSER, P.J. BACKER, A.P., 1983. Monitoring beach and dune advancement and vegetation changes 1937-1977 at the farm Twinstreams, Mtunzini, Natal, South Africa. In: McLachlan, A., Erasmus, T. (Eds), *Sandy beaches as ecosystems.* 727-732pp. W. Junk Publishers.

WEISSER, P.J. & MARQUES, F. 1979 Gross vegetation changes in the dune area between Richards Bay and the Mfolozi River, 1937-1974. *Bothalia* 12: 711-721.

WEISSER, P.J. & MÖLLER, R. 1983 Dune vegetation dynamics from 1937 to 1976 in the Mlalazi-Richards Bay area of Natal, South Africa. *Bothalia* 14(3&4): 661-667.

WYNBERG, R. 1993. *Exploring the Earth Summit - findings of the Rio United Nations Conference on the environment and development: implications for South Africa.* Penrose Press. 136pp.

YELD, J. 1993. *Caring for the earth, South Africa - a strategy for sustainable living.* Southern African Nature Foundation Publisher.

YOUNG, M.M. 1987. The Alexandria dunefield vegetation. M.Sc. thesis, University of Port Elizabeth.

Personal Communications

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PART 1
Beach Recreation Questionnaire

Beach .... Date .... Time ....

1. Where is your hometown? ....

2. Where do you stay at this moment? Home .... Friends/Family .... Hotel .... Chalets ....
   Caravan Park .... Other ....

3. How did you travel to this beach? Car .... Bus .... Taxi .... Walk .... Other ....

4. How many people are in your group? ....

5. What is the age composition of your group? 0-10 yrs .... 11-20 yrs .... 21-30 yrs ....
   31-40 yrs .... > 40 yrs ....

6. How often do you come to this beach during the year? Public Holidays: Christmas ....
   Boxing Day .... New Year's Day .... Easter .... Summer school holidays ....
   Winter school holidays .... Weekends .... During the week ....

7. When do you visit other beaches during the year? Public Holidays: Christmas ....
   Boxing Day .... New Year's Day .... Easter .... Summer school holidays ....
   Winter school holidays .... Weekends .... During the week ....

8. a) Why do you come to this beach? ....
   b) How many hours do you stay on the beach? 0-1h .... 1-2h .... 2-3h .... 3-4h ....
   Whole day .... Overnight ....

9. Is this beach closest to your accommodation? Yes .... No ....

10. What other beaches do you visit in this area? ....

11. What activities do you partake in? Swimming .... Sunbathing .... Fishing ....
    Picnicking .... Surfing .... Walking .... Other ....

12. Do you approve of off-road vehicles (ORV's) on beaches? Yes .... No ....

13. a) Do you use ORV's on the beach? Yes .... No ....
    b) If yes, what for? ....
    c) What entrance do you use? ....

16. Do you feel comfortable with the no. of people on the beach at this moment? Yes .... No ....

17. How many more/less people can this beach hold at the moment? Half .... Present number ....
    2x more .... 3x more .... 4x more .... > 4x more ....

18. Have you ever felt uncomfortable with the number of people on this beach before? Yes .... No ....

19. Should the number of people on the beach be limited? Yes .... No ....

20. Are you willing to pay an access fee? Yes .... No .... Maximum? ....

21. Do you swim on beaches without shark nets? Yes .... No ....

22. Do you enter the dunes? Yes .... No ....

23. If yes, why do you enter the dunes? ....

PART 2
Dune Questionnaire

The U.P.E. is doing a recreational study of the local beaches. Would you please be so kind as to answer the following questions to assist with our research?

Date .... Beach ....

1. When do you visit the beach and what period of time do you spend there during that time?

   Public Holidays: Christmas .... Boxing Day .... New Year's Day .... Easter ....

   Summer school holidays .... Winter school holidays .... Summer: Weekends ....

   During the Week .... Winter: Weekends .... During the week ....

2. What route did you you use to get access to the beach? Road and Parking lot .... Boardwalk ....

   Official footpath .... Unofficial footpath ....Own path ....

3. Do you enter the dunes when visiting the beach? Y .... N ....

4. If yes, why do you enter the dunes? ....

5. What period of time do you spend in the dunes? < 1h .... 1-2h .... 2-3h .... 3-4h ....

   4-5h .... > 5h ....

6. Do the dunes in your opinion form an important part of the beauty of this environment?

   Yes .... No ....

7. Do you think that dunes have a function? Y .... N .... Don't know ....

8. What function do dunes have? ....

   ....

9. How much do you like to walk in the dunes? (1 = very much; 3 = average; 5 = not at all) ....

10 Do you feel overcrowded/uncomfortable with the number of people on the beach at this moment?

   Y .... No ....

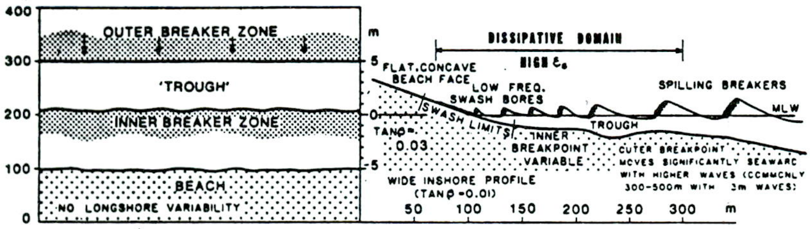
11. How many more/less people can fit on this beach at this moment? Half .... present number ....

   2x more .... 3x more .... 4x more ....

THANK YOU FOR YOUR CO-OPERATION!!

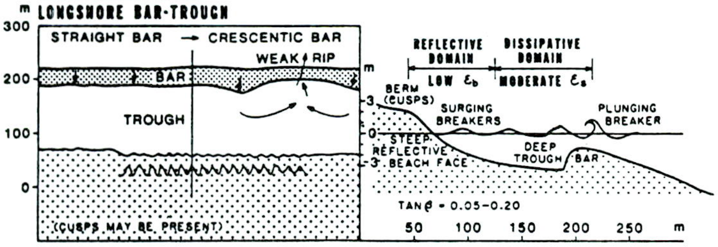
PART 1
Beach Morphodynamic Types and Hazard Rating

DISSIPATIVE



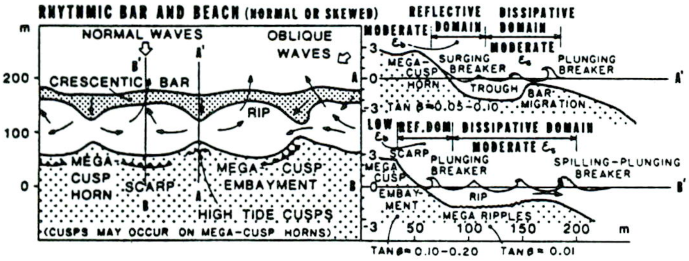
Hazard rating 6/10. Most people stay close to shore. Safest bathing in swash zone.

INTERMEDIATE
LONGSHORE BAR-TROUGH



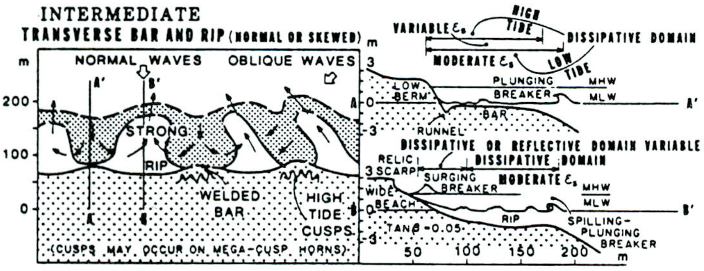
Hazard rating 7/10. Most people stay close to shore. Safest bathing in swash zone and in trough away from rip.

INTERMEDIATE
RHYTHMIC BAR AND BEACH (NORMAL OR SKEWED)



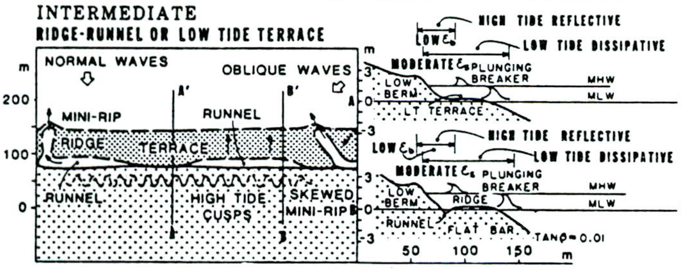
Hazard rating 8/10. Most people wade or swim to shoaler bars, bathers caught or washed into rips.

INTERMEDIATE
TRANSVERSE BAR AND RIP (NORMAL OR SKEWED)



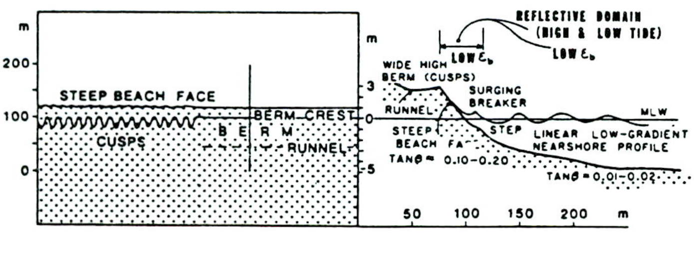
INTERMEDIATE
RIDGE-RUNNEL OR LOW TIDE TERRACE

Hazard rating 8/10. People bathe on shallow bars adjacent to rips, however, bathers can be washed off bar into rip. Inexperienced bathers enter rips.



Hazard rating 4/10. Safest bathing: safe at low tide, deeper and weak rips at high tide.

REFLECTIVE



Hazard rating 3/10. Safe apart from deep water close inshore and from shorebreak during high waves. Steep beach and abrupt drop off to deeper water can make access difficult for elderly and children.

(Short & Wright, 1983).

PART 2
Designated Areas or Features

Should a proposed development impact on any of the areas or features listed below, a full investigation of the impacts should be undertàken through the Environmental Impact Assessment (EIA) or Integrated Environmental Management (IEM) procedures as proposed by DEA (1992). 'Designated areas or features' means any area or feature already declared in terms of an Act of Parliament or by agreement between landowners and the State President or the Minister of Environment Affairs (DEA, 1992).

1. Limited development areas
2. Protected natural environments
3. National, provincial and municipal nature reserves
4. Private nature reserves
5. Mountain catchment areas
6. Wilderness areas
7. National monuments
8. Shipwrecks
9. Archaelogical and palaeontological sites
10. Graves and burial sites
11. National gardens of rememberance
12. Conservation areas
13. Meteorites
14. Off-shore islands
15. Intertidal zone
16. Admiralty reserve
17. Lake areas
18. National heritage sites
19. Sites of conservation significance

PART 3
Demarcated Areas or Features

Should a proposed development impact on any of the areas or features listed below, a full investigation of the impacts should be undertaken through the Environmental Impact Assessment (EIA) or the Integrated Environmental Management (IEM) procedures as proposed by DEA (1992). 'Demarcated areas or features' means any of the following areas or features which are demarcated by a central, regional or local authority (DEA, 1992).

20. Estuaries and lagoons
21. Streams and river channels, and their banks
22. Floodplains
23. Wetlands
24. Lakes
25. Dunes
26. Beaches
27. Reefs
28. Indigenous forests
29. High-potential agricultural land
30. Caves
31. Green belts or public open space in municipal areas
32. Architectural precincts
33. Buildings
34. Battle sites
35. Burial sites
36. Immovable property
37. Landscapes
38. Islands in rivers
39. Biotic assemblages and communities
40. Habitat of Red Data Book species
41. Bird migration sites
42. Aquifers and aquifer-recharge areas
43. Areas with a high natural water table
44. Damaged land
45. Unstable soils
46. Natural resource areas (including minerals)
47. Sites of geological significance
48. Geologically and geotechnically unstable areas
49. Areas or sites of outstanding natural beauty
50. Scenic drives and panoramic views
51. Areas or sites of special scientific interest
52. Areas or sites of religious or spiritual significance
53. Areas or sites of special social, cultural or historical interest
54. State land

PART 4
Policy and Planning Proposals

Should a proposed development involve a policy and planning proposal listed below, a full investigation of the impacts associated with the proposal should be undertaken through the Environmental Impact Assessment procedure as proposed by DEA (1992). *With the policy and planning proposals the Integrated Environmental Management (IEM) procedure should be implemented in such a way that it complements - rather than duplicates - existing planning and other procedures. The IEM procedure should be used to supplement existing requirements rather than replace them* (DEA, 1992).

1. Structure plans (or, in the absence thereof, town planning schemes and zoning schemes)
2. Rezoning applications
3. Subdivisions
4. Land aquisition for national parks, nature reserves, marine reserves, protected natural environments or wilderness areas
5. Establishment of townships
6. Declaration of limited development areas
7. Any government policy on the use of natural resources

PART 5
Project Proposals

Should a proposed development involve a project proposal listed below, a full investigation of the impacts associated with the proposal should be undertaken through the Environmental Impact Assessment (EIA) or Integrated Environmental Management (IEM) procedures as proposed by DEA (1992). *With the project proposals the Integrated Environmental Management (IEM) procedure should be implemented in such a way that it complements - rather than duplicates - existing planning and other procedures. The IEM procedure should be used to supplement existing requirements rather than replace them* (DEA, 1992).

8. Nuclear installations
9. The formal disposal of waste
10. The transportation of hazardous substances and radioactive waste
11. Mining, mineral extraction and mineral beneficiation
12. Power generation facilities with an output of 1 megawatt or more
13. Electrical substations and transmission lines having equipment with an operating voltage in excess of 30 000 volts rms phase-to-phase
14. Storage facilities for chemical products
15. Industrial installation for the bulk storage of fuels
16. Bulk distribution facilities
17. Scheduled Processes under Schedule 2 of the Atmospheric Pollution Prevention Act (45/1965)
18. Industries requiring a permit under section 12 of the Water Act (54/1956)
19. Manufacture of explosives
20. Control Measures under section 6 of the Conservation of Agricultural Resources Act (43/1983)
21. Battery and feedlot farming installations
22. Propagation of invasive alien plant and animal species
23. Afforestation projects
24. Genetic modification of organisms and release of such organisms
25. Major roads
26. Railways

METHOD OF RATING FEATURES INCORPORATED INTO THE ESTIMATION OF RECREATIONAL POTENTIAL INDEX (Tables 8.1 - 8.6)

All characteristics/features are rated on a scale of 1 - 10. It would be advantageous for at least 2 assessors to assess each one independently and adopt the mean of their ratings. The assessment is a broadly subjective exercise; ratings will therefore vary slightly between assessors although these should not exceed ± 2 points.

NATURAL CHARACTERISTICS

1. Pristine Nature

The questions below should serve as a guide to assess pristine nature:

- Is the area completely undeveloped or is there evidence of man's presence?
- To what *degree* do man's activities manifest themselves? Has man's impact been small and confined to a few pathways? Is low-key development evident in the form of modest buildings? Or does the seafront support permanent concrete structures such as promenades, hotels, residential buildings, recreational facilities or artificially constructed lawns and gardens?

Rating: 0 (completely developed) - 10 (completely undeveloped, pristine).

2. Scenic Quality

The scenic quality of a beach-dune area should be assessed relative to the type of area under scrutiny i.e. *undeveloped* areas should be evaluated relative to the beauty of natural wildernesses, and *semi-developed* and *developed areas* relative to the beauty that modified and man-made horizons can afford. It would be inappropriate to evaluate a developed area with wilderness appeal as the standard. This is a highly subjective rating.

Rating: 0 (low scenic appeal) - 10 (high scenic appeal).

3. Educational Value

Educational value is assessed according to the potential of an area to serve as a venue to teach both adults and children about plants, animals, ecology and conservation. The following aspects are pertinent:

- Does the vegetation harbour any threatened, endemic or uncommon *plant species* or species of particular botanical interest? Is there any evidence of plant succession? Does the area support climax forest communities and, if so, to what extent?
- Does the area harbour any threatened, endemic or uncommon *animal* species or species of zoological interest ? Is the area used as a breeding site by any particular animal?
- Does the area harbour *biotic communities* of ecological value?

Rating: 0 (low educational value) - 10 (high educational value).

4. Unique Features

- Are there any *physical features* in the area that are particularly noteworthy and warrant special conservation measures? Are these features of local, regional or national significance? (Examples could include extensive dunefields and beaches, noteworthy rock formations and caves, scenic lagoons and coastal lakes, inshore reefs renowned for their marine life, etc.).

- Are there any *biological features* in the area that are particularly noteworthy and warrant special conservation measures? Are these features of local, regional or national significance? (Examples could include coastal forests, animal breeding sites, habitats of Red Data Book species, etc.).

Rating: 0 (no unique feature(s)) - 10 (presence of unique feature(s) of local or national significance).

5. Biodiversity

- Are many different species of *plants* represented in the area or is the vegetation dominated by a few species?

- Are many different species of *animals* represented in the area or is the animal life dominated by a few species?

- Does the area comprise a single *plant/animal* community or are a few communities represented?

Rating: 0 (few species of plants and animals) - 10 (many species of plants and animals).

6. Ecological Sensitivity

- Will disturbance to or modification of the physical environment affect its physical stability, the extent of a particular environment type, or disturb established patterns or cycles of sand or water movement?

- Will disturbance to or modification of the physical environment impact on individual plant or animal species or on established communities of plants/ animals by increasing or decreasing habitat size or altering its physical or chemical composition? Will disturbance to any single biotic component affect other biotic components in the area? Will it impact a breeding site of any animal species or will it encourage infestation by alien plant species?

- Will the impact of disturbance, through its effect on any plant, animal or biotic community, disturb the ecological balance of the area as a whole?

Rating: 0 (insensitive) - 10 (highly sensitive).

Conservation Merit

This factor gives an indication of the need to take special precautions to conserve the natural character, both in terms of physical and biological features, and ecological functioning of the area.

Conservation merit is thus represented by the mean of the sum of the ratings for *pristine nature, scenic quality, educational value, unique features, biodiversity and ecological sensitivity.*

Rating: 0 (low conservation merit) - 10 (high conservation merit).

Physical Sensitivity

Physical sensitivity is derived from an assessment of the *direction and rate of sand movement* onto or from the shore; it therefore gives an indication of the physical stability of the shore. A shore upon which sand rapidly accumulates (accreting shore) is considerably more stable (i.e. less sensitive, from a physical perspective, to the development of land-based structures) than one where sand is actively scoured to the sea (eroding shore). Note that this factor gives no indication of the biological or general ecological sensitivities of the area.

Rating: 0 (strongly accreting shore) - 10 (strongly eroding shore).

Development Suitability

In rating development suitability, the assumption is made that high levels of development and conservation of the environment are incompatible because construction of permanent structures and the consequent increase in human activity in any area modifies the natural features and can lead to environmental degradation.

The assessment of the suitability of a coastal area for development should take cognisance of both the conservation worthiness (reflected in *conservation merit* which includes an assessment of six factors relating to the biophysical environment) and the physical stability of the area (reflected in the *physical sensitivity* rating). The mean of *conservation merit* and *physical sensitivity* will give an indication of the need to conserve an area both from an ecological and a human perspective. However, taking into account the assumption that development and conservation are, strictly speaking, incompatible, the *antithesis* of the mean should be adopted to reflect *development suitability*.

Development suitability = 10 - [(conservation merit + physical sensitivity) / 2]

Rating: 0 (unsuitable for development) - 10 (highly suitable for development).

RECREATIONAL FEATURES

Recreational features, except *modal beach-surf zone state and beach-surf hazard rating*, can be arbitrarily selected and easily assessed by the assessor(s). Those shown in Tables 8.1 - 8.6 were based chiefly on the features encountered at the study sites. It is important to note that these features were rated on their *current* complement and condition and seen in relation to the type of development (i.e. urban/semi-urban and wilderness) and the volume of visitors that could be expected to use the facilities.

Rating: (for features except *modal beach-surf zone state*):
0 (not suitable for recreation) - 10 (highly suitable for recreation).

Modal Beach-surf Zone State & Bathing Hazard Rating

An exact assessment of the modal state of the beach-surf zone requires considerable experience on the part of the assessor. However, it is not necessary to make a precise classification but it is advantageous to recognise the presence of sand bars, and the position and relative strengths of different rip currents in the surf zone. These features are illustrated in Appendix B, Part 1 for the six beach morphodynamic states; a bathing hazard rating accompanies each one. From the hazard rating, a bathing safety rating may be made.

Bathing safety rating = 10 - bathing hazard rating

Rating: 0 (unsafe for bathing) - 10 (safe for bathing).

Recreational Suitability

This factor represents the mean of all recreational features identified (i.e. features 1 - 11).

RECREATIONAL POTENTIAL INDEX (RPI)

The RPI was designed to reflect the potential of an area to accommodate recreational activities and yet maintain the natural features, biodiversity and ecological processes. If an area has already experienced development, to whatever degree, account needs to be taken of the current level of development. If an area is totally undeveloped, development suitability represents the RPI.

Recreational Potential Index (RPI) = (development suitability + recreational suitability) / 2