

Influence of environmental and prey variables on low tide shorebird habitat use within the Robbins Passage wetlands, Northwest Tasmania

Fiona L. Spruzen*, Alastair M.M. Richardson, Eric J. Woehler

School of Zoology, University of Tasmania, Private Bag 5, Hobart, Tasmania 7001, Australia

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Abstract

Shorebirds feed primarily on tidal flats, and their distribution over these flats is influenced by their prey and abiotic factors. These factors act by influencing the distribution and abundance of the prey, or the shorebirds ability to exploit it. The aims of this study were to investigate the low tide foraging distribution of shorebirds at four sites within the Robbins Passage wetlands, and the environmental and invertebrate factors that may influence their distribution. The greatest densities and number of shorebirds were found at Shipwreck Point and East Inlet. The shorebirds within-site distribution was also non-random, with the shorebirds present in greatest densities at the water's edge and low intertidal stratum, although this varied among species. Generally, on a small spatial scale, invertebrate diversity was positively correlated, and seagrass leaf mass was negatively correlated, with shorebird feeding density. On a large spatial scale, invertebrate biomass and seagrass root mass were positively correlated with shorebird feeding density. Invertebrate biomass and seagrass root mass explained 71% of the variance in total shorebird feeding density on the tidal flats. The variation in shorebird feeding density and diversity was therefore partly explained by invertebrate diversity and biomass, as well as the environmental factors seagrass roots and leaf mass and tidal flat area, although the strength of these relationships was influenced by the two different spatial scales of the study. The strength of the relationships between shorebird feeding density and the invertebrate and environmental variables was stronger on a large spatial scale. The presence of seagrass may have influenced shorebird-feeding density by affecting the invertebrate abundance and composition or the shorebirds ability to detect and capture their prey. The area of the tidal flat had opposing effects on the shorebird species. These results can be used to assist in the development of management plans for the Robbins Passage wetlands and the conservation of important shorebird areas.

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1. Introduction

The ecology of shorebirds is strongly influenced by their food: its location, distribution, abundance and availability. Coastal wetlands and estuaries are places of patchy, but locally abundant prey and shorebirds, migratory and resident, gather in these locations throughout the year. While the distribution and abundance of their prey predominantly determines the distribution of shorebirds on their feeding grounds (Goss-Custard et al., 1977c; Bryant, 1979; Ribeiro et al., 2004), other environmental factors, such as sediment particle size and

composition (Yates et al., 1993; Moreira, 1999) and vegetation cover (Zharikov and Skilleter, 2002) also play a role (Burger et al., 1977; Kalejta and Hockey, 1994). In combination with biotic factors, these abiotic factors can influence the characteristics of the invertebrate prey, or the ability of the birds to exploit it.

Shorebird distributions on tidal flats have been studied extensively (Goss-Custard et al., 1977b; Symonds et al., 1984; Kalejta and Hockey, 1994), as has their feeding ecologies (Goss-Custard et al., 1977a; Goss-Custard, 1985), and prey distributions (Bryant, 1979; Kalejta and Hockey, 1994). Australian researchers have recently begun studies in this area (Thompson, 1993; Rogers, 1999; Dann, 1999a), but as yet little research has been undertaken on habitat use by foraging

* Corresponding author.

E-mail address: lspruzen@utas.edu.au (F.L. Spruzen).

shorebirds (Congdon and Catterall, 1994; Rohweder and Baverstock, 1996; Thompson, 1998; Finn et al., 2007), and the only studies looking at the functional relationship between prey and shorebird distribution have so far been in Western Australia and New South Wales (Tulp and de Goeij, 1994; Rogers, 1999; Owner and Rohweder, 2003). With the exception of Rogers (1999), these studies have looked at only one or two species, while Tulp and de Goeij (1994) focussed on diets and prey intake rates, rather than distribution, of great knots (*Calidris tenuirostris*) in relation to their prey. No comprehensive study on habitat use of mixed species assemblages has yet been conducted in Tasmania.

The Robbins Passage wetlands in northwest Tasmania support the largest and most diverse community of migratory and resident shorebirds in Tasmania, with over 25,000 shorebirds present during the summer months, consisting of 23 different species (18 migratory, five resident) (Woehler and Park, personal communication). Despite this importance, no studies have yet been conducted on shorebird habitat use in this wetland. We therefore investigated the low tide foraging distribution of shorebirds within the wetlands, and the factors that might influence their distribution. Two specific questions were addressed:

1. What are the spatial and temporal patterns of distribution of the shorebirds among the sites and over the tidal flat at each site?
2. Can the measured environmental and invertebrate variables be used to explain the variability in shorebird distributions within and among sites?

2. Method

2.1. Study area

The Robbins Passage wetlands form a coastal intertidal system located in the far northwest of Tasmania (40°40'S, 144°50'E), with an area of over 100 km² (Dunn, personal communication). They consist of two large shallow tidal basins, Boullanger Bay and Big Bay, and smaller tidal areas, comprising Robbins Passage, Duck Bay and West and East Inlets, and the estuaries of three rivers: the Welcome, Montague, and Duck Rivers. The wetlands are an extensive area of tidal channels and intertidal sand flats, with a variety of habitats, including salt marsh, seagrass beds and open sand flats (Dunn, personal communication). The area has a mean tidal range of 3.5 m (Department of Primary Industries Water and Environment, 1999; BOM, 2005). The sand flats are the most dominant feature of the wetlands, comprising approximately 65% of the total site area (Dunn, personal communication). The wetlands contain one of the most important areas of seagrass beds in Tasmania, dominated by *Posidonia australis*, with substantial areas of *Heterozostera tasmanica* and *Amphibolis antarctica* (Department of Primary Industries Water and Environment, 1999). The beds cover an area of approximately 8000 ha and are considered one of the largest seagrass areas

in temperate Australia (Department of Primary Industries Water and Environment, 1999).

The Robbins Passage wetlands regularly support more shorebirds than the rest of Tasmania combined (Woehler, personal communication). They are a site of international significance for five migratory shorebird species: curlew sandpipers (*Calidris ferruginea*), double-banded plovers (*Charadrius bicinctus*), red-necked stints (*Calidris ruficollis*), red knot (*Calidris canutus*) and ruddy turnstones (*Arenaria interpres interpres*), and of national importance for two resident species: pied (*Haematopus longirostris*) and sooty oystercatchers (*Haematopus fuliginosus*) (Watts, 1999; WWF-Australia, 2004). Recent land use changes in the wetlands' catchments are potential factors threatening the shorebirds in the area.

2.2. Survey methods

The distribution and density (birds ha⁻¹) of feeding shorebirds was investigated at low tide at four intertidal flats in the wetlands: East Inlet (EI), Robbins Passage (RP), Shipwreck Point (SP) and West Beach (WB) (Fig. 1). The sites were chosen to encompass a range of sediment types and vegetation cover, although the choice of sites was also influenced by accessibility, logistics and safety considerations. Between October 2004 and March 2006, the four sites were surveyed within an hour of predicted low tide twice a month during October to March and once a month April to September. All four sites were sampled within a 3-day period. Surveys were conducted during daylight, although some shorebird foraging occurs at night (Bibby et al., 2000).

Each site consisted of a 400 m long transect on the sand flat parallel to the shoreline, extending on each side from the high water mark to the low water mark. Due to the varying slopes at each of the feeding sites, the extent of the area exposed at low tide differed. The intertidal width of the feeding sites ranged between 400 m and 600 m, while the area of the sites ranged from 13 ha to 22 ha. To determine whether the shorebirds displayed any preference for a particular section of the flats, each site was divided into four zones: high, mid- and low intertidal strata, and the water's edge, which was defined as the narrow 1–2 m strip between the low intertidal stratum and the open water, covered by a thin surface layer of water.

Each survey was conducted by walking the length of the transect parallel to the shoreline, equidistant between the high and low water mark and scanning the area up to 200 m ahead with a 32x Kowa (TSN-821) spotting scope to minimise disturbance to the birds (Altmann, 1974; Clarke and Warwick, 2001). Each bird was identified and counted and its location on the tidal flats recorded as high, mid-, low intertidal strata or water's edge. The influence of the tide was standardised by conducting the surveys within a 2-h window around the low tide and only on low tides less than 1.3 m (range = 0.7–1.3 m).

2.3. Habitat and invertebrate sampling

The following habitat characteristics were measured at each feeding site: seagrass cover (%), seagrass biomass (g dry

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