The ecological and economic analysis of beach management strategies:

Assessing the ecological impact of beach clearing on coastal biodiversity in Scotland.

My thesis aimed to use the two disciplines of ecology and economics in order to provide useful management advice for beach managers. In order to understand the best management options for beaches it is necessary to not only be informed as to how beaches are currently being managed and how this impacts on the ecosystem services but also to be aware of how these services are valued by the beach users. This thesis looked at how beaches can be managed more effectively for both the environment and for beach users. Mechanical beach grooming is just one type of anthropogenic pressure affecting the coastal environment. The reasons behind beach managers' decisions to groom their beaches and what impact this is having on biodiversity were also examined and possible solutions identified.

Introduction

The beach environment is especially vulnerable to the trade-offs which necessarily exist between the need to manage for both biodiversity and for people. Beaches are large tourist attractions and can bring in much needed revenue for local economies. One way that beach managers may think they can both attract tourists and maintain biodiversity is by obtaining a beach award such as the European Blue Flag. Managers of beaches with an award often take the decision to clear the stranded wrack from the beach using mechanical equipment. Many of the councils in Scotland and Sweden clear the tourist award beaches on a regular basis, weekly or even sometimes daily. One of the habitats affected by beach grooming is the strandline community. The strandline is an essential aspect of the beach ecosystem and an important habitat for birds and dune plants and facilitates nutrient remineralisation. Beach managers trying to obtain or hold on to Blue Flag status are far more likely to mechanically groom their beaches.

Mechanical grooming and beach award status are associated with low strandline biodiversity in Scotland (Gilburn, 2012). This study found 46% fewer taxa on groomed beaches compared with ungroomed beaches. A study carried out in

California by Dugan, (2010) found that wrack cover was more than nine times lower and plant abundance and richness were fifteen and three times lower, respectively, on groomed beaches. Mechanical grooming on beaches in south Wales was seen to have a serious deleterious effect on overall strandline-related species diversity and population abundance (Llewellyn & Shackley, 1996). Previous studies of the impacts of grooming have concentrated only on the effects of grooming in one location. These additional variables have largely been ignored in the literature until now, and this study aims to investigate their importance.

MASTS funding

The objective of the work funded by MASTS was to determine the impacts on biodiversity associated with grooming and other environmental variables, along two environmentally contrasting coastlines in Scotland and Sweden. The MASTS funding helped to pay for fieldwork carried out in Scotland and a separate source of funding was secured via Lund University for the Swedish work. These two countries differ markedly in their beach ecology, and this work concentrates specifically on the impacts associated with tidal range. The key aim of this study was to determine how tidal range may interact with and amplify the negative impacts of beach grooming. To do this we compared the presence or absence of eight key invertebrate taxa on groomed and ungroomed beaches in Sweden and Scotland. All of the taxa chosen are reliant upon the presence of stranded macrophytes (or seaweed) on the beach to complete their life cycle. Along with the presence or absence of the eight taxa, measurements of environmental variables including tidal range, salinity, algal wrack depth, exposure, aspect, slope and substrate were also taken during both the summer and the winter.

Macroinvertebrate biodiversity was positively correlated with algae depth. Taxon diversity and algae depth were affected by interactions between tidal range, beach grooming and season (winter or summer). Swedish sites had a tidal range of 5-20cm which is considerably lower than Scotland’s sites, which range between 4-5m. We found sites with a higher tidal range recovered more slowly following grooming. In Sweden, the wrack bed often straddled the waterline and much of the material was left submerged after grooming. The lower level of biodiversity found on Scottish beaches outside the grooming season could be because it takes longer for seaweed

deposits to be replenished through storm events whereas a ready supply of wrack can still be available in areas with lower tidal range. These results suggest that beach management to maintain coastal biodiversity should consider the tidal range at mechanically groomed beaches.

This study is the first to observe interactions between beach grooming and other environmental variables, in this case tidal range. It has already been established that beach grooming reduces strandline biodiversity, but the results from this study clearly indicate that different environmental conditions may lead to different impacts of beach grooming. An interaction between grooming status, grooming season and tidal range affect the amount of algae on the beach and therefore the levels of biodiversity. Larger tidal ranges are more impacted by grooming and beach managers should use this information to plan their beach management strategies according to the type of beach they manage, although the clear message everywhere is the less mechanical grooming the better. The results from this study also suggest that other environmental variables not included in this study may have an impact on the effects of grooming and these may also require future investigation.