ETHEKWINI MUNICIPALITY

DURBAN'S BEACHES... *More than just sand*

Beaches in Durban are generally regarded as little more than fine picnic spots. Their unique biodiversity and critical and irreplaceable services they provide will be most affected by urban development and climate change if these important ecosystems continue to be neglected.

Contents

PRINTED ON RECYCLED PAPER - CYCLUS OFFSET

1. Glossary

AQUATIC	Associated with and pertaining to water e.g. aquatic plants and animals.
BEACH MORPHO-DYNAMIC TYPE	Used to classify beaches and is based on sand grain size, beach slope and wave and tidal climates.
BEACH SLOPE	This refers to how steep or how flat a beach is.
BENTHOS	Bottom dwelling organisms that live buried in sand or mud.
BIOTURBATION	Stirring or mixing of sediment by organisms, usually through their feeding or burrowing activities. It's similar to tilling the soil to make it more fertile and hospitable.
DRIFT LINE	The upper limit of the swash during the previous high tide. This area of the beach is usually characterised as the line of debris (drift wood, algae, and in some instance anthropo-genic litter) that have accumulated at the top of the beach at high tide. The drift line is also used as a proxy for the high tide mark as this is not easy to distinguish.
DISSIPATIVE BEACHES	Flat beaches with fine-grained sand, in which the energy of incoming waves is dissipated with the swash zone.
EFFLUENT LINE	The saturated layer on a sandy beach that occurs low down on the shore. It is represented by a "glassy layer" on the beach and that portion of the beach that is continually wetted by the swash action.
INHOSPITABLE	Providing little shelter or sustenance.
INTERSTITIAL	Refers to the pores between individual sand grains.
INVERTEBRATES	Animals that do not possess a back bone or spinal cord.
INTERTIDAL	That part of the beach alternatively covered and uncovered by tides.

HIGH WATER SPRING	Highest point the sea reaches during a spring tide. The drift line is often used as a proxy for the high water mark.
LITTORAL ACTIVE ZONE	Combination of the surf zone, intertidal beach, dune system, and in some instances, river mouths and estuaries. Sediment dynamics is one of the defining characteristics of sandy shores; accordingly, the littoral active zone, which refers to the zone of sand that is continually reworked by wind or wave action, encompasses all the elements of this system.
LOW WATER SPRING	Lowest point the sea reaches during a spring tide. Often characterised by the presence of a small berm and sharp increase in water depth as one progresses further seaward.
MACROFAUNA	Burrowing benthic invertebrates.
MEIOFAUNA	Benthic organisms that live between the sand grains, in the interstitial pore system. They are larger than 38 um and smaller than 1000 um.
NUTRIENT CYCLING	Involves all the processes by which nutrients are transferred from one living thing (plant or animal) to another.
ORGANIC MATTER MINERALISATION	The conversion of organic matter (such as dead or dying plants and animals) to their constituent inorganic parts (e.g., nitrogen).
REFLECTIVE BEACHES	Course grained, steeply sloped beaches in which the energy of incoming waves are reflective by the beach face.
SANDY BEACH	That part of the littoral active zone alternately covered and uncovered by tides. Implicit in this definition is the exclusion of muddy beaches (intertidal sand flats near estuaries), along with gravel, pebble, cobble and boulder beaches and inclusive of any beach consisting of sand with a median grain size of between 53 mm and 2000 mm.
SPECIALLY ADAPTED	Having specific bodily or behavioural modifications for particular environment. For example, mole crabs have specially adapted legs to allow them to burrow rapidly so that they do not get washed out to sea with tides and waves.
SPECIES DIVERSITY	Number of different species. May also be referred to as species richness
SIPHONS	Tubular organs that molluscs use to take in and extract water.
SPRING TIDE	Periods of extreme high and extreme low tides brought about by the gravitational pull of the moon on the earth. Spring tides occur during full and new moons.
SURF ZONE	Area of the shore where waves break, characterised by foamy water
SWASH	The up run of water up the beach face after a wave has hit the beach
SWASH ZONE	The area in which the swash occurs.
TROPHIC LINKS	Trophic refers to food relationships between organisms. Trophic links are the connections between food web components. Trophic links are usually animals that occupy a space in the middle of food webs.
WRACK	Refers to organic material, particularly seaweed that is washed onto the beach near the drift line.

2. Why are Durban's sandy beaches important?

Covering close to 70 % of the planet's shorelines, beaches are the interface between the marine and terrestrial environments, interacting with both sea and land.

Unfortunately most people regard beaches as marine deserts. In reality, beaches teem with unique life and impart many important goods and services that include the cleaning of our coastal waters, nutrient cycling and storm protection.

Seventy-nine percent of the South African coastline is composed of sandy beaches. The city of Durban boasts a wealth of coastal resources along its 97 km of coastline. These include rocky shores, mangrove forests, coral reefs, coastal forests, wetlands and sandy beaches. Of these, the least studied and most underappreciated are sandy beaches. It has often been pointed out that it is these neglected ecosystems that will ultimately bear the brunt of change. Rapid population growth and the assosiated increase in the demand for coastal infrastructure has lead to the excavation of sandy beach and dune systems in favour of development. This is made worse by climate change and associated impacts which include sea level rise and an increase in the frequency and severity of storms.

Beaches are thus forced into a coastal squeeze, impacted on by both sea and land. When the beach is lost, not only are coastal properties threatened but biotic communities resident on the beach disappear. This has dire consequences for the functioning of coastal ecosystems.

2. *What is a beach?*

A sandy beach ecosystem is composed of three important zones:

- The **surf zone** – the nearshore area where waves break, characterised by 'foamy' water.
- The **intertidal** sandy beach – the sandy area alternatively covered and uncovered by tides.
- The **sand dunes** (or if there are no dunes, the area of continual dry sand) above the **drift line**, landward of the beach.

Beaches are not homogenous piles of sand but exist in a range of types. The different **beach morphodynamic types** are determined by three factors: sand grain size, wave action and tidal regimes.

The different beach types include:

- Dissipative: fine sand, gently sloped beaches with a wide surf and **swash zone**.
- Reflective: coarse sand, steeply sloped beaches with a narrow surf zone where waves break directly on the beach face.
- Intermediate: share characteristics of both dissipative and reflective beaches.

Most Durban beaches are of the intermediate type. The central "beachfront beaches" are sheltered by the bay (maintained by sand pumping), and are either dissipative or intermediate dissipative. Their finer sand, flatter slopes and gentle waves are the primary reason for the popularity of these beaches.

This combination of the surf zone, intertidal beach, dune systems and sometimes, river mouths and estuaries, is referred to as the **littoral active zone** of sediment transport. A change to any one of these parts impacts the entire system.

Battery Beach is the only fully dissipative beach in Durban. It has the most diverse beach life in Durban and acts as a 'source' of biodiversity for other Durban beaches. As one moves towards the exposed shores of the south coast of Durban (e.g., Bluff, Isipingo) beaches get more reflective. Beaches on Durban's north coast also have coarser sands and steeper slopes (e.g., La Lucia, Umdloti).

3. *More than sand: biodiversity of Durban's beaches*

At first glance, it is easy to understand why a casual observer may mistake sandy beach ecosystems as barren and sterile. They are physically demanding and dynamic environments that are continuously transformed by ocean currents moving sand on- and offshore; by waves crashing on the beachface; and by wind transporting sand to and from dunes. These factors make beaches **inhospitable** for most organisms.

However, hidden among the sand grains lies a hidden world composed of life that is **specially adapted** to the harsh beach environment, most of which do not occur in any other ecosystem. The unique biodiversity of sandy beaches comprise representatives from all the major food web components, including decomposers (bacteria and fungi), primary producers (small chlorophyll containing cells called diatoms), filter feeders (crabs and clams), carnivores (worms called polychaetes), scavengers (snails) and predators (birds and fish).

In terms of sandy beach **benthos**, the most important animals are **macrofauna** and **meiofauna**.

Mole crabs - *Emerita austroafricana and Hippa sp*. are common crustaceans on Durban's beaches. They're found in the swash zone, where they use their feathery antennae to strain plankton (on which they feed) out of the water. They are very fast burrowers and it is often difficult to catch a mole crab. However, they are made visible by the distinctive "V" patterns (see figure) that their antennae make in the sand as they filter feed.

Plough snails – *Bullia natalensis* uses its big "foot" to surf up and down the beach with the tides in order to scavenge on carcasses that have been stranded on the shore. They find carrion through the use of chemical cues. *Bullia* can be said to be one of the many cleaners on the beach. Together with mole crabs, plough snails are an important food source for birds and other larger animals inhabiting the beach.

Clams – More than pretty shells, *Donax madagascariensis* and *Tellina spp.*, are important filter feeders on sandy beaches. Many fish species feed on the delicate **siphons** of these animals. *Tellina* can grow to have a shell width of ~ 4 cm and are sometimes harvested by subsistence fishermen.

Donax

Tellina

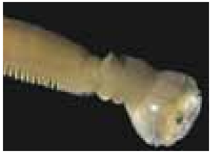
3.1 MACROFAUNA

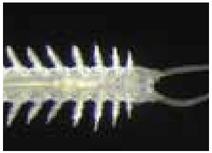
Macrofauna are small **invertebrates** that are defined by their habitats (living buried in the sand) and their size (larger than 1 mm). They are rapid burrowers to prevent being washed away by waves and tides; a fact that makes them difficult to see. The macrofauna on beaches are usually molluscs (snails), crustaceans (such as crabs and sea lice) and polychaetes (worms).

Macrofauna are one of the most important components of aquatic ecosystems for a number of reasons:

- They are ecological indicators of environmental pollution.
- Macrofauna are key **trophic links**: they occupy an intermediate level in marine food webs, that is they prey on smaller invertebrates and are prey to shore- and seabirds, surf zone fish and marine mammals. In this manner, they play an important role in energy transfer in marine ecosystems.
- Some species play a significant role in **nutrient cycling** and **organic matter mineralisation**, ensuring that our coastal waters are clean.

Pictured below are some of Durban's sandy beach polychaetes: *Scolelepis squamata*, *Glycera tridactyla* and *Glycera natalensis*, *Lumbrinereis sp.*, *Pisionidens indica*, *Pisione africa*.





Worms on the beach! – Durban beaches support several different polychaete species and they occur in abundances from 10 to more than 300 000 individuals per running meter metre of beach! Polychaetes on beaches can attain lengths of up to 10 cm, with body widths of up to 5 mm. They live in carefully constructed burrows in the sand where they aid in the deposition and breakdown of organic matter which would otherwise foul beaches.

Other crustaceans that can be found on Durban beaches include **isopods** (sandfleas), *Eurydice longicornis*, *Pontegeloides latipes*, *Excirolana natalensis* (RIGHT) and more rarely, **amphipods** (RIGHT BELOW) (*Mandibulophoxus stimpsoni, Urothoe grimaldi*).

Isopods and amphipods on Durban beaches can grow up to 1.5 cm although smaller forms of about 5 mm are more common

Ghost crabs (*Ocypode ryderi*) run so fast it looks like they're floating above the surface of the sand, hence the name. They are often used as fishing bait and like most beach animals, are important trophic links and beach cleaners.

Springtails (*Anurida maritima*) have little hydrophobic hairs on their bodies to allow them to stay above the surface of the water. In Durban, springtails can usually be found on beaches near rocky pools.

The beach is also an important place for the more iconic members of marine food webs like **birds** and **turtles** (although not on Durban beaches) that use beaches as nesting and breeding sites.

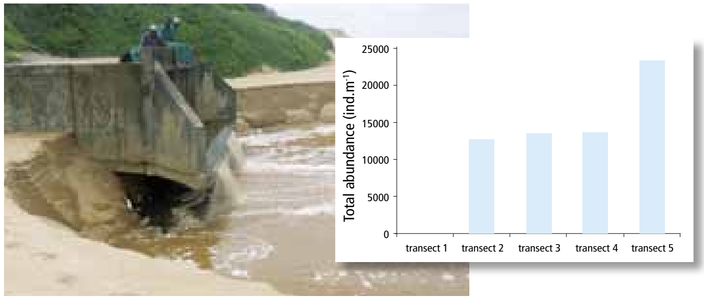
3.2 MEIOFAUNA

Meiofauna (derived from the greek *meio* meaning smaller) are similar to the macrofauna but instead of burrowing into the sand, meiofauna have special adaptations to live in the spaces between individual sand grains.

They are too small to be seen with the naked eye but meiofauna are functionally an extremely important group of organisms, perhaps even more so than the larger macrofauna.

- As **trophic links**, they transfer energy from the microbial/algal community to macrofauna and fish and bird predators.
- As agents of **bioturbation**, meiofauna increase the availability of detritus to detritivorous consumers. Through feeding and respiration (breathing), meiofauna break down large particles, making it easier for other animals to ingest.
- They play an important role in **mineralization** of organic matter and in **nutrient cycling** in marine ecosystems, ensuring productivity of the coast and keeping it clean.
- Their small size, relatively fast generation times and fast metabolic rates, make meiofauna a good indicator of environmental disturbance. For example, meiofaunal crustaceans are very sensitive to pollution and disappear from heavily polluted ecosystems. These polluted habitats are then dominated by worm-like nematodes. This can then give a clues as to the health of a system.
- Being among the first invertebrates to colonise areas of disturbance, meiofauna are essential components to **ecosystem resilience**.

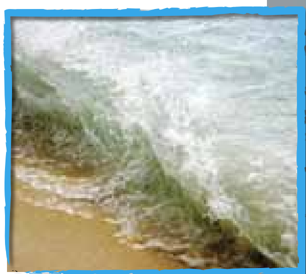
Meiofauna are the most abundant animals on sandy beaches. They can occur in numbers of up to six million individuals per running metre of beach!

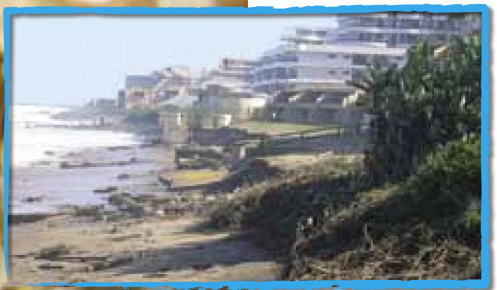


At La Lucia and Umdloti, surveys showed that meiofauna abundances were drastically reduced near stormwater outlets. This is because these animals are extremely sensitive to environmental disturbance. Transect one was closest to the stormwater outlet and transect 5, furthest away.

4. *Ecosystem services provided by beaches*

- **Storm protection**: Dunes on the beach backshore naturally protect coasts from storms.
- **Coastal Buffers**: Beaches absorb and dissipate the potentially destructive energy of waves.
- **Nutrient cycling**: Beach animals are important to both marine and terrestrial food webs and play a crucial role in nutrient cycling. This ensures the continued productivity of the coastal zone on which humans and other animals depend.
- **Biofiltration and detoxification**: Beaches are large biological filters. The sand, and the organisms that live within, clean and detoxify our coastal waters through a process known as biofiltration.
- **Nesting and breeding sites**: Beaches often function as pantries and nursery grounds for many threatened vertebrates (turtles, birds and fish).
- **Recreation and tourism**: Durban beaches are tourism hotspots because the region as a whole enjoys good weather all year round. Tourism is very important to the local economy.
- **Subsistence harvesting and recreational fisheries**: Some animals (clams and crabs) are harvested by rural communities and fishermen often use beach animals as bait.





6. Threats to Durban's sandy beach ecosystems

- **Climate change**: Threatens beach systems from the seaward side due to predicted increase in the severity and frequency of storms, and sea level rise. Storms will further erode beaches and sea level rise will drown them.

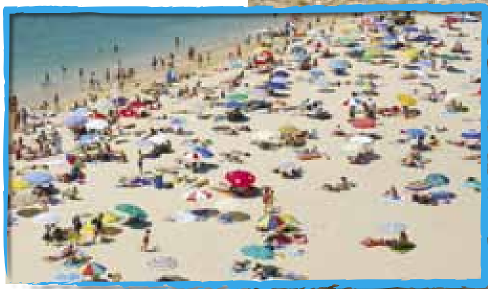
- **Coastal infrastructure and development**: Together with sea level rise, encroaching developments result in beaches being trapped in a coastal squeeze. Beaches would normally migrate landward in response to sea level rise but these hard structures mean that beaches have nowhere to go. Navigational channels and pipelines built at sea also disrupt sediment movement, negatively impacting beach ecosystems, increasing beach erosion.

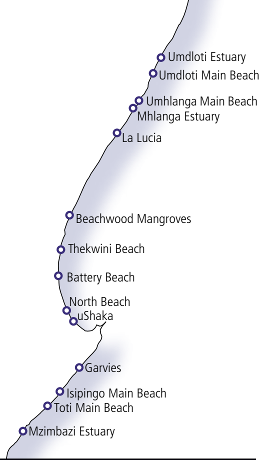
- **Shoreline armouring and erosion**: As humans continue to build on dune systems, we face the growing problem of erosion. To counteract this, we build seawalls and groins. These structures further stress the beach ecosystem by disrupting the natural sand movement processes. This is going to become a larger problem as we start experiencing the effects of climate change.

- **Beach nourishment**: As beaches erode and coastal property gets threatened, humans try to prevent this by adding sand to the beach. Beach nourishment, if done incorrectly, can be detrimental to the animals that live on the beach.

- **Sandwinning and dam construction**: Upstream impacts like sandwinning and the construction of dams may contribute to the loss of beaches by robbing the beach of sand carried down by river systems.
- **Resource exploitation**: The unsustainable harvesting of beach organisms negatively impacts coastal food webs.
- **Pollution**: Agricultural, domestic and industrial pollutants from upstream ultimately end up on the beach and in the sea. These are harmful to marine life, often resulting in decreases in biodiversity and the disruption of ecosystem functioning.
- **Grooming and cleaning**: Mechanical cleaning of beaches provides a beach free of rubbish and improves its aesthetic appeal but it also severely disrupts natural ecological processes. Removing wrack deprives the beach of an essential habitat. Wrack also assists in the growth of dunes by stabilising wind-blown sediment.
- **Recreation and tourism**: Damage to organisms through trampling and off-road vehicles.

Because we've taken these systems for granted for so long, it is difficult to fully understand the ramifications of losing them. Not only will we lose a unique and poorly understood biodiversity but also critical and irreplaceable ecosystem services.





7. A survey of Durban's sandy beaches

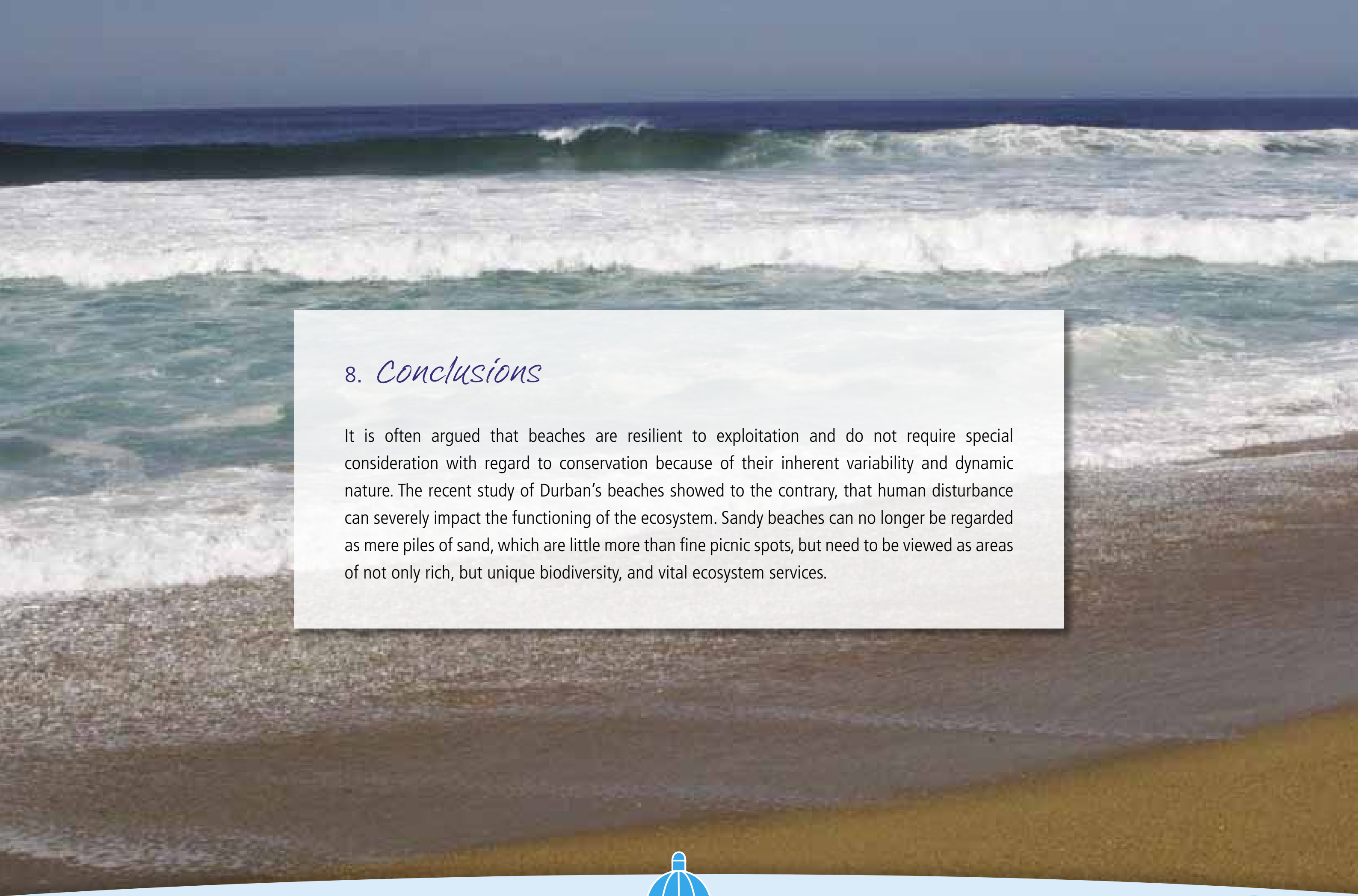
Despite South Africa being a leader in sandy beach research, Durban's beaches have been neglected in terms of this research mostly because they were previously thought to be barren and sterile. The first comprehensive survey of representative sandy beaches along the Durban coastline was conducted in 2007/2008. This study found that Durban beaches, despite being highly urbanised, had rich and abundant animal communities. The following table summarises some of the findings of that study.

D = DIVERSITY/NUMBER OF DIFFERENT SPECIES FOUND and AB = ABUNDANCE OR TOTAL NUMBER OF INDIVIDUALS PER RUNNING METRE OF BEACH ("running metre" is a unit of measurement used by beach ecologists that takes into consideration the area sampled and the total area of the beach).

BEACH	MACROFAUNA		MEIOFAUNA		THREATS	INTERESTING FEATURES
	D	AB	D	AB		
Mdloti Estuary Beach			19	5 282 030	nutrient loading from eutrophic estuary, development on dunes.	Very high meiofauna diversity dominated by crustaceans.
Umdloti Main Beach			19	6 214 906	storm water outlets, excessive development, pollution from stormwater outlets	This highly urbanised and disturbed beach had interesting patterns in meiofauna distribution. Virtually no animals were found near the stormwater outlet. As one moved further away, meiofauna abundance increased. Meiofauna communities are unable to cope by high levels of anthropogenic disturbance (in this case freshwater intrusion and erosion caused by the stormwater outlet) and thus do not colonise the area of disturbance.
Mhlanga Estuary Beach			12	1 381 706	pollution from estuary	Estuary beaches are thought to be more productive than ordinary beaches. It was therefore surprising that this beach had such a low diversity of animals. This may be a as a result of pollution from the adjacent estuary.

Umhlanga Main Beach			10	3 419 760	erosion, beach nourishment after storm events altering beach type, storm/waste-water outlets	Following storm events this beach has changed from being more reflective to being more dissipative. Meiofauna was dominated by nematodes which are more tolerant to disturbance. This is an indication of the declining health of this beach.
La Lucia	11	401515	19	5 695 974	storm water outlets on beach, excessive development on dunes	Most reflective beach in the EMA. Globally, the trend is that reflective beaches have an impoverished macrofauna. La Lucia, however, has the second most diverse and most abundant macrofauna of the sampled EMA beaches. Also, like Umdloti, samples near the stormwater outlet showed that hardly any meiofauna colonised this area of the beach. Sensitive meiofauna communities cannot establish viable populations in the face of anthropogenic disturbance.
Beachwood Mangroves			19	3 471 504	pollution from Umgeni estuary	Only beach that was studied in the EMA that had a population of the molecrab, Hippa sp. Because it is a relatively low access beach, disturbance is minimal and ghost crabs abound.
Thekwini Beach	10	1157	11	7 492 228	development, trampling	One of the longer beaches in the EMA. Central Durban beaches may act as sources of biodiversity for other beaches in Durban.
Battery	13	2311	20	6 446 881	development, trampling	Only dissipative beach in the EMA with highest macrofauna and meiofauna diversity. Beach diversity on this beach is comparable to KZN beaches in reserves e.g., Cape Vidal and Sodwana. This beach type has been shown globally to support a high diversity of animals. Despite Battery's high levels of urbanisation, it is still an important biodiversity source for EMA beaches. Recent dune rehabilitation projects on this beach is likely to enhance the functioning of this beach.
North Beach			17	6 596 562	development, trampling, erosion	Central Durban beaches may act as sources of biodiversity for other beaches in Durban.

uShaka	10	2894	16	6 796 650	development, trampling, erosion	Underlying layers of this beach is composed of large rocks, possibly from the harbour. This could injure beach animals. Central Durban beaches may act as sources of biodiversity for other beaches in Durban.
Garvies	6	61951	14	2 949 699	harvesting, development, off-road vehicles	This beach is very productive because of the rocky shore. Ghost crabs can be found in high abundances. Seaweed from the rocky shore washes up onto the beach, resulting in a well developed drift line.
Isipingo Main Beach			12	2 362 448	pollution, harvesting, development	A notable feature of this beach is the many dead beach animal carcasses strewn about the shore. Once a very diverse sandy beach and rocky shore, Isipingo is now losing many invertebrate species because of trampling and harvesting.
Toti Main Beach			11	520 644	development, trampling, erosion, pollution	Such low meiofauna abundances are an indication that this beach is in a poor state. It was impacted very severely by storm events and the beach has never fully recovered because of the high degree of urbanisation of the surroundings.
Toti Estuary Beach			6	884 122	development, trampling, pollution, erosion	Toti beach had the lowest number of meiofauna species. In addition to excessive development and high levels of recreation, this beach is also affected by a polluted estuary. The meiofauna community structure may reflect thepoor quality of this beach. Measures must be put into place to ensure continued ecosystem functioning.
Mzimbazi Estuary Beach			17	6 170 352	development	The dune system of this beach is in a relatively good condition. Unlike the more urbanised beaches, this beach is long and wide and supports a healthy meiofauna population.



8. Conclusions

It is often argued that beaches are resilient to exploitation and do not require special consideration with regard to conservation because of their inherent variability and dynamic nature. The recent study of Durban's beaches showed to the contrary, that human disturbance can severely impact the functioning of the ecosystem. Sandy beaches can no longer be regarded as mere piles of sand, which are little more than fine picnic spots, but need to be viewed as areas of not only rich, but unique biodiversity, and vital ecosystem services.

ETHEKWINI MUNICIPALITY

For further information contact:
Natasha Govender
Environmental Management Department: eThekwini Municipality
031 311 7144 / 031 311 7875
govendernatasha@durban.gov.za
www.durban.gov.za

PHOTOGRAPHS HAVE BEEN SUPPLIED BY: DR. AJ SMIT, MR. ALISTAIR MCINNES, MS LINDA HARRIS AND MS NATASHA GOVENDER