Sand Dunes at Holkham NNR, Norfolk

26. Coastal sand dunes

Climate Change Sensitivity: **Medium**

Introduction

Sand dunes have potential to adapt to some impacts of climate change through natural sediment processes. (Rees et al 2010). Unfortunately, past and present interventions have often reduced or constrained sediment processes, while built development has reduced the ability of dunes to migrate landwards, both resulting in a reduced capacity for adaptation. Dunes are therefore likely to be more susceptible to climate change where space and sediment are limited. Sea level rise and changes in the coastal movement of sediment are projected to contribute a 2% loss in area between 1999 and 2020 within the UK (Jones et al 2011). These projections need more data to validate them in England.

Habitat Description

Dunes are formed where intertidal beach plains dry out and sand grains are blown inland. Formation starts when dune-building vegetation colonises deposits above the high tide mark. Over time, these can develop into complex landforms of dune ridges and hollows ('slacks'). Physical, climatic and coastal processes influence topography, hydrology and vegetation. Most current English dune systems originated about 6000 years ago.

Phases of mobility and natural coastal dynamics lead to a sequence of dune vegetation types, which increase in stability further from the sea, reflecting the development of soils and vegetation (Jones et al. 2011).

Sand dune communities vary geographically, reflecting both the distribution of species and as a consequence of the chemical properties of the sand. For example, lyme grass *Leymus arenarius* has a more northerly distribution, growing alongside marram grass in mobile dunes; while wild thyme *Thymus polytrichus* is found on base-rich sands, typically found in south-west England, where shell fragments are present within the beach material.

Sand dunes form in relatively exposed locations, and in a number of physiographic situations. Major dune systems are widely distributed around the English coast, with the major concentrations and largest sites on the north-east, north-west and south-west coasts. The most common are bay dunes, where a limited sand supply is trapped between two headlands eg Druridge Bay, Northumberland; spit dunes, which form as sandy promontories at the mouths of estuaries eg Spurn Point, East Yorkshire; and hindshore dunes, which occur in the most exposed locations where large quantities of sand are driven some distance inland, over a low-lying hinterland eg Sefton Coast, Merseyside. The total area of sand dunes in England is approximately11,897 ha (Radley 1994).

Potential climate change impacts

Cause	Consequence	Potential impacts
Sea Level Rise Increased frequency of storms	Altered coastal dynamics	■ Changes to the amount of sediment being supplied and removed from dunes.
	Increased erosion	■ Beach lowering and steepening of the foreshore. ■ Changes in dune hydrology can affect the flow of water from dune slacks. ■ Changes in shoreline position and dune system area are likely to affect sand stability, dune mobility, and groundwater levels and flow patterns, which in turn will affect the ecology of dune habitats. ■ If beach plains are narrower or wetter there is likely to be less wind-blown sand. ■ Species assemblages will change, affecting bird and mammal food sources. ■ In combination with hard sea defences, coastal dynamics will change, with loss of sediment exchange between the beach plain and dune system; and a lowering of beach levels. This leads to increased wave energy causing more erosion to the dune face and net loss of habitat
Higher annual average temperatures	Longer growing season	■ Dune systems may become more stable due to warmer temperatures favouring growth of dune grasses, and exacerbated by Nitrogen deposition (Mossman et al 2013, Jones et al 2008) increasing the rate of successional change. ■ Increased stabilization of dune systems and soil development. (Rees et al 2010).
Drier summers	Drought	■ Lower dune water tables (Clarke & Sanitwong 2010). The associated drying out of dune slacks would lead to the loss of specialist species. ■ Increased drying of sand may lead to more wind-blown sand, leading to dune expansion, the creation of new blow outs, and more early successional stage habitat.
Wetter winters	Wetter winters	■ Wetter conditions could prevent beach plains from drying out. Wet sand is less likely to be moved by the wind, which can affect dune processes and hence vegetation.

Adaptation responses

Sand dunes are a component of dynamic coastal systems, and much of the emphasis on adaptation at the coast has been to maintain the natural coastal processes where possible; including through managed realignment. Under this approach, sand dunes will be lost in some places but develop in others. In the long-term this is likely to be the most important response. However, some on-site actions to increase the resilience and diversity of dune systems are also possible.

Some of the potential adaptation options for this habitat are outlined below.

- Restore or maintain habitat in favourable condition and ensure that non-climatic pressures are reduced.
- Manage recreational use to prevent excessive pressure on vegetation, by rotational exclusion of people, especially from fore-dunes and fixed dunes, and by retaining vegetation that can trap sand.
- Minimise large-scale surface sand erosion on fixed dunes through flexible management, for example by adjusting stocking density and timing of grazing in response to seasonal variation in growing conditions, while maintaining a proportion of bare sand.
- Manage dunes to maintain the full range of successional stages, avoiding a build-up of organic soil layers and the development of coarse grassland and scrub.
- Ensure hydrological conditions are fully conserved to offset potential reductions in rainfall, where possible. Reduce abstraction pressures and ensure maximum recharge of dune water tables by reducing the impacts of scrub, trees and coarse grassland.
- Develop management plans that respond to predicted changes across the whole coast and not individual sites in isolation.
- Anticipate and develop approaches to managing the landward movement of dune systems, which will require consideration of the impacts on adjacent agricultural land.
- Adopt a strategic approach to coastal planning and develop an understanding the sediment budget, to ensure there is adequate space for dune systems to migrate, and that there is a continued supply of sediment.
- Adjust designated site boundaries and interest features as coasts evolve, with the aim of enlarging functional units.
- Plan for the relocation of human assets in flood or erosion risk areas. The future of dune golf courses will need to be addressed specifically.

The Natterjack toad is found in a handful of places and breeds in warm shallow ponds in sand dunes and sandy heaths

Relevant Environmental Stewardship options

Maintenance of sand dunes (HP01)

Restoration of sand dunes (HP02)

These options, which rely on seasonal grazing, are only suitable on fixed dune grasslands and heaths that can be maintained either by grazing with stock or by mowing, and on vegetated swards that can be grazed by stock.

Creation of coastal vegetated shingle and sand dunes on arable land (HP03)

Through detailed planning and management, this option supports the creation/expansion of sand dune and vegetated shingle systems on arable land where there are suitable underlying sediments. This option will help to re-create and strengthen the distinctive local character of coastal landscapes.

Further information and advice

The Sand Dune and Shingle Network
The aim of the Sand Dune and Shingle Network is to conserve sand dunes and shingle as dynamic landscapes.

Marine Climate Change Impacts Partnership Coastal Margin Habitats, in MCCIP Annual Report Card 2010-11.

JNCC (2008) UK BAP habitat description Coastal Sand Dunes.

Relevant case study examples

Sefton Coast Adaptation Study
This adaptation study considers the potential impacts of coastal change including climate change on the Sefton Coast. It identifies the risks and opportunities arising from coastal change helping to highlight the issue of coastal change for partners so that they can consider options and how these might be included in policies and management plans.

National Trust (2005) Shifting Shores - Living with a changing coastline
To gain a better understanding of how coastal change will affect National Trust properties, the Trust commissioned Halcrow Group Ltd to study how erosion and flooding might affect its coastal sites over the next 100 years.

National Trust (2008) Shifting shores in the South West

Key evidence documents

Beaumont et al (2010) National Ecosystem Assessment (NEA): Economic Analysis Coastal Margin and Marine Habitats, Final Report.

Carter, RWG (1991) Near-future sea level impacts on coastal dune landscapes. Landscape Ecology 6, 29-39.

Clarke, D. & Sanitwong na Ayutthaya, S. (2010) Predicted effects of climate change, vegetation and tree cover on dune slack habitats at Ainsdale on the Sefton Coast, UK. *Journal of Coastal Conservation*, 14, 115–125.

Everard M., Jones L. & Watts, B. (2010) Have we neglected the societal importance of sand dunes? An ecosystem services perspective. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 20: 476–487.

Jones L., Garbutt A., Angus S. & others. (2011) Coastal margins [chapter 11]. In: UK National Ecosystem Assessment. Understanding nature's value to society. Technical Report. Cambridge, UNEP-WCMC, 411-457.

Jones, M.L.M., Sowerby, A., Williams, D.L. & Jones, R.E. (2008) Factors controlling soil development in sand dunes: evidence from a coastal dune soil chronosequence. *Plant and Soil*, **307**, 219–234.

Maddock (2008) Coastal Sand Dunes In: UK Biodiversity Action Plan; Priority Habitat Descriptions. BRIG (ed. Ant Maddock).

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Mossman HL, Grant A & Davy AJ. (2013) Implications of climate change for coastal and inter-tidal habitats in the UK. Terrestrial biodiversity climate change impacts report card technical paper. Biodiversity Report Card paper 10.

Rees S, Angus S, Rhind P & Doody JP. (2010) **Coastal Margin Habitats** in MCCIP Annual Report Card 2010-11, MCCIP Science Review, 21pp.