

In this series, coordinated by Thomas Mondain-Monval (Lancaster University, UK, t.mondain-monval@lancaster.ac.uk), invited authors discuss themes in wader/shorebird biology, ecology or conservation that arise from publications other than *Wader Study*.

Earthworms on coastal pasture: an alternative food resource for declining waders during the non-breeding season?

The loss of tidal flats is a major threat to waders in many flyways¹. Although the pace of reclamation of intertidal habitats in estuaries for residential and industrial uses has stopped, or at least slowed down, in some flyways (e.g. East Asian-Australasian Flyway²), future sea-level rise related to global warming will lead to significant losses of intertidal habitats. Areas in heavily modified estuaries, where the natural landward migration of intertidal habitats is constrained by hard coastal defences, are particularly at risk. According to the IPCC³, global coastal wetlands will lose 20–90% of their area depending on the emissions scenario.

Wader species that rely heavily on intertidal areas during the non-breeding season are likely to be affected by habitat loss. They can respond to estuarine habitat loss by emigrating (e.g. moving to another estuary) or by trying to survive in any remaining areas. As a result of settling in areas already occupied by other birds, displaced waders may have to compete to meet their daily energy requirements. The consequences for the displaced birds could be an increase in mortality rates and a loss of body condition⁴. Ultimately, the effects of changes to intertidal habitat can be carried over to other parts of species' flyways^{5,6,7}.

The Numeniini (13 species of wader – curlews, godwits and Upland Sandpiper *Bartramia longicauda*) is one of the tribes of waders particularly vulnerable to change in environmental conditions at non-breeding sites and, because of historical declines occurring in many flyways, is



Eurasian Curlew foraging in an arable field in the Humber Estuary, UK (photo: Pete Short).

highly threatened⁸. Although Numeniini species rely mostly on the tidal flats of estuaries to forage during the non-breeding period, some species use terrestrial habitats to supplement or complement their diet. Eurasian Curlew *Numenius arquata*, for example, is one of the few wader species at temperate latitudes in northwest Europe that

¹Sutherland, W.J., J.A. Alves, T. Amano, C.H. Chang, N.C. Davidson, C. Max Finlayson, J.A. Gill, R.E. Gill Jr., P.M. González, T.G. Gunnarsson, D. Kleijn, C.J. Spray, T. Székely & D.B.A. Thompson. 2012. A horizon scanning assessment of current and potential future threats to migratory shorebirds. *Ibis* 154: 663–679.

²Melville, D.S. 2018. China's coasts – a time for cautious optimism? *Wader Study* 125: 1–3.

³Intergovernmental Panel on Climate Change (IPCC). 2019. Summary for Policymakers. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* (H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegria, M. Nicolai, A. Okem, J. Petzold, B. Rama & N.M. Weyer, Eds.). Geneva, Switzerland.

⁴Burton, N.H.K., M.M. Rehfish, N.A. Clark & S.G. Dodd. 2006. Impacts of sudden winter habitat loss on the body condition and survival of redshank *Tringa totanus*. *Journal of Applied Ecology* 43: 464–473.

⁵Baker, A.J., P.M. Gonzalez, T. Piersma, L.J. Niles, I.d.L.S.d. Nascimento, P.W. Atkinson, N.A. Clark, C.D.T. Minton, M.K. Peck & G. Aarts. 2004. Rapid population decline in red knots: fitness consequences of decreased refuelling rates and late arrival in Delaware Bay. *Proceedings of the Royal Society of London B*: 271: 875–882.

⁶Piersma, T., T. Lok, Y. Chen, C.J. Hassell, H.-Y. Yang, A. Boyle, M. Slaymaker, Y.-C. Chan, D.S. Melville, Z.-W. Zhang & Z. Ma. 2016. Simultaneous declines in summer survival of three shorebird species signals a flyway at risk. *Journal of Applied Ecology* 53: 479–490.

⁷Studds, C.E., B.E. Kendall, N.J. Murray, H.B. Wilson, D.I. Rogers, R.S. Clemens, K. Gosbell, C.J. Hassell, R. Jessop, D.S. Melville, D.A. Milton, C.D.T. Minton, H.P. Possingham, A.C. Riegen, P. Straw, E.J. Woehler & R.A. Fuller. 2017. Rapid population decline in migratory shorebirds relying on Yellow Sea tidal mudflats as stopover sites. *Nature Communications* 8: 14895.

⁸Pearce-Higgins I.W. D.I. Brown D.I.T. Douglas I.A. Alves M. Bellio & Y.I. Verkuil 2017. A global threats overview for Numeniini

consistently use both tidal flats and agricultural fields (coastal pasture and arable land) to forage in winter. Black-tailed Godwits *Limosa Limosa* are also known to use extensively managed coastal pastures throughout Europe during the non-breeding season. In these terrestrial habitats, the main food available to them is earthworms (Oligochaeta).

As sea-level rise will lead to significant losses of intertidal habitats, it is conceivable that coastal pasture and arable land surrounding estuaries could have the potential to buffer the effect of these losses. There is a large body of evidence documenting the use of a number of anthropogenic habitats and their importance as alternative foraging areas for waders (e.g. salt-pans⁹). However, little is known about the food supply in agricultural systems such as coastal pasture, which are used by large wader species (e.g. the genus *Numenius*) foraging on earthworms.

Navedo and colleagues¹⁰ recently examined the behaviour of wintering Eurasian Curlew, a Near Threatened wader species, feeding on earthworms at a coastal pasture in northern Spain, and assessed food supply and prey selection and estimated consumption. In contrast to expectations, the study found that they preferred the smallest size class (<32.5 mm) of epigeic earthworms. European Lumbricids can be divided into three ecological groups: epigeic, endogenic and anecic. In contrast to the latter two groups, epigeic worms do not make burrows but exploit the surface layer of the soil, feeding on dead organic matter. In an earlier study, Onrust & Piersma¹¹ found, when controlling the spreading of farmyard manure, that

hunger forced epigeic worms to spend more time on the surface. These authors concluded that the availability of these worms could be managed for meadow birds (e.g. Charadriiformes) by delaying the application of farmyard manure in spring.

At temperate latitudes where coastal grasslands are utilized by waders in winter, understanding how food supply or habitat characteristics drive their utilisation is of value to enhance conservation measures for wader populations. This is particularly relevant for many estuaries in north-west Europe where the space to re-create tidal flats is limited, as they are surrounded by dense industrial and residential areas. Where it has not been possible to re-create tidal flats in estuaries, the loss of foraging grounds has been mitigated through the creation of coastal wetlands, for example coastal grasslands for foraging Eurasian Curlew. Navedo and colleagues show Eurasian Curlew to be selective of the smaller earthworms in coastal grasslands and conclude that they constitute an abundant food supply for them. In coastal grasslands, epigeic worms could be encouraged through controlling the spreading of farmyard manure, cutting or by altering grazing regimes. These grasslands and epigeic worms could play a significant role in maintaining the survival rate and fitness of Eurasian Curlew overwintering in estuaries which are susceptible to ongoing losses of intertidal habitats.

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⁹Lei, W., J.A. Masero, T. Piersma, B. Zhu, H.-Y. Yang & Z. Zhang. 2018. Alternative habitat: the importance of the Nanpu Salt pans for migratory waterbirds in the Chinese Yellow Sea. *Bird Conservation International* 28: 549–566.

¹⁰Navedo, J.G., J.S. Gutiérrez, P. Salmón, D. Arranz, M. Novo, D.J. Díaz-Cosín, A.G. Herrera & J.A. Masero. 2019. Food supply, prey selection and estimated consumption of wintering Eurasian Curlews feeding on earthworms at coastal pastures. *Ardea* 107: 263–274