

**UPL Chemical Spill  
Scientific rationale for the maintenance of an Exclusion Zone during  
the restoration phase of the uMhlanga Estuary.**

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**TABLE OF CONTENTS**

|   |           |
|---|-----------|
| <b>1 PREFACE .....</b>  | <b>1</b>  |
| <b>2 INTRODUCTION .....</b>   | <b>2</b>  |
| 2.1 Converging Pathways at the Estuary – Mouth Dynamics, Disturbance and Restoration..... | 2         |
| <b>3 EVIDENCE OF IMPACT BY RECREATIONAL ACTIVITIES .....</b>                              | <b>3</b>  |
| 3.1 Understanding the impacts of human and dog disturbance on beaches and estuaries.....  | 3         |
| <b>4 EXCLUSION ZONE AS A RESTORATION INTERVENTION .....</b>                               | <b>6</b>  |
| 4.1 Birds as dispersal agents .....   | 6         |
| <b>5 CONCLUSIONS AND RECOMMENDATIONS .....</b>  | <b>8</b>  |
| <b>6 REFERENCES .....</b>   | <b>10</b> |

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**1 PREFACE**

This report is submitted as a stand-alone document focussed on the scientific rationale for the recommendation to continue to implement an exclusion zone in the estuary and immediately adjoining beaches. This version of the report deals only with the background information which expands on and supports the recommendations in the MER Status Report ver 3.6.

## 2 INTRODUCTION

Urban coastal ecosystems provide the essential service of tourism and recreation. However, these ecosystems also support critical ecological functions and biodiversity conservation which are seldom considered or prioritised. Despite being important natural and economic resources, these urban systems have not received adequate attention and, consequently, the management of sandy beaches has not been founded on an ecologically sustainable basis.. This point comes into stark focus when considering the restoration of the uMhlanga estuary

### 2.1 Converging Pathways at the Estuary - Mouth Dynamics, Disturbance and Restoration.

Monitoring of the uMhlanga estuary over the past twenty-four months has clearly shown that the mouth dynamics of the estuary have begun to change. The estuary is closing for longer periods and moving towards a condition more akin to the historical mouth state pattern. This is considered e a positive progression towards the restoration of the estuary. Pre-spill condition was a D category. After the spill the estuary health state was rated an F, the lowest possible, but more recently in July 2023 was rated at an E.

Continual disturbance at the estuary and the immediately adjacent beaches does however have the potential to impede further progress and negatively affect the estuary in three ways:

- a) Increased pedestrian traffic past or in the vicinity of the estuary has increased and will increase the risk of artificial breaching during the beneficial low flow, closed periods. Since the rejection of responsibility for the maintenance and management by UPL , communicated by Mr N. Brauteseth on the 26 July 2023 without discussion with the MER team, disturbance has escalated significantly at the estuary. This has not only had significant impacts as per b) and c) below but has significantly increased the risk of the artificial breaching tuary referred to above. A breaching attempt was observed by MER during the September 2023 monitoring visit and again more recently during a site visit by the authorities. The same risk was highlighted on Monday 9<sup>th</sup> October in MER's presentation at the JOC/UPL Specialist meeting.
- b) Disturbance of all fauna contributing to the biodiversity and ecological functioning of beaches which cause declines with wider ecological ramifications for nutrient cycling, coupling of terrestrial and marine systems via the incorporation of material delivered by estuaries, provision of food for fishes and birds and trophic subsidies. The data collected by this study regarding ghost crabs showed the conclusive evidence of the impacts of disturbance.

- c) Disturbance to the waterbird and shoreline birds have a direct impact on the estuary health index score and will influence the assessment of restoration. In addition, disturbance of the bird fauna can be an indirect negative influence with increasing evidence suggesting that bird-mediated transport is an important mechanism for many invertebrates.

### **3 EVIDENCE OF IMPACT BY RECREATIONAL ACTIVITIES**

Beaches and estuary mouths are critical habitats for a diverse range of species, including shorebirds, fish, invertebrates, and plants. These habitats are often subject to disturbance by activities related to recreation as well as the presence of dogs, both of which can have significant negative impacts on biodiversity.

It must be noted that beaches and estuary mouths are dynamic habitats that are subject to a wide range of natural disturbances. While physical disturbance is a natural part of estuarine ecosystem dynamics, excessive or inappropriate disturbance can have significant negative impacts on biodiversity (Turbelin *et al.* 2015). The problem of disturbance on beaches and estuary mouths is complex, with a range of contributory factors, including human population growth, urbanization, and the increasing popularity of outdoor recreation. The MER team has explored the impacts of disturbance on beaches and estuary mouths by people, recreation, and dogs as part of the analysis of the restoration and recovery process following the UPL Chemical Spill.

#### **3.1 Understanding the impacts of both human and dog disturbance on beaches and estuaries.**

The potential effects and impacts of disturbance have been widely recognised in conservation legislation and agreements, as has the need to develop conservation measures to protect fauna using estuaries, particularly water associated or dependent birds. This is notably true for estuaries along the South African coast as these are highly significant nodal areas for feeding, roosting, and breeding. In estuaries, movements of people and dogs typically constitute a major disturbance, particularly if they are intensive or occur over prolonged periods, as exemplified by the uMhlanga estuary.

The size of the area available to birds significantly affects levels of disturbance. On small estuaries there may be very few alternative locations available for birds moving away from a disturbance, and it takes only a few repeated activities to make much of such an area unacceptable to roosting or resting birds. The scientific evidence for this is clear and is summarised below.

The main sources of disturbance on beaches and estuary mouths are human recreational activities, such as walking, jogging, beachcombing, swimming in the estuary or dog walking, which can cause physical damage to habitats and disrupt wildlife behaviour (Schlacher *et al.* 2019).

Recreational activities by people alone can also cause degradation or loss of habitat and consequently impact the diversity and abundance of aquatic organisms (Venohr *et al.*, 2018). The term ecological impact indicates an undesirable change as a result of anthropogenic use (Cole & Hammitt, 1998), but is a more precise term than disturbance because the term disturbance is value loaded. Ecological impact is therefore the term used in this report. The (ecological) impact of visitors on natural areas depends not only on the overall number of visits, but also on the duration and type of activities and the fragility of the respective ecosystem or species under consideration.

A broad global analysis of the ecological impacts of recreational activities in aquatic habitats shows that the responses of organisms to human disturbance differ substantially. For example, fish, amphibians, reptiles and birds will leave an area and change their location as a reaction to human disturbance. Similarly, mobile invertebrates react to temporary disturbance with migration to undisturbed areas. Recolonization may occur but is not necessarily always the case.

Dogs cause disturbance to beach and estuary fauna, which can have significant cascading impacts on ecosystems. For example, the presence of dogs will disrupt nesting activities of shorebirds, leading to reduced reproductive success and ultimate declines in population numbers. This can be an impact that goes way beyond our borders with Palaearctic migrant disturbance being a critical feature. Studies supporting these statements include several studies that have demonstrated that walkers and particularly walkers with dogs will increase the disturbance and reduce the abundance of shorebirds. For example, a study conducted in the United Kingdom found that the presence of people and dogs reduced the abundance of dunlins (*Calidris alpina*) by 50% and reduced the foraging success of redshanks (*Tringa totanus*) by 66%.

The African-Eurasian Migratory Waterbird Agreement (AEWA) is an international treaty that aims to promote the conservation and sustainable use of migratory waterbirds and their habitats across Africa, Europe, the Middle East, and parts of Asia. It is an intergovernmental agreement under the framework of the Convention on Migratory Species (CMS). South Africa is one of the signatory countries of AEWA and plays an important role in the conservation and management of migratory waterbirds. As a signatory to AEWA, South Africa is committed to

implementing measures to protect and conserve migratory waterbirds and their habitats. This includes the establishment and management of protected areas, monitoring, and research programs, promoting international cooperation, and raising awareness about the importance of migratory waterbird conservation. This speaks to the need for effective management strategies to minimize the impacts of human recreation and dogs on biodiversity in beaches and estuary mouths in the long term, but in the short to medium-term it is even more critical given the current ongoing monitoring and assessment in this zone which will determine the outcomes or future actions.

Dogs can also disturb the foraging and resting activities of mammals, which can impact their survival and reproductive success (Weston & Stankowich 2018). However, even more subtle are the various indirect effects that can influence the overall ecological dynamics of these habitats. A few examples are provided below:

- a) **Alteration of Animal Behaviour:** The presence of dogs can cause changes in the behaviour of wildlife. Animals may alter their activity patterns, feeding behaviour, or breeding activities in response to the presence or scent of dogs. This disruption can affect their normal ecological interactions and potentially lead to reduced foraging efficiency, altered predator-prey dynamics, or changes in reproductive success.
- b) **Impacts of Dogs on Water Quality:** dogs are often allowed on beaches, and their presence can have significant impacts on water quality, as they can introduce faecal coliform bacteria into the water (Green *et al.* 2019). This can be a particular problem on estuaries that are used as safe swimming areas for particularly smaller bodied individuals such as children, as the bacteria and the other pathogens that their presence indicates may pose a significant health risk to humans.
- c) **Habitat Avoidance:** Wildlife may actively avoid areas where dogs are frequently present. This avoidance behaviour can lead to habitat fragmentation, where certain areas become underutilized or inaccessible to wildlife. Consequently, this can result in a loss of available habitat and restricted movement patterns for various species.
- d) **Nesting Disruption:** Dogs can disturb nesting sites of birds, or other animals that rely on beaches and estuaries for reproduction. The disturbance of nests can lead to nest abandonment, egg damage, or increased vulnerability to predators. Such disruptions can have cascading effects on population dynamics and reproductive success.
- e) **Altered Trophic Interactions:** Dogs may impact the ecological balance by affecting the abundance or behaviour of prey species. For instance, the presence of dogs can disturb small mammals, shorebirds, or intertidal organisms, leading to changes in

their populations or distribution. This, in turn, can affect the food availability for other predators or disrupt the trophic cascades within the ecosystem.

The use of ghost crabs are known significant indicators of recovery. However, they are also vulnerable to recreational disturbance on beaches. A study by Schlacher *et al.* (2014) found that ghost crab abundance and burrow density decreased with increasing levels of beach use. This suggests that ghost crabs are sensitive to recreational disturbance. In support of this, a study by Vasconcelos *et al.* (2016) found that ghost crabs were affected by different types of disturbance, including beach nourishment, construction of artificial structures, and recreational activities. ghost crabs are good bioindicators of disturbance because they are responsive to a range of stressors and are easily monitored. Therefore, incorporating ghost crab abundance and burrow density data into beach monitoring programmes provided valuable insights into the effects of recreational disturbance on beach ecosystems.

## **4 THE IMPLEMENTATION OF THE EXCLUSION ZONE AS A RESTORATION INTERVENTION**

The exclusion zone was recommended in May 2023 to facilitate and potentially enhance restoration benefits for beach and estuary organisms with the most obvious of these being the invertebrates (with ghost crabs as the indicator), as well as the shorebirds and waterbirds. Both are key indicator groups which were selected in this project by agreement between UPL and authorities following specialist recommendations, to monitor the onward recovery of the estuary and adjacent beaches.

### **4.1 Birds as dispersal agents**

Waterbirds can serve as important dispersal agents for invertebrates in various ways. This dispersal process is known "avian-mediated dispersal". There are many examples in the literature which show that there are a number of viable ways this can occur:

- ❖ Transport on feathers and feet: Invertebrates like insects, snails, and various aquatic organisms can attach themselves to the feathers and feet of waterbirds. As birds move between different aquatic habitats, these invertebrates can hitch a ride, allowing them to colonize new areas. This passive mode of dispersal is particularly relevant for smaller invertebrates.

- ❖ Ingestion and Excretion: Some invertebrates have adaptations that allow them to survive passage through the digestive systems of waterbirds. For example, seeds and eggs of aquatic invertebrates like crustaceans may pass through a bird's gut unharmed and be excreted intact in a new location, aiding their dispersal. These have been shown to remain viable.
- ❖ Adherence to mucous secretions: Certain invertebrates have specialized structures or adaptations that allow them to adhere to the mucus secretions on the bodies of waterbirds. These invertebrates can be transported as the bird travels between different wetland areas.
- ❖ Nesting Material: Waterbirds often use materials from aquatic environments to build their nests. In the process, they inadvertently transport invertebrates, such as aquatic insects and snails, to new locations. These invertebrates may then colonize the new habitat.
- ❖ Intergenerational Dispersal: In some cases, invertebrates lay their eggs on or near waterbird nests. When the young birds fledge and leave the nest, they may carry the invertebrate eggs with them, dispersing them to new locations.
- ❖ Long-Distance Dispersal: Waterbirds often cover large distances during their migrations, which can enable the dispersal of invertebrates over long distances. This can be especially important for species that have limited mobility on their own.

It's important to note that the effectiveness of waterbirds as dispersal agents for invertebrates can vary depending on the specific species of bird and invertebrate, as well as the environmental conditions. Nonetheless, this mode of transfer plays a significant role in the distribution and colonization of invertebrates in wetland ecosystems and beyond.

Waterbirds are now recognised as vital vectors of dispersal for all kinds of organisms, and their dispersal capacity constitutes one of the most important ecosystem services provided by these birds (Green & Elmberg, 2014). Waterbirds are excellent for long-distance dispersal (LDD), whereas other vectors such as fish and mammals disperse similar propagules, but over shorter distances. Empirical studies of internal and external transport by waterbirds have also shown that the former mechanism generally is more important (Green *et al.* 2023). Recent spatially explicit models of seed dispersal by waterbirds have been expanded to include invertebrate dispersal, and to compare multiple bird species in the same landscape. Internal transport is widely recognised for aquatic plants and aquatic invertebrates with resting eggs,

but also is important for other organisms (e.g., terrestrial flowering plants not dispersed by frugivores, bryophytes, tardigrades, crustaceans, fish eggs).

## **5 CONCLUSIONS AND RECOMMENDATIONS**

The significance of the exclusion zone has been underscored by the positive transformations in sandy beach invertebrates and, particularly, the notable changes in the waterbird community. It was considered that the aggregations of large flocks of waders (particularly those that travel great distances) and other large-bodied wading birds, such as Woolly-necked storks, at the estuary was of paramount importance as they play a pivotal role in the dispersal of plant propagules and invertebrates among estuaries and various wetland ecosystems (Okamura *et al.* 2019; Green *et al.* 2023).

To this end, it is recommended that the exclusion zone be maintained, to exclude all recreational beach users and dogs, but shortened as per Figure 5-1. It is important that this still includes a short stretch of beach either side of the estuary. It is recommended that the exclusion zone is maintained, until the conclusion of the 2023/2024 summer season (March/April 2024). This measure is especially vital in light of the escalating foot traffic and canine presence which has occurred during August and September 2023 as a result of the removal of the security guards, signage and protective barriers in this zone. This is considered an important restoration intervention for the estuary.

It was mooted in May 2023 that if the exclusion zone was not implemented this would be prejudicial to the monitoring and assessment of the estuarine restoration process. This remains the case, with data analysis from July 2023 indicating restoration of the estuary remains an issue. For example, recovery is evaluated in part based on shorebird and water bird counts and this is in turn affected by consistent disturbance and flushing of these species by people and dogs this would result in the data interpretation around UPL's responsibility for restoration being jeopardised.

The benefits of the exclusion zone have now become even more apparent with a scan of the restoration literature revealing the possible recolonisation of the estuary with the assistance of birds. It is therefore recommended that the closure of the estuary water area and shorelines, along with a short stretch of adjacent beaches is maintained up until at least end of March 2024. This will be the point at which the next steps will be considered, and the health of the estuary and beaches will determine the need for any future action on this matter. As a final point it is again stressed that the progress of estuary restoration is completely contingent on upstream (sub-slab, tributary and wetland) activities and restoration.



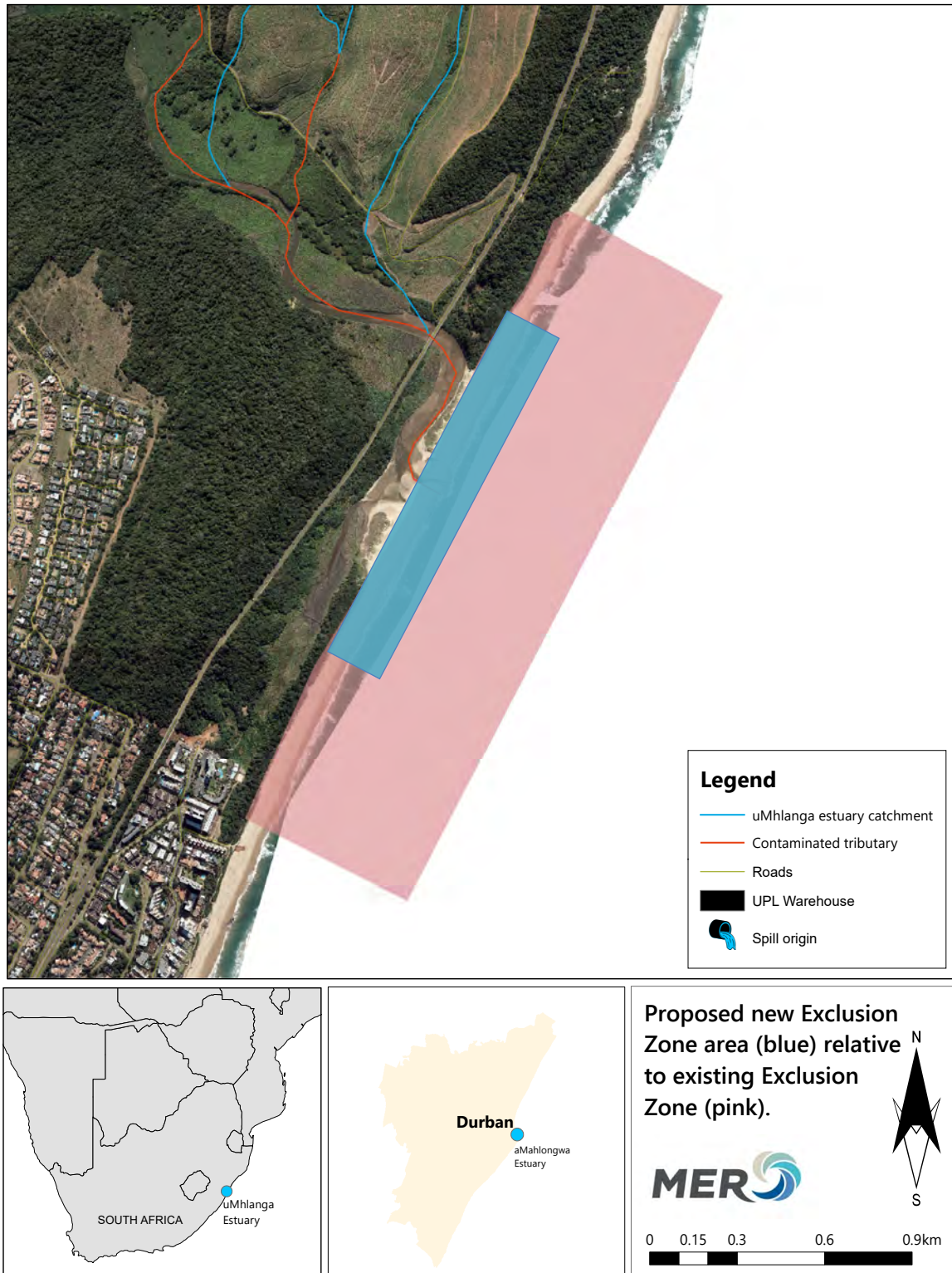


Figure 5-1 Proposed new exclusion zone area (blue) with existing exclusion zone indicated (pink)

## 6 References

- Cole, D.N. & Hammitt, W.E. 1998 *Wildland recreation / ecology and management*, Wiley
- Green, H., Hart, M., & Baldock, K. (2019). Impacts of dogs on wildlife and water quality: A review and synthesis of current literature. *Conservation Science and Practice*, 1(12), E92.
- Green, A. J., & Elmberg, J. (2014). Ecosystem services provided by water- birds. *Biological Reviews*, 89, 105-122.
- Green, A. J., Lovas-Kiss, Á., Reynolds, C., Sebastián-González, E., Silva, G. G., Leeuwen, C. H. A. V., & Wilkinson, D. M. (2023). Dispersal of aquatic and terrestrial organisms by waterbirds: A review of current knowledge and future priorities *Freshwater Biology* 68(2). Wiley-Blackwell.
- Meyer, N., Schafft, M., Wegner, B., Wolter, C., Arlinghaus, R., Venohr, M., and von Oheimb, G. 2021. A Day on the Shore: Ecological impacts of non-motorised recreational activities in and around inland water bodies. *Journal for Nature Conservation*, Volume 64.
- Okamura, B., Hartikainen, H., & Trew, J. (2019). Waterbird-mediated dispersal and freshwater biodiversity: General insights from bryozoans. *Frontiers in Ecology and Evolution*, 7, 29
- Schlacher, T. A., Lucrezi, S., Peterson, C. H., Connolly, R. M., Olds, A. D., Althaus, F., Hyndes, G. A., & Weston, M. A. (2014). Seafloor denudation correlates with ghost crab burrow density on sandy beaches. *Estuarine, Coastal and Shelf Science*, 138, 35-41.
- Schlacher, T. A., Weston, M. A., Lynn, D. H., Schoeman, D. S., Huijbers, C. M., Olds, A. D., ... & Connolly, R. M. (2019). Beaches, birds, and biases: informing effective threatened shorebird management through quantifying human disturbance. *Journal of Applied Ecology*, 56(6), 1400-1411.
- Turbelin, A., Malhi, Y., & Gerard, F. (2015). Impacts of human disturbance on large-scale patterns of biodiversity. *Biological Conservation*, 191, 11-19.
- Vasconcelos, R. P., Martins, G. M., Bertocci, I., Sousa-Pinto, I., & Jenkins, S. R. (2016). Ecological effects of coastal defence structures on sandy shores: exploring methods and research priorities. *Estuarine, Coastal and Shelf Science*, 169, 109-122.
- Weston, M. A., & Stankowich, T. (2019). Dogs as agents of disturbance. *Biological Reviews*, 94(4), 1392-1413.

Venohr, M. Langhans, S.D., Peters, O., Hölker, F., Arlinghaus, R. Mitchell, L. & Wolter C. (2018). The underestimated dynamics and impacts of water-based recreational activities on freshwater ecosystems. *Environmental Reviews*, 26 (2) (2018), pp. 199-213,

Yalden, D.W. (1992) The influence of recreational disturbance on common sandpipers *Actitis hypoleucos* breeding by an upland reservoir. England. *Biological Conservation*, 61 (1), pp. 41-49.

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