CoastAdapt

Snapshot

Living between the sand grains: Beach nourishment and benthic macroinvertebrates

Summary

Sandy beaches hold high social, economic and biological values for Australian society. Beaches provide endless recreational spaces, aesthetic value, nutrient cycling, protection against extreme wave events and habitat for a wide range of fauna. As climate change and coastal development increase, one predicted consequence is the acceleration of beach erosion. Around Australia and globally, beach nourishment is increasingly being used to combat this issue. While this practice is protecting the social and economic value of beaches, its impact on Australian sandy beach ecosystems remains poorly understood. This snapshot focuses on the impact of beach nourishment on macroinvertebrate communities — macroinvertebrates are a form of minute fauna that reside between the sand grains and that have an important role in cleaning our oceans. We outline considerations and procedures that have been used in several marine rehabilitation projects and that may assist with the recovery of this important faunal community.

Keywords

Beach nourishment, macroinvertebrates, sand replenishment, biodiversity, beach scraping

Introduction

Coastal erosion is increasingly becoming a problem faced by coastal managers, planners and scientists. Finding a suitable and sustainable way to adapt to this issue continues to be a challenge. A variety of control mechanisms are being implemented around the world, including artificial reefs, breakwaters, seawalls, mats, groynes, dissipation of wave energy, sand-wetting devices that reduce wind-based sand loss, and beach dewatering systems. Unfortunately, most are focused on shoreline stabilisation and preservation of oceanfront buildings and infrastructure rather than protection of ecosystems or beach quality (Pilkey and Cooper 2012). Typically, there are three types of erosion control:

- soft stabilisation (e.g. beach nourishment)
- hard stabilisation (e.g. seawalls or other structure)
- retreat from the shore.

All three options have advantages and disadvantages around environmental, economic and social values.

Around Australia and globally, the method of beach nourishment is increasingly being used to combat coastal erosion (see Figure 1). Commonly used beach nourishment practices include:

- replenishment (the use of sand from the same coastal or adjacent area)
- artificial nourishment (the importation of sand to a beach from a site external to the beach's immediate or adjacent area)
- beach scraping (the mechanical redistribution of sediment from the intertidal zone to the backshore).

Beach nourishment was conducted on 130 beaches in Australia between 2001 and 2011 (Cooke et al. 2012); however, very few of these projects considered monitoring of efficacy or biological impact. This is particularly unfavourable to macroinvertebrates, as the largest biological impact of beach nourishment will be on this small form of fauna that resides between the sand grains, and that has a very relevant role in maintaining marine recreational spaces.

The role of macroinvertebrate communities

Invertebrates are animals that do not have a backbone or spine. This includes animal such as arthropods (insects, mites and crayfish), molluscs (snails, mussels and octopus) and annelids (earthworms, brittle worms and leeches). Some examples are shown in Figure 2. In an aquatic habitat, 'macroinvertebrate' is the term given to animals without a backbone, that are large enough to be seen with the naked eye and can be captured in a 0.5 mm net or sieve. In a marine habitat this includes beach worms and crabs, while in a freshwater habitat this also includes insects and their larvae.

Macroinvertebrates are a vital component of the benthic ecosystem, from both environmental and economic perspectives. These communities have an important role as:

Ocean cleaners
They tunnel through the sediment, feeding on organic material and breaking down detritus, which increases nutrient cycling and oxygen levels in the sediment.

Food source
They are a key component of marine food webs: during low and high tide macroinvertebrates provide food for fish and birds. They are also important for humans, since beaches are filled with delicacies like clams, oysters, mussels, sea cucumbers and even worms.

Industrial supply
The economic importance of macroinvertebrates, particularly marine worms (polychaetes), is increasing. The *Onuphidae* and *Eunicidae* worms (see Figure 3) commonly found along Australian beaches are often collected for bait fishing. They are also used on a commercial scale to feed prawns and fish in aquaculture.

Environmental indicator
They are commonly used as indicators of environmental quality. In particular, the *Capitellidae* and *Spionidae* worms are abundant in habitats affected by nutrient loading. Macroinvertebrates also play an essential role in the rehabilitation of damaged ecosystems.

Figure 1: Sand nourishment pump in action, Woorim, Bribie Island. Source: © The State of Queensland (Department of Environment and Heritage Protection).

Figure 2: Selection of bivalves (clams) and gastropods (snails) from the intertidal zone. Photo: © Shona Marks – Benthic Australia.

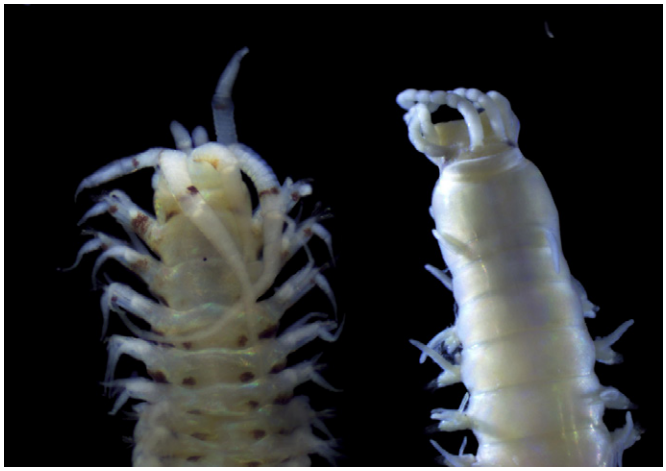

Figure 3: Onuphidae and Eunicidae worms are commonly found along Australian beaches and are often collected as bait for recreational fishing. Photo: © Shona Marks – Benthic Australia.

Beach nourishment and macroinvertebrates

The impact of nourishment on Australian sandy beach ecosystems remains poorly understood. Beach nourishment is considered to be one of the most environmentally friendly options for coastal erosion control, however most research indicates that there is a negative effect on macroinvertebrates as:

- mortality is high at the sand collection site because fauna is crushed and impacted by disturbance of sediment during collection
- mortality is also high at the nourishment site, as macroinvertebrates are buried and crushed by replacement sand
- the weight of bulldozers during beach sculpting further crushes any surviving fauna
- changes to critical habitat properties—such as the size of sand grains, beach slope, beach width and tidal reach—will impact the species that can survive in the nourished area.

The few ecological studies that have been conducted show that recovery of macroinvertebrates can take days or even months to occur. One study (Schlacher et al. 2012) showed that nourishment impacts were not uniform across the intertidal zones. The sediment of the upper shore level lost all invertebrates when it was tested two days after nourishment. This means that all of the original fauna died, and suggests that any fauna that may have come over from the collection site died upon deposition. Five months after the nourishment, the degree of recovery varied at different levels of the intertidal zone. The upper level was still azoic and recovery had not begun, whereas species richness appeared to have been full restored at the mid and low shore (Schlacher et al. 2012). One possible explanation is that the lower intertidal zone was recolonised with fauna that were being transported in the water column from undisturbed parts of the beach.

Recommendations

The following considerations and procedures have been used in other marine rehabilitation projects and may assist with the recovery of macroinvertebrates after beach nourishment practices:

- limit use of heavy machinery to minimise the fauna being crushed by the weight
- leave unfilled intertidal refuge islands or strips of undisturbed sand to allow surviving organisms to recolonise (these should be no-drive zones for machinery)
- ensure the size of the sand grains in the fill sand is similar to that of the area being nourished
- use techniques that spread the fill sand in thin layers over a few days to minimise mortality by burial
- consider the height and position of sand placement - place the sand in the subtidal zone and allow slow wave distribution of sand up the beach
- collect sand and macroinvertebrates before nourishment and use this to "seed" beach after nourishment; this will assist fauna with no planktonic larval stage.

There is a large amount of scope for more research in this area, both from an ecological impact assessment perspective, and also to determine the effectiveness of different techniques to encourage macroinvertebrate recovery. As climate change and coastal development increase the potential for beach erosion to occur, consideration must be given to maintaining the biodiversity of macroinvertebrates, so these small animals can continue maintaining the health of our beaches and ocean waters.

References

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Further reading

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