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Short communication

The value of wader foraging behaviour study to assess the success of restored intertidal areas

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ABSTRACT

The loss of intertidal habitat in estuaries has resulted in the need to create new habitats in order to protect waterbird populations. In order to examine the waterbird colonisation of restored intertidal areas created in 2003 through the realignment of the flood defence in the Humber Estuary (UK), the feeding behaviour of Redshank (*Tringa totanus*) was observed in April 2008. Numbers of pecks, probes and paces (numbers of steps) and the prey intake events were compared between Redshank foraging on the restored mudflat and on the adjacent established mudflat. Redshank prey intake and success rate (prey intake divided by the total numbers of pecks and probes) were significantly lower on the restored mudflat compared to the adjacent established mudflat. Conversely, the number of steps taken while foraging and the number of paces per successful feeding event were significantly greater on the restored mudflat. This shows that focal behaviour in restored intertidal areas can be directly compared with that in natural established mudflat in order to examine differences in foraging behaviour. The findings emphasise that a study of foraging behaviour should be incorporated into the assessment of restoration success of intertidal areas as an indication of habitat quality.

1. Introduction

Throughout Western Europe and elsewhere, managed realignment schemes (also referred to as depolderisation) are in place to enable the creation and restoration of habitats lost as the result of land claim, erosion and coastal squeeze (Elliott et al., 2007). Intertidal areas can be created by moving the flood defence inland, allowing estuaries to flood the previous terrestrial land (French, 2006). Long term ecological monitoring at several managed realignment sites has compared the colonisation by the benthic invertebrate communities of restored or created estuarine mudflats with the adjacent, established mudflats (Evans et al., 1998; Garbutt et al., 2006; Mazik et al., 2007, 2010; Marquiegui and Aguirrezabalaga, 2009). Similarly, several studies have assessed the success of new intertidal habitats for waterbirds (Simenstadt and Thom, 1996; Evans et al., 1998, 2001; Atkinson et al., 2001, 2004; Armitage et al., 2007; Mander et al., 2007), focussing on species richness and abundance. However, these parameters provide only limited structural ecological information when assessing the responses of birds to habitat restoration and creation in the intertidal zone; here we consider that functioning information is more valuable as a measure of successful restoration (Elliott et al., 2007). Lindell (2008) also argues that behavioural sampling in both restoration and reference sites will provide valuable information with which to assess the success of restoration efforts. Although the position realignment sites occupy in the tidal range means that areas of mud remain exposed for longer period and thus can provide supplemental feeding time to waders, if the realignment sites do not succeed in providing similar feeding conditions to the area lost, then bird fitness, demographic rates and population size will be affected. If the success of new intertidal habitats created through realignment sites is to be assessed effectively, an understanding of foraging behaviour of birds which prey upon benthic invertebrates is therefore essential. Despite this, the behaviour of waterbird species in restored or created wetland habitats has been little studied (Brusati et al., 2001; Armitage et al., 2007).

At Paull Holme Strays, one of four realignment sites in the Humber Estuary, UK, Redshank *Tringa totanus* has significantly increased in foraging numbers within the first three years of site development (Mander et al., 2007). Redshank are polytypic, with six sub-species described by Cramp and Simmons (1983) of which two occur in Europe. The nominate race, *T. totanus totanus*, occurs throughout north western Europe, with the UK population representing the north-western edge of this range. *T. totanus robusta*

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breeds in Iceland and the Faroe Islands and moves in winter to the UK as well as around the coasts of north-west Europe. As one of the most common wintering waders in north western European estuaries, Redshank detects its prey by sight, feeding on various prey by pecking or probing the mud and so their behaviour is easy to monitor as they search for food while walking over the intertidal area. There is an extensive literature on feeding behaviour of Redshank and its diet on intertidal areas (Goss-Custard, 1969, 1970, 1977a,b; Moreira, 1996), but little is known about the foraging behaviour of this species on a restored mudflat created as part of the realignment of the flood defence. This short note investigates the value of wader behaviour sampling at realignment sites to evaluate the success of restored intertidal areas. It tests the hypothesis that differences occur in the foraging behaviour of Redshank between a restored and an established mudflat up to five years after the restoration of the intertidal area.

2. Methods

2.1. Study area

The field work was carried at the Paull Holme Strays realignment site on the north bank of the Humber Estuary, UK, in April 2008 (Fig. 1). The Humber Estuary is an important wintering and stop-over site for several East Atlantic Flyway waders, supporting over 150,000 waterbirds in winter (Mander and Cutts, 2005; Calbrade et al., 2010). The Paull Holme Strays site (53°44′N, 0°16′W) is located within the middle section of the Humber Estuary about 10 km east of the city of Kingston-upon-Hull. Historically, the area within the realignment site was tidal marsh and mud, but over the past three centuries it was dyked, drained and converted into arable land. In 2003, a new earthen bank (dyke) was constructed at a distance of up to 500 m behind the existing defences. The existing defences were then breached in two places (north–west and south–east part of the site), in order to allow tidal inundation, accretion and subsequent development of new intertidal habitat. Since the site was breached, the topography, sediment characteristics, floral community and invertebrate assemblage have been rapidly changing in response to twice daily tidal inundation. Waders have rapidly colonised the realignment site, with foraging Redshank increasing from a monthly average of one individual in winter 2003/04 to 33 individuals in winter 2005/06 (Mander et al., 2007). Since the winter 2005/06 usage by foraging Redshank has continued to increase. In winter 2007/08, the monthly average peaked at 174 foraging Redshank (unpubl.data). Macro-infaunal sampling carried in September 2008 in the realignment site and outside on the established mudflat found the total invertebrate abundance to be highly variable but was higher in the established mudflat than inside the realignment whilst biomass did not differ significantly between the established mudflat and the realignment site (Mazik et al., 2010).

2.2. Observation methods

The foraging behaviour of Redshank was examined during daylight hours between 16th and 27th April 2008. At this time of the year, the return passage of Redshank to their breeding grounds leads to a peak count on the Humber, with numbers often greater than during the winter months (Allen et al., 2003; Mander and Cutts, 2005). A peak count of over 5000 birds was recorded on the Humber estuary in April 2004 during the 2003/04 Wetland Bird Survey (WeBS) low tide count (Mander and Cutts, 2005). A focal sampling approach, the systematic observation of just one individual, was followed by sampling individual Redshank. A total of 290 bird observations of randomly selected Redshank were carried out on the restored mudflat located in the realignment site and on an adjacent established mudflat (Fig. 1). The telescopic observations were carried out in daylight over a period of 6 h, starting either on a falling or a rising tide. Every hour up to four focal observations were carried out on individuals present in the restored mudflats and on the adjacent established mudflat. Each focal observation lasted for 1 min during which the numbers of pecks, probes in the substratum and successful intake of prey were recorded. Surface touch of more than half the bill length into the mud were categorised as probes, whist a touch on the mud surface was defined as a peck. The intake of prey was assumed to be successful when we observed either a

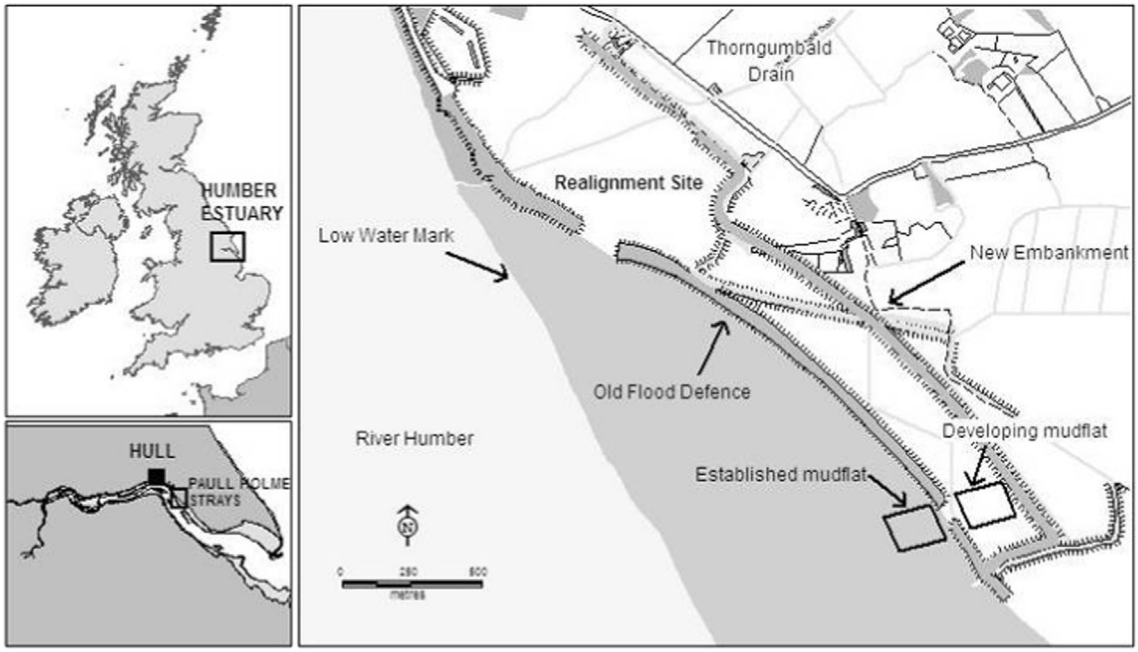

Fig. 1. Location of the Paull Holme Strays on the Humber Estuary and areas surveyed.