

Ugu Lwethu - Our Coast

A profile of coastal KwaZulu-Natal

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3 Coastal and Marine Ecosystems

3 Coastal and Marine Ecosystems

Ecosystems are defined as groups of living organisms (animals, plants and microbes) interacting together and with the non-living components of their environment (air, water and minerals). Coastal and marine ecosystems encompass a wide range of habitat types, providing an integral link between terrestrial and aquatic environments.

The KZN coastal environment is home to a range of ecosystems that support high diversity and endemic species. These include coastal and aquatic vegetation, sandy and rocky shores, transitional ecosystems such as estuaries, coastal lakes, mangroves and wetlands, and dynamic systems such as sub-tidal reefs and soft substrata.

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3.1 Coastal Dunes

Coastal vegetation is that subset of terrestrial vegetation that falls under the direct influence of the ocean and its associated climate. The plants grow on substrates mainly of marine origin, including shells, sand, pebbles, rocks and bedrock.

The nature of the South African coastline, its landform and geology, and the varied climate of the subcontinent results in six major coastal regions, viz. the West, Southwest, South, Southeast, Transkei and KZN coasts. The subtropical KZN coast is characterised by being east or southeast facing, with a summer rainfall, as highlighted in *Section 2.1*, and coastal thicket or forest vegetation. These features separate it from the other five coastal regions.

The terrestrial plant communities along the shoreline are largely influenced by the type of shoreline, which may range from sand or pebble beaches, through rocky headlands or wave-cut rocky platforms. The KZN coast is dominated by sandy shores with exposed rocky headlands or wave-cut rocky shores seen along the southern section of coast, both ecosystems are described in more detail in *Section 3.2* and *Section 3.7* respectively.

The main environmental factors that account for the variety of vegetation types are: the stability of the substratum (e.g. mobile sands driven by strong winds and the related sand blasting); salt spray and occasional inundation with salt water by exceptionally high tides; strong soil acidity gradients from the shore inland; and intense radiation from the sun as a result of reflection from the sea and sand.

Floristic or plant species distribution

There are clear discontinuities in species distributions along the whole coastline from the southwest coast northwards to KZN. Some species are confined to specific regions due to climate or substrate. The distribution of plant species is related to the distribution of their propagules (seeds, fruits or vegetative parts), climatic differences (especially moisture, temperature and wind) and the gradients in the distribution of the major floristic types in southern Africa. As a consequence, the attractive dune creeper *Canavalia maritima* is common on this shore but not found farther southward. Similarly, the Natal wild banana is found in KZN and stretches down the Transkei coast, but does not grow farther west.

KZN coastal dunes, with pioneer vegetation.



Photo: Fiona MacKay



There is a low diversity of species in the pioneer plant communities and changes in species distribution along the coast are reflected in the species composition of these communities. The communities occur in fairly distinct zones from the shoreline landwards and may also represent stages in a successional gradient towards the climax community of the stable dunes. The composition of the climax plant community is largely influenced by environmental factors.

Coastal plant communities

Temperature and moisture (mostly rainfall) are major factors affecting the size, density and structural complexity of the terrestrial plant communities. There is a change as one moves around the coast from Namibia and up the southeast coast to KZN. The KZN coast shows the most complex of vegetation types, with taller trees and shrubs and an abundance of herbaceous layers, reflecting the more equable temperatures and higher and more consistent rainfall along this coast.

Dune systems

Dry coastal dune systems are ever changing with storms and seasons and many of the coastal communities may disappear in a single storm event or gradually change in response to changing environmental factors. Many of the pioneer plant species of coastal dunes are cosmopolitan (e.g. the coastal kweek, or the dune goat's foot). The coastal dune communities are often quite distinct, consisting of monospecific stands of pioneer plants. In other cases there may be a graduation from the pioneers into thicket, so that the different communities are not that distinct.

Pioneer Species and Dune Formation

Dune pioneer plants are able to colonise the bare shifting sand (dune zone) above the intertidal beach zone by means of special adaptations and plant modifications. These are a creeping rhizomatous growth form with leaves covered by a thick waxy cuticle, tolerant of salt spray and abrasion. Many species can withstand burying for some time and have adaptations to prevent water loss. The critical stage is germination and seedling establishment, which usually occurs during the rainy season. Once established, the young plants are able to stabilise the sand, growing in response to the accumulation of sand (accretion). This results in the growth of the sand dunes to form foredunes above the spring high tide mark. If the winds are too strong or persistent or rainfall is too low, the plants are unable to grow and the foredunes may not develop, allowing mobile dune systems to dominate.

The type of pioneer plants often determines the type of vegetation that will establish in that particular region. On the KZN coast, there is a prevalence of longitudinal foredunes if the pioneer plant species are *Scaevola plumieri* and *Ipomoea pes-caprae*, but dune hummocks are formed if the pioneer species are *Arctotheca populifolia*.

Secondary Communities

Most often on the KZN coast, especially on steep dunes, there is a rapid change from pioneer zone species to dune thicket. However, sometimes distinct scrublands occur landward of the pioneer zone. The most common and dominant shrub species is the widespread *Passerina rigida*, which is widely spaced, often with grass species and herbs, and about 1-2 m tall. Many other species occur once the dunes have been stabilised, resulting in extensive stabilised dune fields.



Profile of the Dune System along the KZN coastline, from the pioneer communities to thicket or forest vegetation.

Climax Communities

Dune thicket is a dense tangle of almost impenetrable shrubs or small trees and creepers. There is no distinct layering or strata in thicket and no understory of herbs or grasses. Dune forest, on the other hand, consists of at least three strata; a grass and herb layer, a shrub layer and a tree layer. Lianas may be present, interconnecting the three layers of vegetation. Forests are also not as dense as thickets, but are taller than the thickets.

Rocky shores

Rocky shores differ from dune coasts in having stable substrata and shallow soils, and are often subject to high winds and salt spray. The vegetation on the rocky shores is very sparse and small in size. There may be an accumulation of saline water bodies with brackish streams in some sites where halophytic salt marsh plants may be found. The accumulation of sand on the rocky shores may result in the establishment of pioneer species and communities common to the dune fields.

Successional change in the coastal dune field

The dunes in the Mlalazi Nature Reserve at Mtunzini provide an excellent example of succession on a prograding coastline. In fact, it is one of the most outstanding areas in the world to study the change in plant communities over time. At this site it is possible to see distinct dune ridges or longitudinal dunes running parallel to the shore. As one moves inland across the dune ridges one can observe the change from pioneer communities, through a variety of shrub and grassland communities, to a climax coastal forest farthest inland.

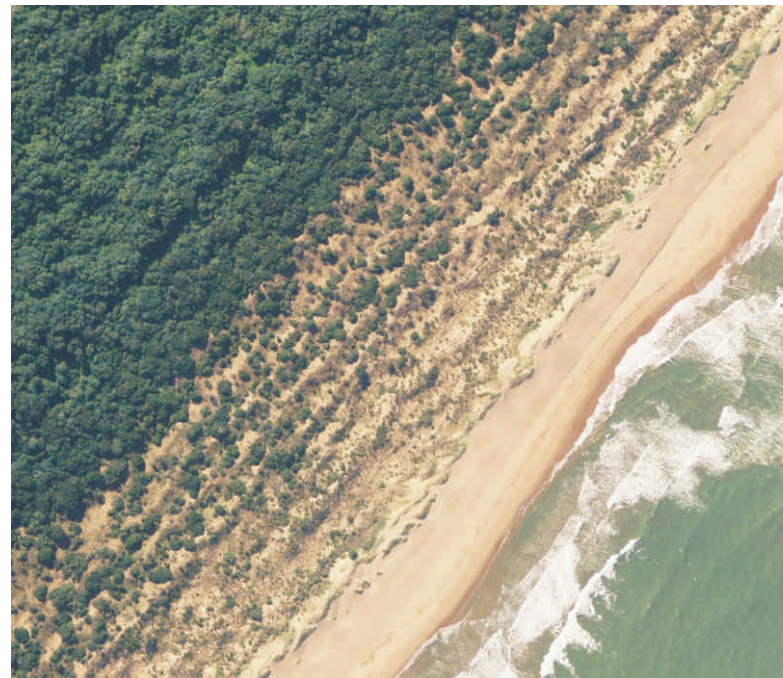
In this region, the high summer rainfalls and supply of sand from soil erosion along the Thukela River ensures a continuous deposition of sand and silt at the river mouth; and by longshore drift northwards to Mlalazi. This opens up new dunes for pioneer plants to invade, and over a few years, changes in communities from pioneers to climax forest can be observed.

It is possible to relate successional changes to the chronology of dune development using aerial photographs. A study

showed that it would take five years for a dune ridge to be formed under present conditions in this area. Eight communities were identified along a gradient of increasing distance from the sea, and increasing age of the dunes (from 5-120 years), as estimated from dating the parallel dune ridges. The pathway of change was as follows: pioneer, enriched pioneer, open dune scrub, closed dune scrub, bush clumps, bush clump/forest margin transition, forest margin and, finally, forest.

These communities showed a general increase in species richness, cover, stature and biomass from pioneer to forest. However, sometimes species diversity can reach a maximum value prior to achieving the climax community, whereafter diversity decreases. As one moves inland the number of species in each community along the gradient increases, as does community complexity.

Coastal habitats and vegetation are under increasing pressures from, amongst others, coastal development, dune mining and the stabilisation of mobile dune systems. The KZN coast has more sandy systems than anywhere else in South Africa, making it a special region. Importance should be paid to the protection of sensitive coastal areas, in order to ensure long-term sustainability. ■



Successional change at Mtunzini.

Photo: DAEA





Photo: Ronel Nel

3.2 Sandy Shores

The coastline of KZN is an ocean-exposed, high-energy interface between land and sea. Sandy shores comprise a significant proportion of this dynamic boundary, noting that here the term “sandy shores” refers to the coupled and contiguous dune, intertidal beach and surf-zone ecosystems.

Some of the most spectacular and pristine beaches in the country are found in KZN. Sandy shores also harbour a suite of unique biota, and provide numerous ecosystem goods and services that support human livelihoods, health and well-being and contribute to the province's economy (see *Chapters 7 and 8*).

Complex interactions between tides, wave climate, and nature of the sediment give rise to a continuum of beach morphodynamic types. These range from reflective beaches with coarse-grained sand, a steep slope and narrow surf zone, to dissipative beaches with finer-grained sand, a flat slope and wide surf zone. There are a range of intermediate forms between these two extreme states, characterised by sand bars, rip currents and cusps.^{1; 2; 3}

In KZN, conditions are microtidal (<2 m tide range), with strong wave action, a narrow continental shelf, and a supply of sand mainly from rivers and estuaries. Consequently, the KZN beaches tend to be coarser grained and steeper sloped, with narrow surf and intertidal zones. They also often have cusps and rip currents as features of the shore.^{4; 5} This means the predominant beach morphodynamic types for KZN are intermediate and reflective.

Global trends show that both diversity and abundance of beach macrofauna decrease from dissipative to reflective conditions.^{6; 7; 8} Macrofauna communities in KZN comprise relatively few species (9-10 on average), with a range of 1-16 species recorded on individual beaches.⁹ Although species richness is relatively low, it is important to note that these are unique species with high levels of endemism.⁹ In addition, the meiofaunal and microbial communities on intermediate to reflective beaches are prominent,^{10; 11} which in turn underpin key ecosystem services such as nutrient cycling.^{12; 13; 14}

KZN sandy beach.

The sandy beaches of KZN occur within the Natal-Delagoa Bioregion.¹⁵ The Natal-Delagoa is a subtropical coastal bioregion (i.e. an oligotrophic system), making the beach food web particularly dependent on allochthonous inputs from terrestrial and marine sources.

Dune ecosystems comprise four broad categories, including bare/free dunes, vegetated dunes, dunes related to topographic barriers, and wetlands-associated dunes, with three to four different types listed under each category.¹⁶

Spatial distribution

The KZN coast is dominated by sandy beaches, of which less than 1% are dissipative beaches; 18% are dissipative-intermediate, 29% are intermediate and 8% are reflective.⁵ Dunes line the full length of the coast, except where burgeoning population growth, urban development, and shoreline defences (seawalls) have replaced this natural barrier.^{16; 17}

Today, the KZN coastline is characterised by three regions. An undeveloped, near-pristine northern section stretches from Kosi Bay to Mapelane, with very good conservation protection in the iSimangaliso Wetland Park. A mixed-use central section is found from Richards Bay to Durban, with areas of complete habitat modification interspersed with untransformed habitat. Lastly, a developed southern section stretches from Durban to Port Edward.⁴ Interestingly, the distribution of beach morphodynamic types along the provincial shoreline reflects the same three zones,^{4; 5} and the distribution of dune types follows a similar pattern.¹⁶

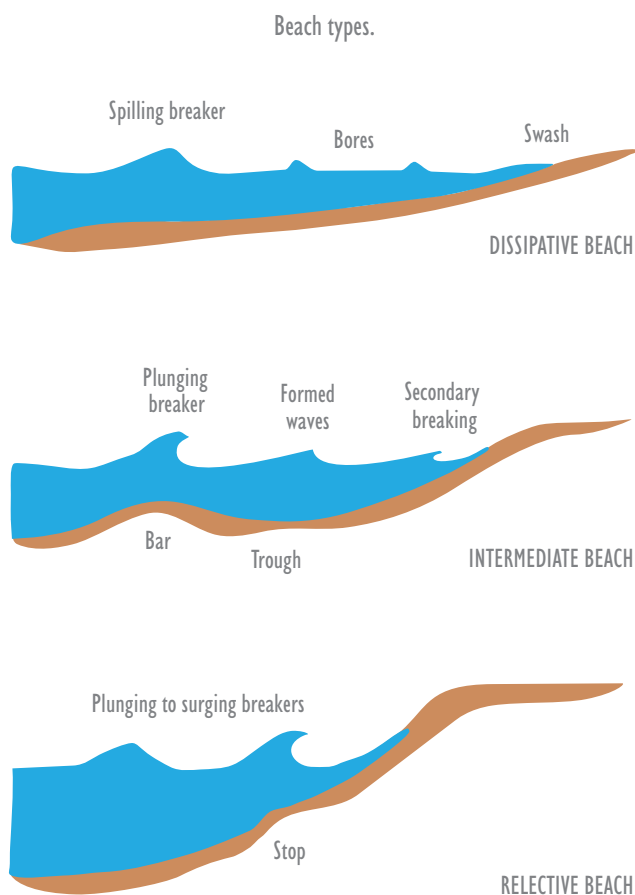
The northern section comprises beaches of the intermediate to dissipative-intermediate state with some reflective beaches in sections. Here, large and intact bidirectional parabolic dunes line the beaches, and include well-established coastal dune forests. Scattered among these vegetated dunes are buttress reversing barchanoid dunes (bare sand).

The central section is mainly composed of intermediate beaches, with some reflective portions. For the most part, the dunes backing these beaches are small hummock, blowout and barrier dune types that tend to be associated with bayheads and estuary mouths. Of note are the parallel beach ridges of prograding shoreline at Mtunzini, and a section of cliffed dunes with cirque-like slump scars between Port Durnford and Richards Bay.

In the southern section, the beaches are predominantly reflective, fragmented along the shore by many rocky and mixed shores. The dunes are the same as those found in the central section.

Uniqueness of the KZN sandy shores

The value of sandy shores in KZN is reflected in their ecological, economic and cultural importance, which, at a local scale, is often related to the unique features that are prominent along the coast. From an ecological perspective, and in light of the fact that most of the world's beaches are eroding,¹⁸ a key feature of the KZN coast is the prograding shores at Mtunzini. This is one of two places in the country where the coastline is recognised as accreting.¹⁶ Importantly, the sandy shores of the iSimangaliso Wetland Park (northern KZN) are nesting grounds for loggerhead and leatherback turtles (Section 4.3). Several shorebird species also use beaches as nesting, foraging and/or roosting grounds (Section 4.8).





KZN sandy beaches offer areas for recreation and tourism.

Sandy shores are highly-valued natural assets, for recreational, cultural and traditional reasons. Sandy shores also provide economic value through tourism and the extraction of natural resources for commercial and subsistence use (see *Chapters 6, 7 and 8*). Apart from their direct economic contribution, sandy shores provide a number of invaluable ecosystem services, such as water filtration, nutrient recycling and disturbance regulation by buffering heightened wave energy during extreme tides and large storms.

Threats to sandy shores

The greatest threat to the sandy shores of KZN is habitat modification, primarily due to extensive coastal development (*Section 9.2*). In many cases, the development is also inappropriately located too close to the shoreline, which leaves no room for the natural landward migration of the coast, and thus results in “coastal squeeze” – the gradual inundation and loss of sandy beaches. In addition, urbanised shores lose the natural barrier provided by dunes, which makes these developed areas vulnerable, as explained in *Section 9.5*. The effect of the KZN storm event of March 2007 was a classic example of this phenomenon.^{19; 20}

There are a number of activities in the hinterland that have important downstream effects on beaches and dunes. In particular, damming of rivers, estuarine sand mining (*Section 9.6*) and agriculture (*Section 8.6*) have altered the supply and quality of sediment reaching the coast. Generally, the result

has been a reduction in the volume of sand supplied to beaches and dunes, which contributes to erosion and further reduces the resilience of the coast to sea-level rise and storms, as explained in *Sections 9.4 and 9.5*.

It is reassuring to note that a diversity of sandy shores with unique ecological attributes is still well represented in KZN, this despite the widespread and increasing levels of disturbance and usage. Mining, sand mining in estuaries, coastal development and damming of rivers all interfere with the dynamic processes that sustain sandy shores and their associated organisms. Deriving sustained goods and services from KZN sandy shore resources is technically possible, but that will take informed planning, sensitive development and good governance. ■

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3.3 Estuaries

Although estuaries are distinct habitats with an individual ecology, they form part of a transition gradient where freshwater from rivers meets saltwater from the sea. In the broadest sense, this is the longest standing and generic global definition of an estuary.^{1;2}

Estuaries include a wide variety of systems from small to large, and those that are either periodically or permanently open depending on factors such as the estuarine type, shape and function. Indeed the interaction of these functions provides a unique, highly productive environment that supports a great diversity of wildlife and resources, contributing great value to the economies of countries.³

In terms of the *ICM Act*, “estuary” means a body of surface water that:

- is part of a water course that is permanently or periodically open to the sea;
- in which a rise and fall of the water level as a result of the tides is measurable at spring tides when the water course is open to the sea or;
- the salinity is measurably higher as a result of the influence of the sea.

Estuaries, where freshwater from rivers meets saltwater from the sea.



Photo: ORI

KZN estuaries

The profile of the coast, our subtropical climate and the size of coastal rivers all contribute to the types of different estuaries represented in coastal catchments of KZN. We know that estuaries are productive, complex and support a large number of different plants and animals. But how do we simplify this diversity and intricate ecology? One way is to organise estuaries into groups. Estuaries can be classified according to the way they were formed and how they function. Once the type is known, it is easier to understand how the estuary behaves. Estuaries are all different in terms of size, depth, tide patterns, catchments, fresh water flows, salinity and types of sediment, which in turn influences the varieties of animals and plants that live there. Thus when it comes to managing estuaries it is seldom possible to adapt information from one estuary type to another.

KZN has a fairly small share of South Africa's 3 200 km coastline, but the 580 km KZN coast (see *Section 1.2*) supports 77 of the 300 estuaries in the country.⁴ KZN has representative examples of all five South African estuarine types, which are 1) estuarine bays 2) permanently open systems 3) river mouths 4) estuarine lakes and the smaller but more numerous 5) temporarily open estuaries.⁵ Although they are the only representatives of this type, the St Lucia and Kosi Estuarine Lake systems account for 90% (365 km²) of the total provincial estuarine area of 400 km², which in turn is 66% of the national area, highlighting the importance of these two systems.

The classification or "typing" of estuaries is important for their management as different estuaries respond in diverse ways to change generated by human use or natural events. Identifying these responses gives us some direction as to how they should be further studied and managed.

Importance and value of estuaries

The *ICM Act* has further defined estuaries and how they should be holistically managed by an overarching *Estuarine Management Protocol* (*Section 10.2*). It highlights that the definition of an estuary pertains to more than just the surface waters and includes the adjacent terrestrial unit, the estuarine functional zone. This zone is most frequently delineated by the 5 m (above mean sea level) topographical contour and includes areas of floodplain and estuarine vegetation that contribute towards protection of animals and habitats,

provides refuge and plant food for estuarine organisms and other uses that people can directly benefit from.⁴

Estuaries are important as they offer an assortment of habitat types and are often termed "nurseries of the sea" where many commercially important fish and shellfish are protected, feed and complete some part of their life cycle. They also offer intrinsic functions, which include filtration of nutrients such as fertilisers from surrounding farmlands. If riparian vegetation and forest are intact, they are natural buffers absorbing the full force of flooding, storm surges and bank erosion.

Aside from natural and fundamental life support services to the environment, KZN estuaries also provide a wide range of benefits that support us through cultural, recreational and subsistence needs and experiences. To us, the direct value of healthy, functional estuaries creates income generating opportunities and influences the economy of coastal areas.^{6; 7; 8}

Threats to estuaries

Generally there is a strong relationship between the size of a catchment's human population and the degree of modification of an estuary.³ Threats can be attributed to direct and indirect pressures on these systems.

Flow alteration

We live in a naturally semi-arid country with a pressing freshwater demand to meet domestic, industrial and agricultural needs for a population of 50.6 million,⁹ as highlighted in *Section 6.1*. The amount and natural timing of river water reaching estuarine and marine environments has been altered through the construction of dams and direct extraction along the river course. These changes affect the way an estuarine ecosystem functions and therefore the services it provides.

Declining water quality

Pollution causes harmful concentrations of chemicals, nutrients, herbicides, pesticides and litter in our estuaries (*Section 9.3*). A consequence of human settlement is that waste water often flows into estuaries, which causes oxygen depletion often leading to fish kills, algal blooms and a host of human health problems.¹⁰ In part, estuaries are productive ecosystems because they receive nutrients from the surrounding catchment. When the quantity of pollutant exceeds the filtration capacity they can be some of the most polluted ecosystems.¹¹

Estuary mouth breaching

Mouth manipulation is often required when inappropriate development has taken place inside the estuarine functional zone.⁴ Artificial breaching of an estuary results in a sudden and catastrophic lowering of water levels for aquatic plants and non-motile animals, which will disrupt natural functioning in the system. Non-managed breaching at an unsuitable time of year can be one of the most destructive effects on a system that may require some time for ecological balance to be restored.

Harvesting of resources

Illegal or irresponsible harvesting of resources can lead to loss of critical habitat and species, sometimes indirectly influencing the wellbeing and health of non-target species.

Poor agricultural practices

Removal of natural vegetation in favour of crops, grazing or housing often leads to soil erosion and mud deposition into rivers and estuaries. With less water flowing into estuaries, normal flushing of accumulated sediments is reduced and habitats are lost as estuaries shallow.

Habitat destruction

Irresponsible planning, design and placement of buildings, concreted embankments, jetties and bridges change water flow, cause erosion, loss of habitat and pollution in estuaries. Indirect effects of urbanisation such as the removal of sand for building can also have permanent and negative consequences on the ecology of the system as outlined in Section 9.6. The provision of sand through estuaries to the coast and offshore marine environment is critical to the services provided by these ecosystems.

Invasive species

Alien species are a threat to our estuaries; they disrupt the natural ecology and pose risks to the economy through damage to infrastructure or displacement of natural species.⁴ Invasive alien species in South African estuaries are found amongst the plants, fishes and invertebrates (Section 4.2). Our KZN example involves an invasion by the quilted melania (*Tarebia granifera*). *Tarebia* is a small snail whose natural

- Estuarine types: 1. Estuarine bay: uMhlathuze Estuary;
2. Permanently open estuary: uMlalazi Estuary; 3. River mouth:
Thukela Estuary; 4. Estuarine lake: Kosi Lake System;
5. Intermittently open estuary: Nhlabane Estuary.

Photos: Fiona MacKay and Bronwyn Goble



Estuarine health conditions for estuaries in KZN districts.					
KZN District Municipality	% of SA estuarine area	2011 Estuarine Health Condition ⁴			
		% of estuarine habitat total for district			
		Excellent	Good	Fair	Poor
Ugu (42)	1	0	26	72	2
eThekweni (16)	2	0	6	22	72
iLembe (10)	0	0	45	55	0
Uthungulu (5)	4	0	6	94	0
Umkhanyakude (4)	61	0	8	7	85
% of total SA estuarine habitat	68				

populations occur primarily in freshwaters of Southeast Asia, being transported via the aquarium trade.¹² First found in Zululand in 1999, this species is now in at least a third of KZN's estuaries.¹³ This spread is an indication of their success in being able to colonise coastal water under a range of salinity and temperature conditions.¹⁴

State of KZN estuaries

Some 30 years ago, all the estuaries of KZN were surveyed and respective health status reported on.^{15; 16; 17} Even then, it was found that many of the smaller intermittently open systems had lost habitat, and natural function was compromised due to unsuitable landuse and landuse practices. Since then KZN estuaries again have been evaluated on the basis of their geomorphology, water quality, aesthetics and fish populations.¹⁸ Most recently, eThekweni's 16 estuaries have had the most intensive health assessment using a combination of living and non-living parameters to evaluate pressures and estuarine responses.¹⁹ None of the 16 systems retain an "excellent" status; five are "highly degraded" and the remainder ranged "good" to "fair".

According to the latest health valuation of South Africa's estuaries in the National Biodiversity Assessment,¹ all of KZN estuaries are in "fair" to "poor" health.⁴ At least 20 (27%) of the provincial estuaries are degraded. Declaring a conservation protection status is one way in which we can reduce estuarine degradation and preserve what is still left of estuarine functional areas. To this end, nine of our 77 estuaries are partially protected but with no specific measures to protect or manage their catchments. Sixty one percent of the country's estuarine habitat is found within the Umkhanyakude District

on the KZN north coast, which equates to only four estuaries. Unfortunately, these are in a poor state.

Future challenges

A new recognised pressure identified by the National Biodiversity Assessment¹¹ deals with climate change challenges. The majority of pressures faced by KZN estuaries are known and understood to a certain extent. Yet those that are anticipated with a different climate regime (e.g. warmer temperatures, sea level rise and intensification of the hydrologic cycle) are going to increase existing pressures on estuaries as well as give rise to new problems. A US programme on Climate Ready Estuaries (CRE)²⁰ warns that existing management strategies and practices will require strengthening as climates change. It may not be sufficient to restore or even sustain present conditions. Sustainability might require innovative thinking such as creating and maintaining new estuarine environments.

KZN has some of South Africa's finest estuaries, which provide a suite of goods and services to the province's communities. However, estuaries are the most vulnerable of ecosystems and this is evident from the degraded state of so many KZN smaller estuaries.

It is clear from this section that the threats to estuaries are well understood but that political will and coordinated action are now urgently required. Most of all, the development of Estuarine Management Plans (EMPs) are an essential tool for the management of KZN's estuaries. ■

3.4 Coastal Lakes

South Africa has two sets of coastal lakes; a group of five in the Southern Cape and a northern series on the sandy coastal plain north of the Thukela River, in KZN.^{1,2} These 13 water bodies differ from the estuaries (see Section 3.3) along this coast in that they lack a surface water connection with the sea under current conditions and are highly variable in their origins and contemporary characteristics.

Although they differ in size, surface flows into these systems are low and they are primarily fed by ground water. This has implications for the water chemistries and consequently for the ecological characteristics, threats that face them and the way in which they and the surrounding landuse should be managed.

Lake origins and characteristics

While they represent a diverse group of water bodies, the coastal lakes of KZN have been little studied. All but Shengeza, Nsezi and Mangeza were probably estuarine in the early stages of their evolution when rising Holocene (Epoch: 11,500 yrs ago to present) sea levels flooded the river valleys along the coast.¹ The lakes were separated from their original estuaries by segmentation (Qubhu, Mzingazi, Zilonde) or by sedimentation (Mgobezeleni, Shazibe, Eteza, Bhangazi South). In the case of Sibaya, Bhangazi North and Nhlabane, isolation of the entire former estuary from the sea took place through dune accumulation that provided a direct physical barrier between the lake and the sea. This process of enclosure was incomplete at Nhlabane, until construction

Young fishers on the shores of Lake Nhlabane.



Photo: Fiona MacKay



of a barrage in 1977 which isolated the lake from its estuary. The lakes have different shapes, sizes (ranging from 7 to over 7 000 ha), depths (from less than a metre to 40 m) and volumes. They all have the characteristics of freshwater lakes but their coastal location causes their hydrological and chemical characteristics and their flora and fauna to differ from typical freshwater bodies.

Ecological function and value

Most of the KZN coastal lakes are characterised by sandy porous soils and a high surrounding water table. Their waters are therefore clear and nutrient poor. Biological productivity is driven by vegetation, either emergent forms in surrounding reed-banks and marshes, or submerged and floating forms in their shallow sections.^{3;4} The highest numbers of animals and most diverse communities occur in the marginal areas. This is likely due to the higher productivity in these areas as well as higher habitat diversity.

All of the coastal lakes are presently isolated from the sea but many (e.g. Mzingazi, Qubhu, Nhlabane) have their estuarine origins still reflected in the composition of their fauna.^{3;4} This was first documented four decades ago when extensive study of Lake Sibaya showed that it retained and supported a productive complement of species that had origins in estuarine and marine ecosystems.^{5;6;7} Now with studies having been done on several more coastal lakes we know that the structure of invertebrate communities (see Section 4.2) in particular largely reflects the degree to which marine connections have influenced salinity regimes even centuries and millennia before.^{3;8;9} What has enabled these estuarine relic animals to continue living in what are now freshwater systems? The answer lies in their physiology, which is centred around marked osmotic and ionic regulation capabilities – adaptations that are still seen in fauna that migrate between salt and freshwaters and vice versa.

Many of the crustaceans found in lake sediments or on plants at the lake edge are South African or regional endemics.^{3;9} In terms of numbers of these and other small invertebrates, KZN coastal lakes are comparable if not more productive, than the province's periodically closed estuaries.¹⁰

Several of the larger invertebrates that use these lakes still rely on a direct link with estuarine and marine environments. These include most notably the paddler crabs (*Varuna litterata*), incredible migrations of which are highlighted in Section 5.1.

Lakes that are still connected to the marine environment appear to be a preferred habitat for these crustaceans based on their relative abundance in these systems compared to estuaries and coastal rivers.¹¹ Other catadromous fauna in the lakes are freshwater *Macrobrachium* prawns. Although adults prefer an environment ranging from fresh to brackish water, early larval forms of many species of these prawns require water at least 20-25% as salty as seawater.¹²

The lakes support less diverse fish communities than estuaries¹³ or adjacent marine habitats.¹⁴ Most are characterised by a set of freshwater species, dominated by cichlids (Mozambique tilapia, banded tilapia and southern mouthbrooder). A set of species with estuarine affinities but which are capable of breeding in freshwaters is also common amongst the lakes and includes small pelagic forms such as estuarine roundherring and Knysna halfbeak as well as several goby species. In systems with marine connections fishes with stronger estuarine dependencies (glassies) and marine spawners such as mullet, pursemouths and stumpnose become abundant.¹¹ Subsistence fishing is conducted and recreational line fishing is popular on some systems, but overall, fish productivity in these lakes is unlikely to support fisheries of any significant size.

Influences and threats

Industry, mining, urbanisation, farming and forestry all pose present or future threats to KZN coastal lakes. These systems are places of aesthetic beauty and are increasingly used as areas for tourism development. Threats also arise from increased exploitation of living resources in these lakes (e.g. reeds, fish).

Because of the low productivity of these lakes they are sensitive to extractive use and water quality and quantity impacts.³ The naturally nutrient poor and clear waters are likely to be easily impacted by even moderate increases in nutrient loads, either from domestic or industrial effluent or agricultural runoff, which causes a marked change in the ecological nature of these unique systems. Similarly, activities surrounding these lakes that affect ground water need to be carefully managed. Forestry and mining for example has the potential to markedly reduce groundwater inputs into these lakes. Invasion by alien plants and animals has long been recognised as a threat¹⁵ and this has proved true in recent years particularly in systems near Richards Bay. Lakes here have also been impacted by the need for water to feed large-

Coastal lakes summary data ¹⁷ (unless indicated)				
Lake	Surface Area (Ha)	Maximum Depth (m)	Average Depth (m)	Potential Sea Connection
Zilonde	89	4	2	outflow
Shengeza	150	6	2	seepage
Sibaya	7 750	43	13	seepage
Shazibe	10			outflow
Mgobezeleni	100	5	3	outflow
Bhangazi (N)	170	8.4		seepage
Bhangazi (S)	337	5	2	outflow
Eteza	160	2.1		floodplain lake
Nhlabane	470	3.2 ¹⁶	1.8 ¹⁶	outflow
Nsezi ³	453	3	1.5	floodplain lake
Mzingazi	1 070	14	6	outflow
Qubhu	464	4		outflow
Mangeza ³	27	2	0.8	floodplain lake

scale industrial and urban development. Construction of barrages at their outlets, built in order to increase water yields has compromised connectivity in these systems, resulting in very marked losses in fish communities and some crustaceans.^{4; 11}

In a semi-arid country such as South Africa these coastal lakes are potentially valuable sources of freshwater. They also have intrinsic value and significance to coastal biodiversity and ecology. It is therefore imperative that these systems be well managed. ■

Significance and importance

On the Zululand coastal plain there are relatively few large rivers and the coastal reaches of these are typically characterised by extremely shallow waters in winter or flowing turbid waters in summer, both unsuitable for many of the species particular to the coastal lakes. Many species appear to have a high preference for coastal lake habitats, and several of these are of conservation significance as recognised by IUCN and SA Red Data listings.⁴ This suggests a potentially high conservation value of these systems and highlights the need for further research. Of all KZN lakes only Lake Sibaya has been well studied.

In addition, the low energy conditions in the lakes mean that they have a high potential as archives of past environmental change. Preliminary work on Lake Eteza and on the peats around Mgobezeleni for example, shows the high degree of preservation of sediments, pollen, diatoms and other indicators of past conditions.

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3.5 Mangroves

Mangroves occur on the eastern coastline of South Africa, from East London (Nahoon Estuary) to Kosi Bay, between mean sea level and mean highwater springtide level. They are inundated during high tide and exposed during low tide.

Mangrove with pneumatophore roots.



Photo: Fiona MacKay

These unique trees have special adaptations to cope with the harsh tidal and saline environment. They have pneumatophores (aerial) roots that allow them to survive in sediments that are poorly drained, saline, anoxic and rich in organic matter.

The South African populations represent the southernmost distribution of mangroves in Africa, and one of the highest

latitudes for this group in the world.

The white mangrove is the most widespread species, followed by the black mangrove and then the red mangrove. Tonga mangrove, Indian mangrove and cannonball mangrove only occur in the Kosi Estuary.

In South Africa, mangroves grow exclusively in the sheltered estuarine environment, occurring in 38 estuaries, 11 of which are in KZN. They occur in both permanently open estuaries as well as temporarily open/closed systems (see *Section 3.3*). However, longer periods of mouth closure (>56 % of the year) have a negative effect on the trees, as they are sensitive to prolonged inundation caused by higher water levels. The black mangrove is more tolerant of basal inundation than the other species, occurring in estuaries that are more frequently closed to the sea.

About mangroves

Mangrove forests in South Africa are generally small. In the past the majority of South African mangrove forests were between 0.5 and 10 ha,¹ but there have been a few very large forests, including Mhlathuze (652 ha), St Lucia (571 ha), Mlalazi (129 ha) and Durban Bay (200 ha) in KZN, with a reported total mangrove area of 1 058 ha for South Africa in 1982. In 2005, mangrove forest cover showed an

increase to 1 634.7 ha, with an increase of nearly 700 ha for the KZN coastline (from 786-1 391.1 ha). This growth is attributed to sedimentation and the increase in available habitat for mangrove colonisation, especially the pioneer white mangrove in the Mhlathuze Estuary.² The Mhlathuze River was canalised and a new mouth was constructed to compensate for the development of the Richards Bay harbour. The increase in intertidal habitat encouraged the spread of mangroves. In other estuaries that have increased sedimentation in their lower reaches, mangrove cover has also increased over time, e.g. Mlalazi and Mgeni.³ In the Kosi Bay tidal delta, the presence of subsistence fish traps set up by local communities have altered tidal flow and increased mangrove propagule deposition and germination.⁴ Mangroves often have fringing thickets of lagoon hibiscus and mangrove fern.

Although there was an increase in the total area covered by mangroves, a recent survey shows that there was a decrease in the number of estuaries in which mangrove stands were found in KZN, from 22-11.^{1;5} These losses were attributed to land being converted to sugarcane farms, and to road infrastructure developments, most notable the N2 Freeway.⁶ Natural events such as floods can also deposit silt, covering the base of the trees and causing die-back.

The most impacted system has been Durban Harbour, from which mangroves were physically removed during harbour construction and expansion, decreasing their area from 200 ha to just 15 ha.

Spatial distribution

Each of the mangrove species found in South Africa has a different distribution pattern. The white mangrove is the most widespread and common of all the species; it is a pioneer species occupying the lower intertidal zone. The black mangrove is also common along the KZN coast, occurring in the higher intertidal area. Although not considered to be a pioneer, it has been found to colonise some temporarily open/closed systems such as the Mgababa, Mzamba and Mtentu estuaries. The red mangrove generally forms large dense stands on the banks of creeks and streams that feed into estuaries. The Tonga mangrove found at Kosi Bay is at its most southern distribution, while the Indian mangrove also only occurs at Kosi, being inundated at spring high tide. The cannonball mangrove is very rarely encountered in South Africa, with only one specimen recorded in the Kosi system.

Importance of mangroves to the KZN coast

Globally, mangrove forests provide protection for natural coastal habitats and the human areas against storms and floods. Within South Africa however, mangroves are generally found in estuaries and consequently their capacity to protect the shoreline is limited. Indirectly, coastal developments along estuaries do benefit from mangroves and the protection they provide during severe storm and sea conditions. It is recommended that a mangrove buffer zone of 25 m be maintained to ensure that adequate protection can be provided by the mangroves.⁷

The ecosystem services provided by intact mangroves are of importance, particularly their regulation of sediment processes and organic export to the ocean. Should these services be greatly modified, the cascading effects on the entire ecosystem could be severe. Durban Bay, for example, has had a significant loss in mangroves due to harbour development, urbanisation, eutrophication and chemical and organic pollution, and consequently the entire estuary is now classified as highly degraded.^{8; 9; 10}

Whilst it may be comforting to know that the total area of mangroves in KZN has marginally increased in recent times, it is of concern that their geographic distribution has been reduced as manifest by their local extinction in a number of estuaries. Changes in freshwater inflow to estuaries, increased sedimentation due to land degradation and transformation, and prolonged closed mouth conditions all negatively affect mangroves.

South African mangroves are at the limits of their latitudinal distribution, and thus are even more susceptible to anthropogenic impacts. Changing the size and structure of mangrove forests decreases their natural ability to recruit and regenerate, thereby further decreasing the ecosystem services provided by these systems. Protection of existing stands of mangroves is essential if people of KZN are to benefit from their goods and services. ■

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3.6 Wetlands

Historically, wetlands were often seen to be synonymous with wastelands and smelly bogs, marshlands, fens and swamps. As a result, many wetlands were drained, filled in or otherwise destroyed, often in support of “development”. But over time, these destroyed wetlands began to manifest themselves in a cascade of environmental perturbations, most notably biodiversity loss and water quality impairments.

It was only in the mid-1970s that there was formal recognition of the intrinsically high value of wetlands when nations subscribed to RAMSAR, the International Convention on Wetlands, which is an intergovernmental convention that collaborates with its members in the listing and consequent protecting of key wetlands or RAMSAR sites.¹ The Convention's mission is “the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.” Established in 1971 in the Iranian town of Ramsar, the Convention presently has 168

contracting country parties, listing 2161 sites of global importance amounting to more than 200 million hectares of protected wetland.¹

Today wetlands are acknowledged for their value and role in delivering environmental goods and services. Fortunately, KZN is endowed with some excellent wetlands and thanks to several past scientists and champions of wetlands, several are well protected and valued.

What is a wetland?

Wetlands are formally defined by the South African *National Water Act* and the *ICM Act* as “land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which in normal normal circumstances supports a vegetation typically adapted to life in saturated soil.”

Aerial view of wetlands around St Lucia.

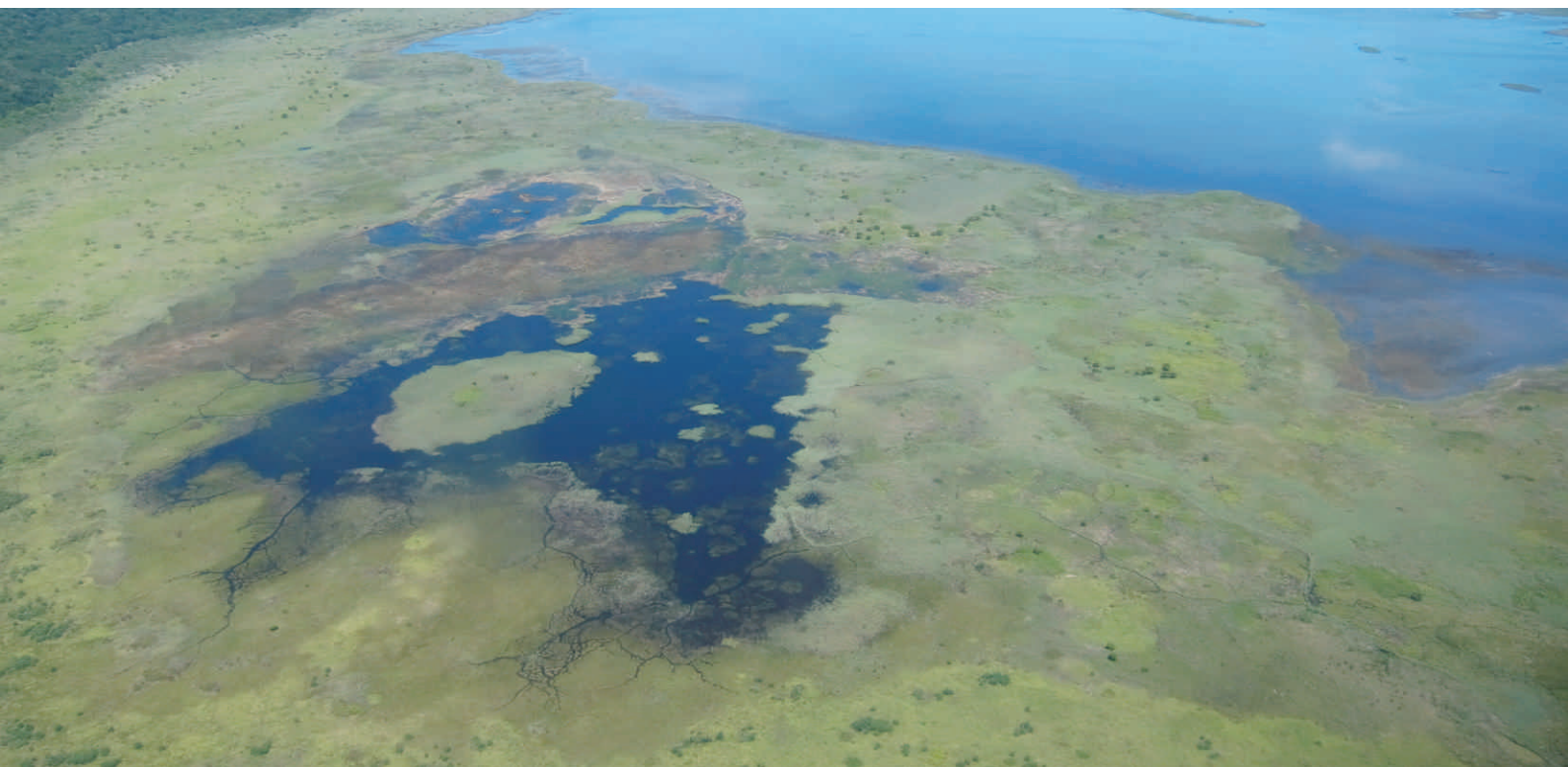


Photo: Fiona MacKay

Typically wetlands thus include riparian river banks, springs, marshes, bogs, floodplains, vleis, seeps and lakes. RAMSAR broadly defines wetlands to include; intertidal coastal areas such as estuaries, mangroves, deltas, tidal flats, salt marshes, intertidal coral reefs and tidal nearshore marine areas. Human-made sites can be included in some cases, such as mariculture ponds, reservoirs and port developments. However for the purpose of describing true wetlands, the *National Water Act* and *ICM Act* definition is adhered to in South Africa.

Wetlands have been considered the third most important life support system on earth. They can function as vast sponge-like reservoirs, filtering natural water thereby moderating both quality and quantity of water. They attenuate floods, reduce erosion, trap sediments, recycle nutrients, oxygenate the water and recharge groundwater.

Wetland goods and services

Besides their hydrological attributes there are other direct goods and services based on their rich biodiversity. Wetlands provide reeds, grasses and mangrove for housing; they harbour organisms with medicinal potential and can serve as tourism destinations based on their exceptional avifauna, frog and plant species and other unique wildlife.^{2;3} Wetlands, including wetlands located far inland, are especially important for coastal environments. The regulation of water quality and flow to downstream estuaries, the trapping of silt to prevent smothering of downstream ecosystems and the bio-degradation of pollutants are but some examples.

Protection of KZN's wetlands

In the 1980s, the then Natal Town and Regional Planning Commission (NTRPC) undertook a detailed survey and assessment of the province's wetlands.⁴ A total of ten major river catchments were investigated, yielding 24 priority wetlands totalling 1 114 km². Many were not protected and many were located on private lands. Subsequently a wetlands policy was developed which aimed at wetlands protection and restoration, providing incentives for protection and encouraging sustainable use of wetlands resources.⁵

This initiative was followed by greater national government action and engagement with RAMSAR.³ South Africa has some 740 identifiable wetlands, totalling about 12 000 km²,

although only 18% are under some form of protection. It has been estimated that more than 50% of the countries' wetlands have already been destroyed and lost. In KZN an estimated 8 101 km² are now classed as wetland, equal to 8.6% of the Province's land area, yet only 477 km² is under protection (less than 6%). Nevertheless, there has been a credible attempt to protect at least some of the most important wetlands.

Since the NTRPC survey several wetlands now enjoy protection and Ramsar status. South Africa currently has 21 declared Ramsar sites amounting to some 551 km² of protected wetland. Eight of these are located in KZN accounting for 86 % of South Africa's declared wetlands area.

Ramsar Wetlands of KZN

There are three key RAMSAR sites within the KZN coastal zone: Kosi Bay, Lake Sibaya and the Lake St Lucia System. Kosi Bay (10 982 ha) is located on the far northern coast of KZN. This system comprises of four deep interconnected estuarine lakes (*Section 3.3*), which are subject to tidal influence, and three extensive swamp forests. Fresh water permeates from groundwater but is also derived from three small riverine catchments. The area offers rich biodiversity and generates considerable local food security. This system falls within the iSimangaliso Wetland Park, a world heritage site, which offers it formal protection.¹

Lake Sibaya (7 750 ha) is the largest natural freshwater lake in South Africa (*Section 3.4*), separated from the ocean by forested dunes, and includes areas of swamp forest and wet grassland. A large variety of endangered or endemic species of reptiles, fish, birds, mammals and plants occur in the area, including relics from geological past connection to the sea. The lake's crystal clear water is uniquely sustained by a small local catchment feeding groundwater and is not fed by rivers. It provides fresh water to local communities. This system falls within the iSimangaliso Wetland Park, a world heritage site, which offers it formal protection.¹

The St Lucia System (155 500 ha) is Africa's largest estuary with a unique assemblage of coastal wetlands and habitat types. It receives water from at least six rivers including the Mfolozi and Mkuze, albeit variably because of droughts and agricultural water abstraction. It is also rich with avifauna and an abundance of flamingos, pelicans, crocodile and hippopotamus, making it an important tourist destination. This system is formally protected as it falls within the iSimangaliso Wetland Park.¹





A wetland on the eastern shores of Lake St Lucia.

Non-protected wetlands

While these large important wetlands are formally protected by RAMSAR, it is important to note that there are a magnitude of smaller wetlands along the KZN coast that play a critical ecological role, most of which are afforded little or no protection. The value of these systems is often forgotten as there are drained for farmlands and filled for development.

KZN is endowed with numerous large and small wetlands, some protected and declared, others not. Wetlands help to protect coastal ecosystems while delivering valuable environmental goods and services to diverse communities. Fortunately, the largest are formally protected as RAMSAR sites. Their continued survival will depend on enlightened administrators as well as greater public interest and awareness of the value of vleis, swamps, marshes and other forms of wetlands. ■

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3.7 Rocky Shores

The shoreline is often called the littoral zone, which embraces the area between the highest tidal reach and the lowest ebb; more precisely defined as the intertidal zone. This is one of the most physically volatile zones with twice daily alternating tidal inundation and exposure, huge temperature fluctuations, dehydration and constant violent wave action. While the littoral zone in eastern Africa can comprise a number of ecosystem types, along the KZN coast this is essentially either sandy beach or rocky shore.

Rocky shores account for about 20% of the coast and are mainly located on the southern and central coast. They are composed of dolerite, granite, as well as Quaternary, Ordovician and Ecca sandstone.^{1;2;3} North of Cape Vidal, the rocky shores are interspersed between long stretches of sandy beach and are composed of Quaternary sandstone.^{1;2;3} As on other rocky shores, the interplay of physical stresses and biological processes have resulted in a highly diverse biota, displaying various adaptations to intertidal life. Because the physical stresses vary as one moves from low to high points in the intertidal zone, so the biota vary in regular bands across the rocky shore with the hardiest organisms nearest the high water limits. This vertical zonation is a characteristic of rocky shores.⁴

Rocky shores in KZN span two biogeographical regions: the southern warm-temperate Natal bioregion and the northern subtropical Delagoa region.^{3;5} The rocky shores of the Natal bioregion are dominated by the brown mussel, while in the more tropical Delagoa region, redbait and the Natal reef-worm occur in much higher densities, especially in the lower intertidal zone.³ This might be due to the significantly higher riverine input in the Natal bioregion.³ Intertidal invertebrates are subject to high levels of subsistence harvesting in the

Delagoa region, whereas intertidal harvesting in the Natal region is lower, being mainly undertaken by recreational fisheries.³

Rocky shore zonation

High on the shore, the supra-littoral or littorina zone is the area usually moistened by sea spray, only occasionally being washed by waves during storms or spring high tides.^{3;6} Few species can tolerate the temperature extremes, high light intensity and exposure experienced in this zone.^{3;4;6} In KZN, this zone is dominated by the very small *Littorina* spp snails.

Rocky shores of KZN.



Photo: Judy Mann



Unique to the East Coast of South Africa, the Natal rock oyster usually occurs in a band directly below the littorina zone, forming an identifiable oyster belt.^{3; 4; 6}

Below the littorina zone and oyster belt lies the mid-littoral zone which is subject to alternating periods of exposure and submersion by the tides, resulting in an increase in species diversity.^{3; 4; 6} Temperature extremes and exposure times decrease, while wave energy and the possibility of sand inundation increases.^{3; 4; 6} Notable in this zone are species well adapted to withstanding strong wave action by being of low profile and very tightly adhering to their rocky substrate. Here we find a diversity of barnacle and limpet species as well as occasional dense beds of tube worms. Here too we can find species of crabs, especially the Natal rock crab. Towards the lower part of the mid-littoral zone, densities increase where fauna and flora compete for space. The main competitors here are the beds of brightly coloured anemone-like zoanthids, brown mussels and seaweeds: especially tufts of coralline seaweeds and beds of the common *Hypnea spp.*^{4; 6}

Directly below the mid-littoral zone, is the infra-littoral fringe, which is only exposed during spring tide lows, and where wave intensity is at its highest; consequently species numbers are lower.⁴ This infra-littoral fringe is home to the commonly known clusters of redbait, often found in the lee of wave action or in more sheltered areas of this zone. Here too are found the commercially important Cape rock oyster. However, in most places, the infra-littoral fringe is dominated by a wide variety of seaweeds, many of which generate nutrients through photosynthesis and are pioneers of reef recolonisation.¹

Although corallines often dominate the seaweeds (Section 4.1), the diversity amongst green, brown and red seaweeds is striking. Moreover, there is considerable variance in seaweed composition from north to south among the KZN coast, with a progressive integration of more tropical species amongst temperate varieties. The tropical varieties north of St Lucia comprise low tufts with an amazing diversity of up to 100 species found in a single 1.5 m² section of reef. These short and dense turfs of seaweed in the infra-littoral fringe,⁶ are heavily grazed by fish and other animals but are known to have exceptionally high growth rates, thereby contributing a source of organic nutrients to the rocky shore ecosystem and beyond. Larger seaweed species include beds of the green multi-species *Caulerpa* and the brown seaweeds *Sargassum* (air-bladders) and turkey-tail characteristic of KZN rocky shores.⁶

Larger, non-sessile animals also occur in this wave exposed zone, although their presence is clearly influenced by the state of tides. Sea urchins, sea stars, brittle stars and sea cucumbers all thrive in this zone where most graze on the seaweeds, although often located in sheltered sections away from fierce wave action. Octopus, several species of crab and at least three species of valuable rock lobster may also be found holed up in this zone.⁷

Aside from their zonation, rocky shores may also be enriched by tidal and sheltered pools. These are important nursery areas, providing protection and food for juvenile fish, crustaceans and other forms of marine life.⁸ Notable groups of fishes include the blennies, gobies, damselfishes and the juveniles of blacktail, stumpnose, flagtail and occasionally butterflyfishes.

Threats to rocky shores

The main threat to KZN rocky shores, as with many ecosystems, is coastal development. It can lead to habitat loss and degradation, decreased biodiversity, disrupt ecosystem functioning and decrease the resilience of the ecosystems.⁵ High levels of marine pollution (Section 9.3) are associated with waste discharges derived from coastal urbanization and development. Toxic bioaccumulation of waste water contaminants can occur in filter feeding organisms such as mussel and oysters, and subsequently move higher up in the food chain.⁹ Excessively high levels of exploitation using inappropriate gear pose a threat, especially as it can upset the succession of biota resulting in stands of seaweeds that were once rich beds of mussels.

Climate change and episodic events may also impact on the rocky shore biota. Sand inundation and temperature extremes are of special concern to this rich and diverse ecosystem.

It is evident that rocky shores represent an important and highly vulnerable part of the coastal zone. Species here are specially adapted to this turbulent environment which is subject to a range of physical stressors. Yet the rocky shore biota plays an important role in organic nutrient generation, cycling and biological interactions, which drive a highly diverse community of fauna and flora. For this reason these systems need careful protection in order to ensure long-term sustainability and productivity. ■

3.8 Subtidal Reefs

The subtidal reefs of KZN can be partitioned into two groups: coral reefs and rocky reefs. The coral reefs are located in the northern subtropical region of the province, where the warm climate and clear water have resulted in rich coral growth and abundant fish life. The rocky reefs are scattered intermittently along the rest of the KZN coast, with the most extensive reef structures found south of Durban, approximately 5 km offshore of the Umkomaas River.

Coral reefs

Coral reefs are limestone (calcium carbonate) structures that have been created over millions of years. The basic building

blocks are tiny animals called coral polyps that are cup-shaped and have tentacles surrounding a central mouth. Coral polyps grow in clusters called colonies. These colonies grow continually as new polyps attach to the existing structure.

There are two main types of corals: hard and soft corals. Hard corals are termed reef-building corals because their calcium carbonate skeletons form the foundation of the reef. In contrast, soft corals do not have a skeleton, but tiny needle-like splinters called sclerites that are embedded in their tissue. The sclerites are widely-spaced which allows the colonies to bend and sway in the current. Hard corals extract calcium compounds from the surrounding seawater to make their limestone skeletons.¹ After centuries of growth, coral

Coral reefs of KZN.



Photo: Camilla Floros



skeletons accumulate to form large, complex structures or reefs that provide a myriad of habitat types for thousands of fish and invertebrate species.

Coral polyps owe their ability to create such prolific structures to microscopic, symbiotic algae that live within their tissue. Through photosynthesis, these tiny algae (zooxanthellae) provide approximately 90% of the nutrients needed by the coral polyps for reproduction and growth.¹ Corals grow in water that contains relatively few nutrients, thus the zooxanthellae are vital for their survival. Because the zooxanthellae depend on sunlight for photosynthesis, reef-building corals are found in shallow, clear water. Corals also require tropical or sub-tropical temperatures for growth.²

Photo: Camilla Floros



Coral reefs are one of the most diverse ecosystems on earth, despite occupying less than 0.1% of the Earth's surface,³ with a diverse range of species relying on them as a source of food and shelter.

The coral reefs in South Africa are classified as subtropical reefs, because they occur at the southern limits of coral distribution, only being found along the Maputaland coast.⁴ They extend for approximately 150 km along the coast from the southern Mozambique border near Kosi Bay to Leven Point, 12 km north of Cape Vidal.⁵ The Maputaland coral reef system can be geographically separated into three reef complexes: the Northern Reef Complex, the Central Reef Complex and the Southern Reef Complex.⁶ They are classified as patch reefs and consist of coral communities that have colonized fossilized sand dunes that were submerged during the most recent rise in sea level.⁵

The Maputaland coral reefs are different from tropical coral reefs in that they are on average deeper (9-30 m) and geologically younger, having been aged at 3 870-5 000 years BP.⁵ Their relatively young age and high latitudinal location have resulted in coral communities that grow as a thin carpet over the underlying bedrock, unlike their tropical counterparts, which grow into a thick base of coral skeletons. Nevertheless, corals are the dominant life form on the reefs and have created an ecosystem that is rich in species diversity and abundance.⁴

Worldwide, there are about 735 species of hard corals, of which 96 species have been recorded on South African reefs, compared to the 40 species of soft coral reported from the same area.⁷ The coral communities consist of a rich mix of Indo-Pacific species, and coral cover is between 50-60% on most of the shallow reefs.⁶ There are at least 500 species of reef-associated fish, which are also of Indo-Pacific origin. A number of endemic fish and coral species are found in these reef communities, including the tiger rockcod and several soft corals.⁷

Value of coral reefs

Coral reefs are valuable ecosystems, providing ecosystem services and shore protection, through the absorbption of wave energy.³ Coral reefs provide habitat for a quarter of

Acropora digitata, a coral found in KZN waters.

all the fish species in the ocean.⁸ In total, one billion people are estimated to depend on coral reefs for food and income.⁹ The global economic value of these services is estimated to be at least US\$ 375 billion per year.³ Tourism generated through coral reefs is estimated at several billion dollars a year and numerous island nations depend solely on coral reef-orientated tourism for their economic growth.¹⁰

In KZN, coral reefs are important for tourism and associated economic activity. The reefs at Sodwana Bay have a long history of exploitation through recreational fishing and SCUBA diving. These activities provide valuable economic benefit to the local communities in the Sodwana Bay area through employment creation.¹¹

Threats to coral reefs

Despite the immense value of these ecosystems, coral reefs throughout the world are being degraded at a rapid rate as a result of human-related disturbances that vary in intensity and scale.⁸ Threats such as overexploitation of fish species, destructive fishing practices (e.g. dynamite fishing), coastal development and pollution all affect coral reefs at the local to regional scale, while phenomena such as coral bleaching and ocean acidification threaten coral reefs on a global scale.¹²

At present, it is estimated that 20% of the world's coral reefs have been destroyed and a further 24% are under imminent risk of collapse.¹³ KZN is fortunate that its coral reefs are situated within two longstanding MPAs (MPAs are described in *Section 10.4*) that form the marine component of the iSimangaliso Wetland Park, a world heritage site.

Rocky reefs

Moving southwards from the Maputaland region, the coral reefs give way to rocky reefs, which, besides a complex off Port Durnford, occur sporadically along the coast until just south of Durban, where Aliwal Shoal, Landers Reef, and Protea Banks are located, approximately 5 km offshore and running parallel to the coast. These three reef complexes result in a series of prominent rocky reefs that vary in length from 200 m to 1.5 km, and are found at depths of between 10 m and 25 m.¹⁴ Geologically, these reefs are similar to the Maputaland reefs, consisting of submerged fossilized sand dunes. However, the topography is more dramatic with rugged rock formations such as pinnacles, caves, ledges, amphitheatres and gullies.¹⁵

The benthic communities on the rocky reefs also differ substantially to the Maputaland reefs and are characterized by more temperate communities.^{16, 17} Algae are the dominant benthic group on the reefs, followed closely by sponges, ascidians and feather stars.¹⁸ Hard and soft corals also occur on the reefs, but in lower species numbers. Nevertheless, on certain exposed pinnacles, the thistle soft coral can be particularly abundant and on the deeper reefs, large black coral trees can grow as large as 2 m. An array of other benthic species also flourish on the reefs such as shrimps, starfish, clams, cowries, nudibranchs, anemones and crabs, which use the abundant rocky outcrops, crevices and caves as refugia.¹⁹

Value of rocky reefs

The fish life found on these reefs is also diverse as discussed in *Section 4.4*, with an estimated 500 reef-associated species recorded to date. The fish communities consist of a mix of tropical, subtropical and warm temperate species and many species are present in high abundance.¹⁶ Pelagic fish and sharks are particularly common on the reefs, due to their considerable distance from shore. The ample fish life attracts a range of recreational activities, detailed in *Section 7.4*, and the reefs are internationally known for shark encounters, which draw visitors all year round.²⁰ These activities on the reefs bring valuable revenue to the small coastal towns in their vicinity, which have grown considerably since they were first discovered in the 1980s.¹⁶ Reef-user conflicts occur due to the diverse services that these reefs offer, and increased concern for the reef biota, particularly on Aliwal Shoal, resulted in the establishment of the Aliwal Shoal Marine Protected Area (MPA) in 2004. The MPA was established to protect and conserve the marine ecosystem around Aliwal Shoal, reducing user conflict and promoting ecotourism.²⁰ Landers Reef and Protea Banks are not within the MPA boundaries; however, the levels of user pressure are not as high as on Aliwal Shoal.

The KZN coast has a diverse and rich assemblage of reefs, including the southernmost coral reefs in the Indian Ocean. Our reefs provide a suite of ecosystem goods and services from food security and socio-economic benefits derived from tourism to unique biodiversity resources. While we take pride in their considerable levels of MPA protection, these fragile ecosystems still require wise management to ensure sustainability. ■



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3.9 Subtidal Soft Sediments

Generally what is considered “marine” relative to “coastal” is separated at the 30m depth contour.¹ Marine habitats extend from the midshelf and beyond into the abyss. Contiguous from estuaries to the coast, in- and offshore to the KZN shelf edge at 20 m is a habitat that is always covered by water (subtidal) and characterised by soft sediment at the bottom.

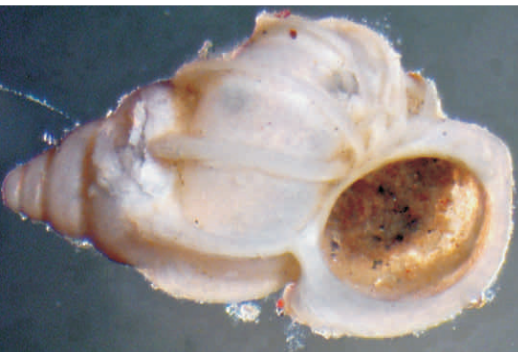
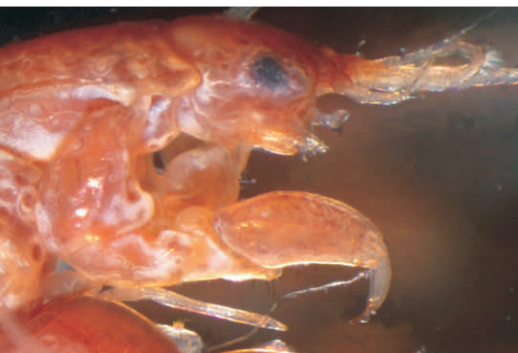
Coastal and marine sediments, ranging from large gravel elements to fine muds, occupy over 70% of the seafloor and constitute one of the largest habitats on earth.^{2;3} This is a three

dimensional habitat, due in part to its relatively unconsolidated nature as opposed to rocky and coral reef counterparts, where biota are confined to hard, impermeable substrates.^{4;5}

Distribution and nature of soft sediments

In KZN the most significant subtidal soft sediment habitat is found on the continental shelf between Richards Bay and Durban. This uncharacteristically wide shelf section, known as the Natal Bight, has been identified as being highly productive due

Types of animals found in or on the KZN seafloor.



Photos: Fiona MacKay

to the influence of local oceanographic features as well as out-welling via the Thukela, one of the largest rivers in the country.^{6; 7}

The African Coelacanth Ecosystem Programme (ACEP) has supported research into this poorly studied area with preliminary findings showing a wealth of marine invertebrate species, particularly around Durban and Thukela, some of which may be new to science.⁸

Influences on ecology

Although the seafloor is considered to be one habitat type, an assortment of micro-habitats can be discerned because the physical nature of the seabed is defined by geological origin, sediment type, topography, depth, light, temperature and effects of wave and tide energy.⁹ The nature of the sediment is also determined by some coastal determinants such as estuarine and river outflow bringing in new sediment types and nutrients.^{10; 11; 12} These combined characteristics influence the type of bottom life that can occupy this vast seascape.

Ecology of soft sediments

While most of the shelf area lies below the photic zone (where light can penetrate), the soft sediment environments support high species diversity. Small macrobenthic invertebrates (<1mm) that live in the sediments are a dominant component as they are secondary producers.^{10; 11; 13; 14; 15; 16} They also have functional roles crucial to many important ecosystem processes such as promoting decomposition, nutrient recycling and transferring energy to other food web components.^{10; 14; 15; 16; 17} In KZN on the inner shelf of the central Natal Bight (10-50 m), this ecosystem supports the only commercial, multispecies crustacean bottom trawl fishery in the country,^{18; 19; 20} the main targets being white, brown and tiger prawn.

Habitat threats

Bottom trawling is a fishing method where large bag-shaped nets are pulled along the seafloor, dragging and digging into soft sediments resulting in habitat destruction. Bottom-dwelling fauna can take up to five years or more to recover from this activity²¹ resulting in areas that never get a chance

to return to their natural state. Trawl fishing is non-targeted and thus many other types of bottom-associated marine life are swept up,²² although efforts are being made to reduce this collateral effect on the KZN shelf.²³

Close to the coast, pollution effects (*Section 9.3*) can alter subtidal soft sediment ecology through land derived nutrients causing eutrophication and even anoxia in shallow waters. The longest seabed ecology studies have happened in localised areas of interest on the Natal Bight, namely Durban and Richards Bay where the cities' effluents are being discharged to the sea through offshore pipeline systems.²⁴ Sewage effects on the seabed appears to increase productivity of animals there, but with time only hardy, tolerant species remain in sediments that become anaerobic.

Soft sediments are the dominant benthic marine habitat found worldwide. Many different organisms live there and many provide valuable economic services (e.g. fisheries). The properties of the seabed, including the sediments, have strong effects on the distribution and abundance of species, as do the impacts from humans. ■

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