Estuarine, Coastal and Shelf Science 139 (2014) 119–126

Contents lists available at ScienceDirect

Estuarine, Coastal and Shelf Science

journal homepage: www.elsevier.com/locate/ecss

Cliff top habitats provide important alternative feeding resources for wading birds of conservation importance wintering on non-estuarine coasts

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ARTICLE INFO

Article history:
Received 9 August 2013
Accepted 24 December 2013
Available online 18 January 2014

Keywords:
sandy shore
rocky shore
cliff top habitats
intertidal
habitat use
waders
invertebrate abundance

ABSTRACT

Rocky shores and beaches are important over-wintering areas for non-estuarine waders but have rarely been studied. We examined cliff top habitat use by 6 species of wader over 75 km of coast to assess their potential value as alternative feeding sites to rocky and sandy shores. Both the regional and local survey showed that waders occurred on golf courses and recreational grasslands in higher frequencies than expected but arable and pasture use was lower than expected. We also compared local wader densities on rocky and sandy shores, pastures, golf courses, caravan parks and recreational grasslands over two winters. Sanderling predominantly fed on the beach whereas Oystercatcher, Dunlin, Turnstone and Redshank numbers significantly increased on golf courses and recreational grasslands over the winter period, with pasture being rarely used. General linear models were used to relate environmental factors to the presence and absence of each species on the cliff top habitats. Redshank was the only species that showed a higher probability of occurrence on cliff top habitats at high tide whereas the probability of Turnstone, Oystercatcher and Redshank occurring increased as temperatures declined. Using core sampling, we determined that invertebrate richness and abundance was significantly higher on the recreational grasslands and golf courses than on the pasture or the beach. Our data demonstrated that cliff top habitats are important alternative feeding areas for over-wintering waders in areas where the intertidal is bounded by cliffs. Current management creates short sward, open field habitats with a diverse and abundant invertebrate food supply exploited by waders. Any alterations to the land use of these areas should be carefully considered by planning authorities in light of the fact that they support species that are of conservation concern.

1. Introduction

Waders are primarily dependent on wetland habitats and estuarine areas (Granadeiro et al., 2006) outside the breeding season, but will also use other intertidal areas (e.g. Summers et al., 2002). Situated along the East Atlantic Flyway, the British Isles are important stop-over and over-wintering sites with an estimated 1.3 million birds overwintering in 1984/1985 (Moser, 1987; Moser and summers, 1987). Further evidence as to the importance of the British Isles comes from the 1997/1998 Non-estuarine Coastal Waterfowl Survey (NEWS)) which estimated that 30.9% of the European population of Oystercatchers (*Haematopus ostralegus*), 41.7% of Dunlin (*Calidris alpina*), 60.0% of Redshanks (*Tringa totanus*) and 52.7% of Turnstones (*Arenaria interpes*) over-wintered in Britain (Rehfisch et al., 2003). The status and population trends of 44 out of the 47 wader populations (93%) along the East Atlantic Flyway have been established and 37% of these are thought to be in decline (Stroud et al., 2006). For example, *C. alpina* accounted for approximately a third of the waders counted during the1984/1985 survey (Moser, 1987) although a 50% population decline over the last 25 years has resulted in this species recently being red-listed in Britain (Eaton et al., 2009). The degradation and loss of coastal habitats has been suggested to be one of the main factors causing the decline in wader numbers (Clemens et al., 2010).

There are many studies examining the use of estuarine tidal flats by waders (e.g. Granadeiro et al., 2006; Spruzen et al., 2008; Clemens et al., 2010). Access to intertidal feeding areas is regulated by the tidal cycle and waders may use adjacent marshes and grasslands to roost or supplement food intake at high tide (Velasquez and Hockey, 1992). Man-made environments can also

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http://dx.doi.org/10.1016/j.ecss.2013.12.029

act as alternative habitats for waders (Colwell, 2010). Waders are known to roost and forage in salt pans/works and lagoons (Shuford et al., 1998; Masero and Perez-Hurtado, 2001; Sripanomyom et al., 2011) as well as in rice fields (Elphick and Oring, 1998; Maeda, 2001; Taylor and Schultz, 2008; Lourenço and Piersma, 2009) both of which can be further managed for waterbird conservation (e.g. Fasola and Ruiz, 1996; Elphick and Oring, 2003; Lourenço and Piersma, 2009)).

In the USA, agricultural coastal grasslands are used as foraging areas for non-breeding waders (Colwell and Dodd, 1995, 1997). Long-billed Curlews (*Numenius americanus*) and Marbled Godwits (*Limosa fedoa*) fed on coastal agricultural fields at high tide (Long and Ralph, 2001). However, in Virginia, USA, whilst Dunlin and Turnstones used fields at high tide, other species (e.g. Killdeer (*Charadrius vociferus*), American Golden Plover (*Pluvialis dominica*) and Buff-breasted Sandpiper (*Tryngites subruficollis*)) fed on such grasslands irrespective of tidal stage (Rottenborn, 1996).

Sward length is particularly important in determining grassland use by foraging waders. Short sward vegetation provides easier access to prey and a clearer view of approaching predators (Colwell and Dodd, 1995; Milsom et al., 1998; Evans Ogden et al., 2008) and appropriate management of agricultural fields can improve their suitability. Evans Ogden et al. (2008) suggested that autumn mowing, planting a mosaic of crops and applying manure to fields were all positive correlates of wader abundance on agricultural fields. Low levels of disturbance and low field boundaries may also enhance site use (Milsom et al., 1998) and ideally fields managed for waders should be within 0.5 km of the sea.

Great Britain has an estimated 17,381 km of coastline of which 42% is classified as hard rock substratum (Jackson and McIlvenny, 2011). However, studies on wader use of non-estuarine habitats are few (Summers et al., 2002; Lourenço et al., 2013) despite important numbers over-wintering on the coast (Burton et al., 2008). In addition, they are major predators on rocky shores (Lourenço et al., 2013). Waders foraging on intertidal areas of the Orkney Islands tended to avoid steep shores and cliffs (Summers et al., 2002) and the different species showed a preference for foraging on particular substrata (e.g. Sanderling *Calidris alba* preferred sand, Turnstones rock and gravel and Purple Sandpipers *Calidris maritima* rocky substrata). From a longer term perspective, there is also concern about the loss of intertidal habitats due to 'coastal squeeze' (Jackson and McIlvenny, 2011) and changes in intertidal invertebrate abundance due to climate change (Kendall et al., 2004). Whilst waders do use coastal fields to supplement intertidal feeding in estuarine areas (Moser and summers, 1987), few data exist for non-estuarine areas or where the intertidal is backed by cliffs.

Managed grasslands in the form of caravan parks, golf courses, and general recreational grasslands are created to support coastal tourism. These man-made habitats may provide cliff top feeding sites for waders when intertidal areas are inaccessible. As some wader species show high over-wintering site fidelity (Catry et al., 2004), there is the need to determine if these habitats are important in order to manage them effectively for both wildlife and recreation.

The current study aimed to assess the potential value of cliff top habitats as feeding sites for waders in non-estuarine areas. We studied the 6 most-common coastal over-wintering waders present in the region including Eurasian Oystercatcher (*Haematopus ostralegus*), Redshank (*Tringa totanus*), Dunlin (*Calidris alpina*), Red Knot (*Calidris canutus*), Turnstone (*Arenaria interpres*) and Sanderling (*Calidris alba*). Other species, such as Grey Plover *Pluvialis squatarola*, Ringed Plover (*Charadrius morinellus*), Bar-tailed Godwit (*Limosa lapponica*) and Eurasian Curlew (*Numenius arquata*) occurred infrequently, whereas Purple Sandpipers (*Calidris maritima*) exclusively foraged on the rocky shore and are not considered further.

We specifically aimed to address the following questions: 1) Do foraging waders in the region use different cliff top habitats with equal frequency and is this independent of tidal stage? 2) Does the number of foraging waders vary significantly between cliff top and intertidal habitats, and is there any evidence of shifts in habitat use over time? 3) Are there any environmental factors that significantly influence the probability of occurrence of waders on cliff top habitats? 4) Do cliff top habitats have a higher invertebrate abundance and diversity than sandy shore areas?

2. Materials and methods

2.1. Site description

The regional between Bridlington (latitude 54.07721°, longitude −0.18386°) and Sandsend (latitude 54.4909°, longitude −0.641937°; Fig 1) is typified by rocky platforms and sandy beaches backed by cliffs >30 m in height. Arable land use predominates on the cliff tops punctuated by holiday parks, recreational grasslands, coastal towns and occasional grazing pasture. We selected 5 cliff top habitats for the regional study of wader habitat use including golf courses, caravan parks, recreational grasslands, arable fields and grazing pastures. Only 5 cliff top golf courses occur across the region, so we selected representative areas of the other 4 habitats as close as possible to these that had an open aspect adjacent to the cliff edge and were between 5–6 ha^{-1} in area (25 sites in total).

To determine whether the waders showed significant differences in habitat use over the winter period, Filey Bay, U.K. (latitude 54.21349°, longitude −0.29169°; Fig. 1) was selected as a site for detailed observations. The site is a 1 km^2 area containing the 5 cliff top habitats used in the regional survey, and sandy/rocky intertidal areas. Our sampling design contained a 6.7 ha^{-1} arable stubble field (AF) plot but this was excluded from further analysis as waders did not use that site. The remaining 6 plots included SS, a dynamic sandy shore plot of medium grained sand (area = 9 h^{-1}at low tide) adjacent to a moderately sheltered complex barnacle–fucoid–mussel mosaic rocky shore (RS) (area = 9 ha^{-1} at low tide). Both intertidal plots were bounded by cliffs and at high tide there was very little supra-littoral habitat remaining at sea level, merely small rocky outcrops used as roosting sites. The PA plot was a 7 ha^{-1} cliff top pasture grazed by cattle during the summer months (mean sward length = 9.6 cm (SE ± 1.2)). The local authority (Scarborough Borough Council (SBC)) manage a cliff top 6 ha^{-1} pitch and put golf course (GC) and a 5 ha^{-1} open access recreational grassland (RG) both regularly mown throughout the year to maintain a short sward length (mean = 4.3 cm, SE ± 0.4). The final plot was a 4 ha^{-1} touring caravan site (CP) constantly managed to maintain a very short sward (mean = 3.1 cm, SE ± 0.1) throughout the year.

2.2. Wader use of regional cliff top habitats

To determine which cliff top habitats were used most frequently by waders across the region, and whether this was dependent on tidal stage, the 25 designated regional sites were visited four times each month (twice at high and twice at low tide) between November–March (500 site visits). On each visit, observers scanned the site from designated observation points and recorded the presence/absence of each species.

2.3. Local surveys of cliff top habitat use over time

A sampling method derived from the standard 'Low Tide Counts' method used by the British Trust for Ornithology (BTO) for the national Wetland Bird Survey scheme (WeBS) (Austin et al., 2007)