



9 Pressures and Threats

9

Pressures and Threats

The coastal environment is under constant pressure from coastal development, extraction of resources, erosion and pollution, to name a few. These in turn threaten coastal habitats, biodiversity and the sustainability of coastal resources. Potentially, these are exacerbated by the threats posed by climate change. This section provides an overview of some of the main pressures and threats facing the KZN coastal environment.

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9.1 Loss of Coastal and Marine Biodiversity

The Earth's biosphere comprises a marvellous array of living organisms. This diversity of life, and specifically the term biodiversity, describes the richness or variety of organisms living on Earth, in an ecosystem, habitat, niche or any defined area. Biodiversity forms the basis of life on earth and sustains human well-being through provisioning (food security), regulating (waste assimilation), and cultural ecosystem services that provide recreational and spiritual benefits. Primary production and nutrient cycling are also essential life support processes attributable to biodiversity.¹

Biodiversity is intimately dependent on a particular supporting ecosystem or habitat, such that the loss of, or damage to an ecosystem is a primary cause of biodiversity loss. The magnitude of biodiversity varies between ecosystems with tropical forests, coastal shorelines and coral reefs being amongst the richest. Yet species in these

systems are often highly specialised and adapted to narrow habitat niches, making them vulnerable to change. Such change can result in biodiversity loss where the mix of species is altered, their numbers reduced or in extreme cases, extinction occurs.² Biodiversity loss invariably also represents a reduction in genetic diversity within populations.

There are many threats to biodiversity and habitat loss, not all directly attributable to human activities. A number of naturally occurring events such as hurricanes, storm surges, tsunamis and eruptions can cause, albeit temporarily, massive loss of habitat and disruption to the abundance and life cycles of species. However, human activities generally result in more significant, persistent and permanent impacts.³

The impact of coastal habitat and biodiversity loss is far reaching, affecting the provision of ecosystem goods and services.⁴

Land cover change and mono cropping are two of the biggest drivers of biodiversity loss.



Photo: ORI



Human drivers of habitat change

There are a number of activities that can cause habitat change and consequent biodiversity loss, including land cover change, water abstraction and pollution. Some culprits are discussed here.

Land cover change as a result of human activities is one of the most significant drivers of habitat loss. Coastal development (see *Section 9.2*) sees the replacement of natural habitats by settlements, harbours, croplands and plantations, mines and quarries and other human constructions.⁵ In KZN, extensive natural land in coastal regions and catchments has been converted to sugar cane, especially between the 1950s and 1980s.¹

Port development has destroyed significant and sensitive coastal habitats, including seagrass meadows, mangrove forests and intertidal soft sediment banks. The removal of seagrass from Richards Bay compromised the nursery function of juvenile stumpnose, a fact later detected in much lower catches of this popular linefish.⁶

Deforestation, sometimes far from the coast, often results in erosion thereby increasing sediment loads so that estuaries and offshore regions become more turbid. Increased turbidity reduces the penetration of much needed sunlight, particularly in shallow waters, affecting a range of plant species and consequently their productivity.³ Increased turbidity also affects the mix of fish and invertebrate species, for example in compromising visual predators, hence altering the natural balance of the coastal environment.

In many parts of the world, aquaculture has contributed to enormous habitat and biodiversity loss. Invariably located in floodplains and estuaries, huge ponds are built at the expense of rich mangrove forests or seagrass meadows. This in turn has compromised the nursery potential for wild stocks and their fisheries, thereby questioning the sustainability of numerous aquaculture facilities. Although aquaculture in KZN is not of such scale, the two established facilities are also located in sensitive estuaries.

Human activities generate a plethora of waste types, including hydrocarbons, fertilizers, nitrates and other chemical effluents that can form part of runoff which ultimately reaches the coastal and marine environment. Toxic runoff impacts the life cycles of many species and hence the biodiversity of coastal ecosystems.³

Inland dams, water abstraction and canalization of water courses for agriculture often decrease freshwater flow to estuaries, increasing the salinity of coastal waters resulting in an alteration of these habitats.³ A most striking example of this has been the degradation of the St Lucia system over many years, having been starved of natural fresh water inflow with huge destruction and alterations in habitat and biodiversity. Fluctuating levels of extreme salinity decimated biodiversity, while extended periods of mouth closure impacted on St Lucia's nursery function as reflected in reduced marine harvests of prawns and several linefish species.

It is estimated that between 1960 and 2000, reservoir storage capacity in KZN quadrupled. Dams also trap and retain natural nutrients; they cut off fish migration routes and drown habitats.^{3;5} Overuse of groundwater aquifers for domestic, agricultural, and industrial purposes affects the natural balance of groundwater and decreases ground water seepage to the coast and its sensitive coastal lakes.²

Decline of coastal ecosystems

More than half of the 14 biomes assessed by the Millennium Ecosystem Assessment have experienced a 20%-50% conversion from natural to human use.¹ The global loss of threatened coastal ecosystems is estimated at between 4% and 9% annually. For corals this is approximately 1%-2% each year, for saltmarshes 1%-3% each year and for mangroves between 2% and 5% a year. To put this into perspective, these losses are more rapid than the global loss of tropical forests, estimated at 0.5% per year.⁴ For KZN, it is estimated that 50% of the coastal environment has been transformed as a result of human activities. Of concern, research shows that areas that experience transformation of between 30% and 50% will see a decline in habitat connectivity affecting population dynamics and interactions.⁷

Should current transformation trends continue, it is estimated that by 2050, 78% of the entire province's landscape will be in a transformed state and the ability of the landscape to support biodiversity will be severely compromised.⁸ This is of concern for as this may lead to higher habitat fragmentation through the complete loss of habitats, which effects the survival of remaining species.² It is imperative that the habitats be conserved in order to maintain ecological functioning and preservation of biodiversity.

What action can be taken?

In order to protect habitats and their biodiversity it is necessary to strengthen environmental planning tools and focus on the conservation and sustainable use of biodiversity and ecosystem services. Not all development needs to be impeded and wise planning and management can mitigate many habitat and biodiversity threats. For example, ports can be designed to include natural habitats. Similarly, coastal development should be in development nodes rather than the ribbon-like development evident.



The establishment and management of appropriate Protected Areas is of great potential benefit to protect biodiversity. Current KZN marine and coastal Protected Areas are not all ideally located in the context of habitat and species diversity, suggesting a review may be justified (see *Section 10.4*). In several cases the MPA management plans and structures are inadequate to address issues such as inappropriate settlement, illegal harvesting, unsustainable tourism and impacts of invasive species. The nature and intensity of exploitation should be closely managed in order to ensure the recovery of individual species.

Genetic diversity needs to feature more prominently in conservation planning amid increasing concern that the range of genetic diversity is decreasing. Ecosystem restoration is a valuable management tool, a common practice in many countries, and certain to become an increasingly important option in coastal KZN as ecosystems become degraded.¹

While humanity has benefited from the exploitation of biodiversity and the conversion of natural systems to human-dominated systems, these have caused losses in biodiversity and changes in these very ecosystem services. This has led to some communities experiencing declining well-being and poverty as resources are no longer available.¹

Loss of biological diversity can be seen in many forms, the most dramatic being the extinction of species. Extinction rates depend on the rate of environmental change and the ability of species to adapt to these changes.⁵ It is therefore important that we understand the environmental implications of our actions so as to mitigate and minimise these. ■

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9.2 Development Pressure

Coastal lands are used for a range of activities, including human settlement, agriculture, trade and user amenities. They are also used as a base for a range of maritime activities such as shipping, fishing and mining. The coast is a favoured residential and holiday destination, resulting in it being under constant pressure for development.

As a result, development is taking place rapidly along the coast, particularly urban development. In fact, 14 of the world's 17 largest cities are located along the coast, and 40% of cities with populations greater than 1 million people are located near the coast.¹ This ever-increasing development pressure brings with it a number of impacts on the coastal environment. In addition, human settlements are often

concentrated around well-watered areas such as rivers and sensitive estuaries.² These settlements undoubtedly affect their surroundings through processes of production, consumption and disposal. This is further exacerbated by the fact that uses are not always compatible and often result in user conflicts and further pressure on the coastal environment.

Coastal development in KZN

Historically, coastal development was closely linked to the availability of existing infrastructure and services. As a result, coastal development in South Africa was concentrated in KZN and the Western Cape, where road and rail networks had been

New development in an already developed coastal zone, Durban.



Photo: Bronwyn Goble

established.³ This pressure is prominent along the KZN coast, which is considered to be one of the most densely populated coastal areas in mainland Africa.⁴

Development is driven by a number of economic, social and legislative drivers, thus development pressure is variable over time and space.⁵ In KZN, historical coastal development was concentrated along the southern sections of coast, being driven by its relative proximity to the Witwatersrand, ease of access due to existing road infrastructure, its safe beaches and year-round warm oceans and climate. It developed primarily as a middle-class, domestic and mostly white, tourist destination.⁶ While this development flourished along the south coast, the north coast remained virtually undeveloped and in a natural state. This can, in part, be attributed to the fact that much of the north coast (21%) was declared to be a “homeland area” and was inaccessible via the major road networks.⁷

Homeland areas in KZN, as with the rest of South Africa, have had a significant impact on historical spatial planning. Homeland areas were derived during the apartheid era, whereby towns and settlement patterns were structured based on race and class.

Since the 1970s, development along the coast has increased, driven by service industries, tourism, resort development and activities related to import/export from ports.² Evidence of this can be seen along the KZN north coast, with the opening of the Richards Bay harbour in 1976 (*Section 6.3*). This brought with it a range of associated industries such as the coal terminal, paper mill, fertilizer plant and aluminium smelter.⁸

That said, there are still large tracts of KZN coastal land, (almost 59% of the total coastline) that remain untouched, predominantly along the north coast, and within the protected area of the iSimangaliso World Heritage Site (some 30% of the total undeveloped coastal land). However, pressure for development and economic activities is increasing in these areas, being driven by improved road access and the new King Shaka International Airport. It is anticipated that this will result in an increase in the development of land north of Durban, in the Ballito areas.

Planned residential and tourist developments and mining activities are likely to absorb a significant proportion of this undeveloped coastal land in the near future. This presents an urgent challenge for the wise management of this land and careful assessment of future developments in the coastal zone.⁷

Managing coastal development

The management of urban expansion along coastal areas is one of the most difficult tasks for coastal planners. The enormous financial value attached to coastal land that has the potential for residential and tourist development often results in the widespread conversion of agriculture, forestry and other low intensity land uses to urban land. This often leads to “strip development”, as urban sprawl spreads up and down the coast from existing urban centres and small coastal towns; eventually resulting in the merging of cities and towns that were once kilometres apart.⁹ Evidence of this type of development can be seen in a number of regions along the KZN coast; notably between Durban and Umhlanga, and more recently the area between Umhlanga and Ballito.

Increasing demand on coastal goods and services

Coastal development places an increased demand on the goods and services provided by the coastal and marine environments. Poor planning results in the loss of natural habitat and functioning, which in turn limits the coastal environment’s ability to deliver the very services and resources that attracted people to the coast in the first place.

Coastal development has in the past been inappropriately located, often too close to the high water mark. This adversely affects the natural functioning of the coastal environment and often results in damage to, or loss of, the developments as a result of coastal hazards, discussed in *Section 9.5*.

Coastal managers and planners need to identify areas and corridors for coastal conservation. These need to be established as “no go” development areas. This can be further managed through the establishment of coastal set-back lines and the Coastal Protection Zone, as outlined in the ICM Act (*Sections 1.2 and 10.2*), which will prevent future development from being inappropriately located. Not only will this ensure the natural functioning of the coastal zone, it will also ensure that the developments and infrastructure themselves are not damaged by natural coastal processes. ■



9.3 Coastal Pollution and Litter

The marine environment has an amazing capacity to assimilate man's waste and has been doing so for centuries. However, there are absolute limits to the quantities, concentrations and the nature of the waste. Exceed any of these and the entire assimilative capacity can be destroyed and pollution results.

Despite the ocean's assimilative capacity marine pollution is a worldwide problem, affecting ecosystems and habitats as well as the social and economic health of coastal communities. Marine pollution comes in a range of forms, from marine litter and debris to sewage, oil, gasoline, toxic chemicals, fertilizer, animal wastes and pesticides.



Photo: Judy Mann

Marine debris

Marine debris can be classified into two categories, land or water/ocean based, depending on where the debris entered the ocean.¹ Land-based debris commonly results from parking lots and streets, being washed, swept or blown into water ways and storm water drains, and ultimately out to sea. Inappropriate disposal of rubbish from beach goers, release of waste from shore-based waste disposal, and sewerage overflows also result in significant land-based sources of pollution.¹ Ocean or water-based debris are also caused by humans, but relate to activities at sea, from small sailing boats and fishing vessels to large cruise ships. They include fishing tackle, the discharge of trash and galley waste, and debris coming from accidental and deliberate discharges from ships.¹

Marine debris can be found across all oceans. Even the most remote localities in the southern ocean, such as Antarctica and the sub Antarctic Islands, which are far from obvious sources, are affected by litter.²

Polluted beach as a result of our daily activities.

Photo: Bronwyn Goble



Pollution from a ship that ran aground on the KZN north coast.

It was reported in 1996 that KZN coastal municipalities spent an estimated R8 million to clean beaches.³ Data from the annual International Coastal Cleanup (ICC) in South Africa showed that most rubbish collected was around dense coastal settlements.^{3;4} The ICC takes place every September, around the world, and has become the largest volunteer effort for ocean health. South Africa is ranked on the list of top ten countries participating in the ICC, which shows great awareness of coastal pollution issues.

Various authors suggest that plastic is the main source of marine debris,^{2; 3; 5; 6; 7} because it is light and durable, and takes a long time to degrade. Plastic fragments smaller than 5 mm (micro-plastics) can absorb highly toxic pollutants from its surroundings, such as DDT, pesticides and polychlorinated biphenyls (PCBs). Filter feeders feed on these particles, absorbing the toxins, which are then carried up the food chain.

Larger pieces of plastic can also be very harmful to marine life. Sea birds, turtles, seals, dolphins and sharks get entangled in, or ingest the plastic litter.⁴ Ingested plastic cannot be digested, and accumulates in the stomach of these animals.³

Marine debris and litter makes beaches unattractive to visitors, discouraging people from utilising these areas. A recent study revealed that a clean beach is of vital importance to visitors, and almost half the people interviewed would travel an extra 50 km to a cleaner beach.² South Africa is part of the international Blue Flag programme, detailed in *Section 8.1*, which gives tourists the assurance that the blue-flagged beaches are clean, environmentally sound and adhere to international standards.

Photo: Jeremy Cliff



Plastic pollution often entangles and kills marine species.

Marine outfalls

A marine outfall is a pipe or a tunnel that transports household and industrial effluents to sea.⁴ Most deep sea outfalls or marine discharges in South Africa are controlled in terms of the *ICM Act*, which stipulates that a permit is required for any outfall and that the effluent must first be purified to a certain standard, as determined by the Act.⁴

In South Africa, there are 63 deepwater outfall pipes, seven of which are in KZN, five lying between Umkomaas and Durban, and two in the Richards Bay area. They are well-designed offshore pipelines with hydraulically efficient diffusers operating in water depths of more than 20 m.⁸

The coastal waters of KZN receive an estimated 555 000 m³ of domestic and industrial effluent every day. This is discharged at sea, through the surf zone (10%) and deep water outfall pipes (90%).⁹ Outfall waste often carries insecticides such as DDT (Dichlorodiphenyltrichloroethane) and Dieldrin, which do not dissolve in water and have a negative effect on marine animals. DDT and other chemicals accumulate in the fatty tissues of animals, and birds eating DDT-infected fish can experience eggshell thinning and the loss of offspring.⁴

Oil spills

South Africa is situated on one of the world's busiest shipping routes. It is estimated that approximately 80% of the world's tanker traffic passes along the South African coast, resulting in an increased potential for oil spills. For example, in 1994 the iron-ore carrier MV Apollo Sea broke up in heavy seas near



Cape Town, spilling 2 400 tons of heavy bunker fuel oil; and in 2000 the tanker MV Treasure sunk near Robben Island spewing fuel oil into the sea near the world's third largest colony of the endangered African Penguins;^{4; 10} and in KZN, the Jolly Rubino ran aground near St Lucia in 2002. Oil is a hydrocarbon that floats on top of the water and affects animals near the sea surface, or as it drifts ashore. It affects the plumage of birds, reducing their insulation ability, which leads to body temperature fluctuations, hypothermia and death.¹⁰

Oil pollution is not solely related to oil disasters; oil is discharged into the sea during day-to-day operations of ships, while cleaning ship engines; and accidental leakages in terminals where marine tankers load and discharge cargo. Many vessels also pump out bilge water, which often contains amounts of oil.¹ When the MT Phoenix, a heavy tanker, ran aground near Sheffield Beach north of Durban in 2011, concern was raised for the potential harm to the northern KZN coastline, as the ship had 450 tons of oil on board.¹¹ Following swift action, salvage operators were able to pump the oil off the vessel and prevent an oil spill disaster.

Metal and organic pollution

Heavy metals such as lead, mercury, cadmium and tin, can enter the marine environment in various ways; for example: runoff from urban areas or industrial plants; contaminated ground water seepage; mining and agricultural return flows; dredging and deep-sea outfalls.¹² These metals usually bind to fine-grained sediments, such as mud and organic matter, and can be trapped on the seabed or harbour floor and only released with dredging.¹² Heavy metals can cause damage to sessile marine filter feeders; for example, mussels and oysters, because they can not metabolise metals effectively. Mussels are seen as an ideal bio-indicator, because of their ability to accumulate metals in higher concentrations than that found in the seawater.¹³ However, a 35-year study of mussels growing on the navigation buoys in Richards Bay's main channel showed that the metal concentration in their tissue remained relatively constant and manageable.¹³

The concern is that heavy metal pollutants accumulate higher up the food chain so that top predators such as sharks and dolphins may have the highest concentrations of these toxins.

Invasive species

A survey done on marine debris floating in the Atlantic Ocean found that the debris can be colonised by organisms such as barnacles, which can then be transported to new areas and pose a possible invasive alien threat to the indigenous biodiversity.^{2; 5}

In addition, KZN is home to two major ports, which support a considerable volume of shipping traffic.¹⁴ This increases the risk of introducing invasive species through ballast water discharge and hull fouling.¹⁴ However, the high wave energy of KZN's exposed coastline may to some extent mitigate against the impact of potential alien species settling and becoming invasive.¹⁵

Legislation, Conventions and Agreements

In addition to local policies and legislation, South Africa has also signed international conventions and agreements pertaining to coastal pollution, including: the *London Dumping Convention*, the *International Convention for the Prevention of Pollution from Ships (MARPOL)*, and the *United Nations Convention on the Law of the Sea (UNCLOS)*.⁴ New IMO rules came into force on 1 January 2013 banning the dumping of almost all solid waste at sea, including cardboard, rags, glass, cans, dunnage, paper and many other items previously allowed.

Recently, South Africa developed a National Programme of Action (NPA) in order to reduce land-based sources of pollution affecting the coastal and marine environment. More details about the action plan can be found in *Section 10.3*.

The negative impacts of pollution on the KZN coast is an ongoing concern.⁴ It is very important to assess, monitor and predict the impacts of pollutants on South African marine ecosystems in order to ensure long term sustainability of their resources.

One simple personal contribution relating to marine debris is to reduce the amount of plastic used; almost everything we buy contains plastic and even micro-plastic can be found in facial cleaners and exfoliating material. Buy environmentally friendly products and avoid using detergents and pesticides. ■

9.4 Climate Change

Climate change is no longer an abstract topic debated by a fringe group of scientists; the evidence of climate change is unequivocal. In view of its serious global impact the UN established a team of top international scientists to objectively evaluate all available climate data. This Intergovernmental Panel on Climate Change (IPCC) first met in 1988 and periodically produces definitive assessment reports, progressively reflecting improvements in data collection.

The IPCC has indeed brought climate change into focus and in its 5th assessment report¹ in 2013 concludes:

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased..."

Drivers of climate change

It is not uncommon to attribute everyday events to climate change. However not every storm, drought or cold winter is the result of climate change and many may be normal climatic occurrences. However, there is now a much better understanding as to the drivers of climate change.

There are a number of natural drivers of climate change, including natural events such as solar and volcanic activities. However, human influence on the climate system are clear and evident from the increasing greenhouse gas concentrations as a result of fossil fuel use.

Implications of climate change on marine environment

There is now a much better understanding as to the mechanisms that explain some of the climate change implications for coastal and marine environments, all of which affect human activities and resource use.

Oceans

Much of the Earth's increased climatic heat is stored in the oceans, some 90% of the accumulated energy, causing oceans



Damage to property as a result of an unusual climatic event.

Photo: Simon Bundy





to warm, especially near the surface (60%), where the upper 75 m has warmed by 0.11°C [0.09-0.13°C] per decade over the past 40 years.¹ Year-on-year trends are highly variable as they are also driven by the El Niño phenomenon, making predictions less precise. Nevertheless, global mean surface temperature has increased by 0.6°C [0.4-0.8°C] over the last 100 years.² Ocean warming is projected to continue with heat increasingly penetrating from the surface to the deep ocean and thus affecting ocean circulation and currents.

The greatest increases are predicted for tropical and Northern Hemisphere surface waters, while warming will be most pronounced in deeper waters of the Southern Ocean. Best estimates of ocean warming in the top 100 m range from 0.3-2.0°C and from 0.3-0.6°C at depths of about 1 000 m by the end of the 21st century. Indian Ocean surface waters have warmed over the last 50 years although deeper layers appear to have cooled,³ which in turn has increased rainfall in the tropical regions of the Indian Ocean and decreased the rainfall over eastern Africa.³ Here too the interplay between ocean warming and the El Niño Southern Oscillation of the Indian Ocean and associated current systems (e.g. Indian Ocean Dipole) complicates climate change predictions.

Warmer oceans have numerous consequences; changes in current systems will have major impacts on climatic factors such as rainfall. Besides, many marine species have life cycles linked to current systems, such as the case for KZN where currents play an important role in our coastal biodiversity.

Salinity too is effected. For example, regions of high salinity where evaporation dominates have become more saline, while regions of low salinity where precipitation dominates have become fresher, indirectly confirming that evaporation and precipitation over the oceans have changed. As temperatures change, conditions become unfavourable for species, causing them to relocate to more favourable temperatures, ultimately changing their distribution and habitat. Evidence of such changes has already been reported in South Africa with shifts in populations of commercial pelagic species.

Sea-level rise

As oceans warm, thermal expansion causes sea levels to rise. Based on tide-gauge and satellite altimeter data it has been shown that thermal expansion together with melting ice sheet and land-derived water is now known to have increased the world's sea level by on average 2.8 mm [2.3-3.4 mm] per year over the past decade – up from previous decadal

estimates of 2.0 mm [1.7-2.3 mm] per year. Global mean sea level will continue to rise during the 21st century and the rate of sea-level rise will very likely exceed that observed during 1971-2010 due to increased ocean warming and increased loss of mass from glaciers and ice sheets.¹ The implications for sea level rise vary for different regions. While KZN may not be at the same levels of risk as some low lying islands, the impact is nevertheless likely to be severe, as detailed in *Section 9.5*.

Coral bleaching

Many organisms are sessile and sedentary, hence cannot easily relocate. Reefs and especially coral reefs are a good example of this, considering their slow growth and often centuries old reef ecosystem. With increased temperatures corals may undergo mortality through a process called “bleaching”. Corals are made up of individual coral polyps that secrete aragonite, a form of calcium carbonate (CaCO₃) skeletons that over time creates the reef structure. Corals polyps are host to microscopic algae, known as zooxanthellae, that live in the outer layer of the coral's tissue and that give reefs their colour. These algae provide corals with about 95% of their food and are essential for the survival of coral reefs.

Coral bleaching occurs when their environment becomes stressful causing the zooxanthellae to be expelled or die, revealing the white calcium carbonate skeleton of the coral below.⁴ It has been shown that temperatures in excess of 28°C for a few days can cause catastrophic bleaching.⁴ This happens especially when elevated sea temperatures are associated with El Niño Southern Oscillation events.

There have been several mass bleaching events in the WIO, especially closer to the equator in 1998 and 2005. This impacted severely on the coral ecosystems of several countries.^{4;5} These bleaching events were geographically widespread, with coral reefs throughout the world being affected.² Such warm episodes of El Niño have been more frequent and intense since the mid-1970s.² Current trends in sea surface temperature are evidence that bleaching events similar to those associated with El Niño-like water temperatures will increase in frequency and duration by 2030.⁴

Although some bleaching has been reported for KZN's coral reefs, the extent was minimal because of the cooler temperature regime and the fact that local corals are located in deeper water and hence not exposed to excessive heat at low tides.⁶ Clearly, this adds extra responsibility to caring for our corals as a future genetic resource. By reducing stressors

such as sedimentation, nutrient pollution and overfishing, we can assist in reducing stress on coral ecosystems and thus increase their resilience in the face of rising ocean temperatures.⁴

Impact on coastal ecology

The impact of climate change-induced sea-level rise on coastal ecosystems such as mangroves, marshes, sea grasses and wetlands will vary regionally and will be affected by erosion and deposition processes.² For example, mangroves, occupying a transition zone between sea and land, will have a varied ability to adapt to climate change. Mangroves found in low coastal regions where sedimentation is high and erosion low may be better able to deal with the effects of sea-level rise, as deposited sediment will create new habitats for colonisation.

It is anticipated that changes in climatic factors, may adversely affect freshwater wetlands in low-lying regions. These could be displaced by saltwater habitats driven by sea-level rise, more intense monsoonal rains, and larger tidal or storm surges.² Estimates show that approximately 20% of global coastal wetlands could be lost by the year 2080.²

management, forest conservation and the development of ocean-based renewable energy. While adaptation mostly refers to actions taken to reduce the effects of climate change on human and natural systems,⁵ it can involve physical responses, such as building of dykes or resettlement of people. Adaptation also infers a biological process where organisms adjust genetically over time to cope with a changing environment. In some cases acclimatization occurs where organisms are able to adjust their physiology immediately to cope with a changed climate.

The African continent contributes less than 4% of total greenhouse gas emissions, yet it is one of the most vulnerable and least resilient regions to climate change. In particular, the effects of climate change are very real for the marine and coastal environments and the livelihoods of many, coastal KZN included.

Most important for KZN is the development of adaptation programmes in key areas such as water, food security, nutrition, agriculture, coastal zone management, health and infrastructure. ■

Call to action

Because climate change is a slow and somewhat uncertain process there is a lack of urgency and political will in dealing with it. However, a response is indeed required, if only for the sake of our next generation. Aside from the obvious need to reduce greenhouse gasses globally, a range of actions were identified by West Indian Ocean experts. Three major areas of intervention were identified: vulnerability assessment, mitigation and adaptation.

A formal process to identify areas, species and communities that may be most vulnerable to climate change is required.⁵ Mitigation to offset high levels of CO₂ emission in South Africa is also important and includes energy conservation, clean and energy-efficient urban transport and waste

Coral bleaching has affected KZN coral reefs.

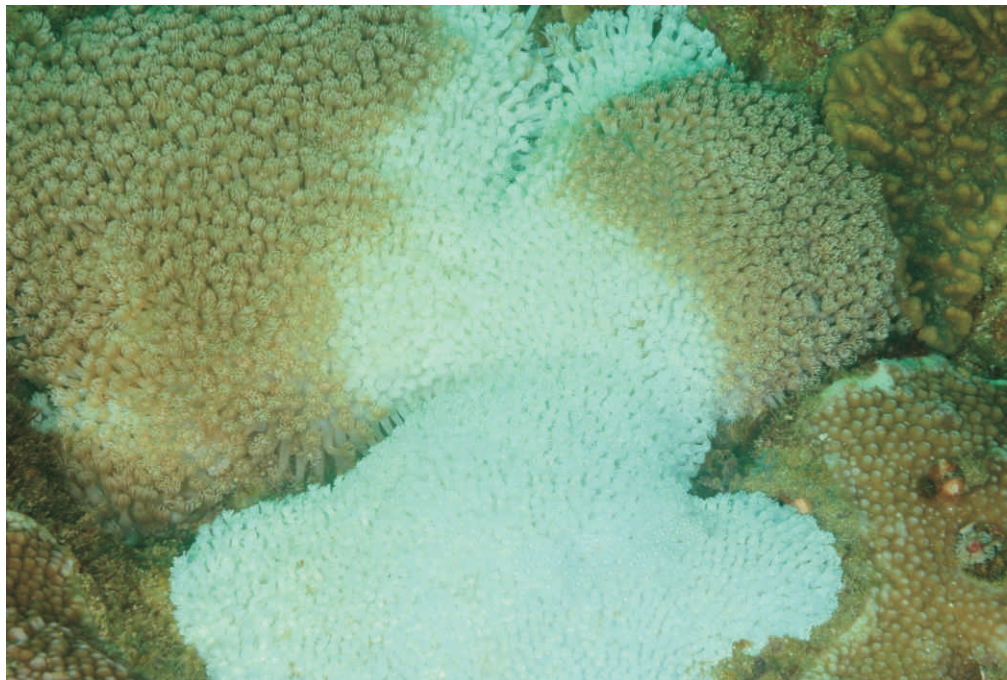


Photo: Camilla Floros



9.5 Coastal Hazards

Hazardous events often significantly affect and alter the natural environment and render populations vulnerable to loss and injury. Vulnerability to these events manifests in a number of ways: vulnerability to a direct impact; vulnerability to indirect impacts; and vulnerability to maladaptation through failed attempts to adapt to hazards.¹

Coastal hazards can result in loss of infrastructure and properties, loss of resources and loss of unique coastal habitats. The risk of vulnerability is exacerbated by the combination of development pressures (Section 9.2) and stressed ecosystems. Coupled with the predicted effects of climate change (Section 9.4), the effects of hazard events become significantly higher and more costly to manage. Effects of sea-level rise and coastal erosion are of particular concern for KZN.

Sea level rise

Limited historical sea level rise analysis has been undertaken in South Africa, as records only date back as far as the 1950s and are of variable quality, with numerous gaps.^{2; 3} One of the earliest studies, based on data collected from 1960-1975, concluded that there were no significant trends in sea level change around the coast of South Africa.⁴ Later studies however, determined a long-term inter-annual trend along the west coast of South Africa and Namibia.⁵ The dataset was further extended, and it became evident that high sea level events propagated polewards from the equatorial Atlantic.⁶

Tidal records for southern Africa were recently reassessed and results showed that sea levels are rising around the southern African coastline, in line with current global trends.^{7; 8; 9}

Coastal erosion damage in Ballito from the 2007 storm surge event.



Photo: Simon Bundy

However, there are distinct regional differences in the estimated rate of sea level rise. On the west coast of South Africa/Namibia, sea level was seen to be rising by +1.87 mm per year; the south coast by +1.47 mm per year; and the east coast (KZN) by +2.74 mm per year. These differences were attributed to the difference in vertical crust movements between the east and west coasts of South Africa, and the different oceanographic processes occurring along the east and west coasts.⁹ (Section 2.3)

Sea-level rise is highest for the KZN coastline, which is a major cause for concern, as the majority of the coast comprises sandy shores (Section 3.2). Sandy shores are the most vulnerable to change, not only in the physical sense, but also from a biological viewpoint.¹⁰ Rising sea levels have the ability to cause a progressive retreat in the shoreline,¹¹ as is evident from historical shoreline records for KZN.¹²

Sea-level rise is a real threat, exacerbated by human interference with natural coastal functioning, and more recently climate change. Climate change projections give a good indication of potential future changes in sea level, but the resultant impacts are largely unknown.

Coastal erosion

The KZN coastline is generally eroding, as is the case with most of the world's coastlines, at rates of between 20 cm to 2 m per year.^{13; 14; 15; 16} In addition, there is considerable seasonal and episodic fluctuation of the high water mark.^{13; 14; 15; 16}

Coastal erosion is often portrayed negatively in the media, especially when beachfront properties and coastal infrastructure are threatened. Nevertheless, erosion is an intrinsic part of the natural coastal system, whereby a coast adjusts to the availability of sediment and the ambient wave and tide conditions, within the framework of the surrounding solid geology.

Coastal erosion events are driven by sea level rise and an apparent increase in wave height with time.^{17; 18} At Durban, the average significant wave height is 1.65 m, with an average swell direction of 121°. ¹⁹ A regional sand deficit, due to extensive droughts, sand mining, dam construction and

unwise coastal development, is exacerbating coastal erosion.^{20; 21; 22} Thus, coastal erosion will continue to increase along the KZN coast. An obvious exception to this rule is the stretch of coast between the Thukela River Mouth and Mtunzini, which has advanced seawards in historical times through the addition of sand from the Thukela River.

The KZN coastline experiences regular erosion on the normal spring high tide, which produces characteristic beach sand scarps, exacerbated by high swells.²³ Eight to 10 m swells have been recorded during mid-winter storms in the KZN Bight.²⁴ Tropical storm Imboa (early February, 1984) produced a significant wave height (Hs) of 9 m off Richards Bay.¹⁸ The high swell of March 2007 produced a wave height of 8.5 m off Richards Bay. Such a swell can be expected about once every 25 years,²⁵ which suggests that the event was unusual, but not extreme.

Coastal erosion is commonest in winter, being driven by southerly to south-easterly swells, which create a south to north littoral drift, triggering erosion in the southern parts of bays. In summer the direction reverses, causing a seasonal beach rotation;^{26; 27} but the winter pattern dominates over the long term.

The KZN coastline is also subject to longer-term erosion. The 18.6 and 4.4 year lunar cycles appear to drive coastal erosion, although the 18.6 year cycle appears to be the most prevalent.²⁷ During March and September 2006, scattered parts of the KZN coastline experienced strong equinoctial tidal erosion. The 18.6 year peak nodal tidal cycle occurred in October 2006, resulting in an astronomical tide of 2.3 m.



Photo: Simon Bundy

The impacts of coastal erosion are becoming more prevalent along the KZN coast.



This very high tide was due to the Moon and Sun being at their closest to Earth and coinciding with the Spring Equinox. During this time, Eastmoor Crescent in Durban suffered severe erosion (up to 30 m of beach loss). Historical photographs indicate that this location underwent similar erosion during 1989.

Coastal adaptation

In order to cope with and address coastal hazards such as short and long-term erosion and sea level rise, coastal systems and populations need to adapt. In this context, “adaptation” refers to an adjustment in natural or human systems as a response to actual or expected impacts, which moderates harm or exploits beneficial opportunities.²⁸ In the last twenty years, four global approaches to managing coastal vulnerability and risk have been developed: 1) defend, 2) managed retreat, 3) do nothing, or 4) accommodate.²⁹ The “defend” approach ensures that the risk of damage and loss is reduced by decreasing the probability of impact; this includes a range of hard, and more recently soft, engineering techniques that ensure the protection of infrastructure and properties landward. This is the most often used approach, particularly in areas where properties and resources offer high economic return.^{28; 29}

The “managed retreat” approach is focused on making space for natural coastal processes and functioning, while at the same time considering socio-economic, tourist and environmental

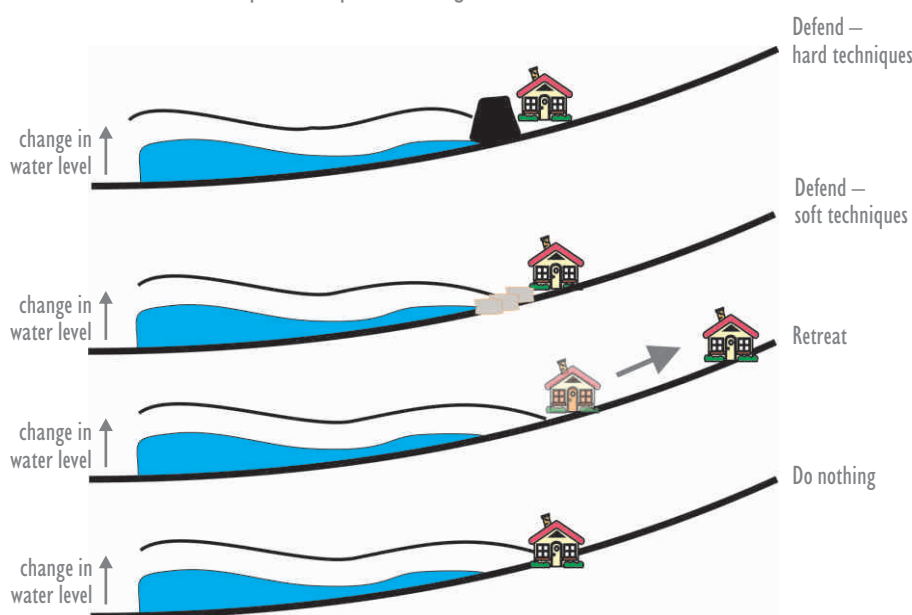
factors. It ensures that infrastructure that is located in vulnerable areas and/or is hindering coastal processes is removed from harm’s way, either entirely, or retreated in a planned, well-managed way, over time.²⁹

The “do nothing” approach is an approach that allows the natural functioning of the coast to continue without any intervention, ultimately resulting in the loss of any infrastructure in its path. This approach is rarely planned, but often adopted when it is too late for alternative interventions and when the cost-benefit analysis shows that the cost of defence exceeds the value of the properties to be protected.

The “accommodate” approach relates more to social change. Society’s ability to cope with the effects of the event is taken into account. This approach relates to the implementation of emergency response strategies and early warning systems.²⁸ Both the managed retreat and do nothing approaches take into consideration aspects of the accommodation approach as part of their management strategies.

Coastal hazards are exacerbated by changing environmental conditions coupled with increased coastal development and the transformation of natural habitats, the effects of which are usually unevenly distributed, with vulnerable groups being likely to suffer a disproportionate share of the impacts.

Examples of adaptation strategies.²⁹



There are also indirect effects such as tourism losses, re-allocation of the fiscus towards disaster relief at the expense of planned development programmes and higher insurance premiums for coastal property.

The 2007 KZN storms affected the coastline and many of its beaches, resulting in a loss to the province's tourism sector. In addition there is a risk to human life when storms accentuate higher sea levels. ■

9.6 Sand Mining in Estuaries

Golden beaches and sandy bays are a primary asset of the KZN coast but often taken for granted with little consideration given to the source and supply of its key ingredient: sand. While sand may appear to be in abundance, this is not always the case as sandy beaches are dynamic ecosystems with sand continuously on the move and in need of replenishment.

The main supply of new sand to the beaches of KZN is derived from riverine sources via its 77 estuaries. Interrupt the supply of sand and beach nourishment, suddenly beaches fade and disappear. Port cities such as Durban know only too well what happens when the natural supply of sand to their beaches is compromised.

However, the construction industry values this supply of clean sand, and often “mine” their sand from environmentally vulnerable estuaries. Sand mining is largely driven by demand

for development of houses and associated infrastructure.¹ Sand mining is a consumptive activity that results in a net decrease in the resource, such that less sand may be available for coastal replenishment and hence other, often non-consumptive, uses such as recreation and tourism.² A number of estuaries are now under threat from sand mining activities.

Estuaries are one of the most important ecosystems found within the coastal zone, as discussed in *Section 3.3*. Estuaries are known for their high levels of biodiversity and services, such as nursery areas for fish, shrimps and crabs, as well as feeding and roosting sites for waders and other migratory birds.³

A study in 2007 showed that there were approximately 60 sand mining operations within 18 of KZN’s estuaries, predominately occurring in the bigger systems.³ The number of operations occurring on a single system varied, from a

Sand mining activities in the Umgeni Estuary.



Photo: Bronwyn Goble



single operation on the Thukela to 10 on the Mvoti Estuary.³ A previous study, done in 2003, showed that the total mining volume for all KZN estuaries was approximately 742 900 m³ per annum, split across 14 systems in the Province.² Of concern is that sand mining activities have an adverse effect on estuarine and river functioning through the depletion of sand.

Types of sand mining in estuaries

There are various ways in which mining activities are undertaken in estuaries, including dry-pit mining, wet-pit mining, bar skimming and pits on the adjacent floodplain; all of which have varying impacts on the natural environment. Dry-pit mining refers to pits excavated on dry ephemeral streambeds or exposed bars; this is done using bulldozers, scrapers and loaders.⁴ Wet-pit mining is more complicated, requiring the use of a dragline or hydraulic excavator to remove sand from below the water table or in a perennial stream channel. Dewatering is often undertaken in order to make the site more accessible and allow for easier excavation.⁴

Bar skimming or scalping is the process of “scraping off” the top layer of sediment from a bar without excavating below the summer water level.⁴ Depending on elevation, pits are often located above or below the water table on the adjacent floodplain away from the main channel. However these can be integrated in-stream following sudden changes in the channel course as a result of flooding.⁴

Impacts of estuarine sand mining

The removal of material from within or near the streambed has a direct impact on the physical environment and habitats within the estuary. It affects, amongst others, the channel geometry, substrate composition, depth, velocity, turbidity and the transportation of sediments.⁴ This in turn has an adverse effect on the instream biota and riparian habitat; biota are adversely affected due to three main changes: 1) alteration of flow patterns due to modification of the river bed, 2) an excess of suspended sediment and 3) damage to riparian vegetation and instream habitat.^{3;4} Instream mining effects natural functioning through bed degradation and sedimentation, as this is dependent on the balance of stream flow, sediment supply and channel form.⁵ This in turn effects channel and habitat development, and can result in effects on

downstream habitats.⁵ Species generally require specific habitat conditions in order to ensure their survival. Disruptions to these habitat conditions results in declines in biological diversity and productivity. Alterations to riparian vegetation can cause changes in channel functioning, affecting aquatic ecosystems. In addition, the disturbances caused by the activity may have effects far greater than those seen at the site, negatively affecting upstream and downstream functioning.⁴

Effects of sand mining can be much further reaching than the immediate habitat, whereby the quantity of sand that reaches the coast is negatively affected. This affects coastal stability and functioning of beaches. Sandy beaches are identified as critical for a range of socio-economic reasons, with direct benefits from eThekweni sandy beaches being estimated at R 113 596 667 per km, through value for recreation, tourism and aesthetics. In addition, indirect benefits were valued at R 915 000 per km for factors such as erosion control, biological control, habitats and existence value.² Depletion of sand instream and at the coast can result in alterations to estuarine mouth functioning, the effects of which are compounded by sea-level rise and coastal erosion.⁵

In some cases sand mining can in turn lead to damage of infrastructure and properties, through the undercutting of banks, increased erosion and a change in the carrying capacity of the stream.⁵

Sand mining in KZN estuaries has an adverse effect on both estuarine and coastal functioning, having contributed to the reduction of natural buffers, predisposing sections of the coastline to damage from increasingly variable seas and storm surge events. Impacts on the biological function of estuaries have also been recorded. While the need for building material is unquestionable, other terrestrial sources of sand should be preferred. Moreover, estuarine sand mining should be better and more wisely managed by the permitting authority, the Department of Mineral Resources, in order to halt a cascade of negative environmental effects. ■

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9.7 Species at Risk

The marine and coastal environment of KZN is enormously rich and diverse in plant and animal species. Precise numbers do not exist, but the more than 1 800 species of coastal fish, some 8 000 types of invertebrates, about 250 species of seaweed, at least 40 sorts of marine mammals and about 100 species of coastal and oceanic birds are testimony to the marvellous diversity of our coastal environment (see Chapter 4 for details).^{1; 2; 3; 4; 5}

Marine species are generally considered to have low risk of extinction because of the size of the world's seas, which create large continuous habitats, and because of the open nature of marine habitats and the life-history characteristics of many marine species. This is no basis for complacency, as various threats to our marine fauna and flora exist, and critical population declines for marine species have occurred.

Why are some species more vulnerable than others?

Vulnerability can be interpreted in different ways, ranging from the extreme risk of extinction to different levels of depletion as

in the case of some fish stocks. Moreover, risk is not confined to direct human exploitation but may also be attributable to indirect impacts, the state of the environment, climate change and the inherent biology of species.

There are a number of natural features that may render a particular species susceptible to higher levels of risk. Slow growth and late maturity is one element of risk, normally resulting in low population turn-over times. Examples of this can be seen in several types of fish, sharks, rays and sea turtles. It is no surprise that fish such as the red steenbras, brindle bass and musselcracker are at risk when maturity is only attained after 7-10 years and specimens can reach an age of 33-45 years. Endemism is also a major feature of vulnerability, as endemic species are confined to a limited local distribution and thus cannot be replenished from elsewhere. Some 16% of our coastal fishes are endemic, rendering them vulnerable to exploitation. Examples include slinger, Scotsman, bronze bream and white steenbras. In some cases, isolation and habitat fidelity heightens vulnerability. Small animals that live burrowed in the muddy bottom of estuaries are confined to a particular

Loggerhead turtle returning to the water after laying her eggs. Laying eggs on the beach makes turtles vulnerable to predation and human pressures.



Photo: Camilla Floros



system, and are thus highly vulnerable to changes in its health and natural functioning. Their demise can have a cascade effect on other species in the food web.

Breeding behaviour can also elevate the risk to a species. Some fish and crustaceans aggregate in huge spawning concentrations, making them vulnerable to predation and harvesting at a critical phase, as in the case of the once plentiful linefish, the seventy-four. Similarly, sea turtles are enormously vulnerable to attack and depletion when females emerge onto a beach to nest. Their eggs and new hatchlings are also highly vulnerable to exploitation and predation (Section 4.3). Some are naturally rare species, which increases the risk to their survival. A good example is the coelacanth (Section 4.5), which, though not immediately under threat, is nevertheless vulnerable to environmental and human impacts.

In recent years, climate change has been recognised as a factor increasing risk for some species. Rainfall affects estuarine species, and especially the rich offshore muddy banks such as the Thukela Banks, which sustain valuable prawn populations. Increased temperatures over time may threaten our coral reefs and also those temperate endemic fish species that are unable to adapt to warmer conditions as detailed in Section 9.4.

How is risk evaluated and measured?

Unfortunately, there is no perfect way to measure and quantify the risk to a marine species, as they have to be abstractly assessed and modelled to establish their risk status. However, some risk assessment systems have been developed and provide a useful yardstick against which to measure the relative risk profiles of species and to plan protective actions accordingly.

IUCN-Red List System

One system that encapsulates vulnerability is the IUCN Red List, primarily developed for terrestrial use as an indication of the risk of extinction of individual species, but progressively improved to be of relevance to marine organisms.

Species are allocated to categories of risk depending on their level of depletion and risk of extinction. Criteria for such grouping include population size, maturity levels, population reductions and continued declines, extreme fluctuations, severely fragmented populations, range and area of

occupancy. Evaluations are conducted by a network of specialists who assess the status of species based on the best expertise and information available. Clearly, there are too many plant and animal species in the world to do justice to them all, so that greater effort and progress is often made by the personal interest and most diligent of respective specialist groups.

The IUCN⁶ currently “red-flags” a total of 738 marine fish species for the West Indian Ocean region, including KZN. However, more useful is the combination of the three most vulnerable categories. This reveals a list of 78 fish species (73% being sharks and rays); 10 critically endangered (CR), 11 endangered (EN) and 57 vulnerable (VU). Of these, 25 occur in coastal KZN, with 4 critically endangered, 4 endangered and 17 vulnerable. The high proportion of sharks and rays signifies the higher levels of risk associated with elasmobranchs.

For invertebrates, the IUCN red-flags 618 species for the West Indian Ocean, with 102 species listed as “threatened”. However, all are tropical hard corals, of which eight are considered endangered. Several of these species occur in KZN; all of which are found in the well-protected iSimangaliso Wetland Park. Some 19 species of marine reptile are red-flagged for the region, all but five being sea-snakes not common in KZN. However, all five turtle species found in the region are grouped as “threatened”, with two critically endangered, two endangered and one vulnerable (Section 4.3).

In all, some 40 marine mammals are red-flagged for the West Indian Ocean, with 3 endangered and 4 vulnerable. Of the 13 most common species of marine mammals that frequent coastal KZN, two are listed as vulnerable.

Coastal vegetation is also under threat. The once prolific seagrass *Zostera* is listed as vulnerable and declining, while several species of mangroves are especially at risk in KZN, largely because of estuarine degradation.

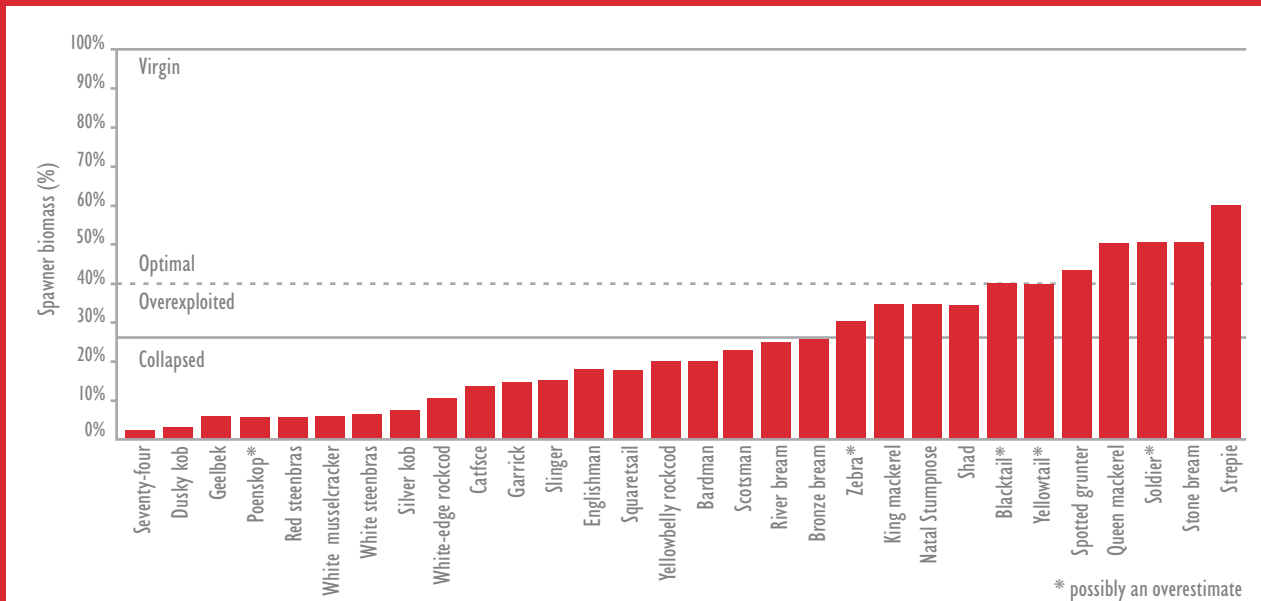
CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora

CITES is an international agreement between 177 governments and agencies to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Species are allocated to lists, based on a comprehensive assessment of their status. *Appendix I* is a list of those species that are under critical threat and may not be traded at all, while *Appendix II* documents threatened species and places trade controls for the listed species.

National species conservation lists

In addition to the red-flagged and CITES-listed species, countries also identify additional species at risk, as is the case for South Africa. This is especially the case for harvestable fishes, where the status is often statistically calculated as a percentage of its virgin reproductive potential. Based on the species' growth rate, reproductive output and prevailing mortality rates, its spawner biomass is calculated. A biomass level above 40% of the unexploited state of the species is considered stable, whereas 25% is the lower threshold below which the species is considered to have collapsed.

The graph below shows the lamentable situation for 30 KZN linefish species with 18 (60%) rated as collapsed and only seven species in optimal condition.⁷



A number of marine species are listed, and those relevant to coastal KZN include sawfishes, several sharks, the coelacanth, several fish species and one species of sea turtle (see Section 4.3).

For years, mankind viewed the ocean as a source of infinite resources. Its vast size and depth and unexplored frontiers made the ocean appear invulnerable to overexploitation. Despite our relatively healthy marine and coastal environment, a considerable number of KZN species are vulnerable, and thus are at heightened risk to human activities. These risks are various, including ecosystem and/or habitat destruction, climate change and fishing pressure. Severely declining catches have rung alarm bells, globally and in KZN. The decline of sea turtles, depleted linefish such as the seventy-four, and concern about shark populations have resulted in actions being taken. ■

The once-plentiful Seventy-four is extremely rare and vulnerable.



Photo: Dennis King

