Disturbance of roosting shorebirds on the Exe estuary: another case where attention to detail is important

John D. Goss-Custard[1,2] and Lindsay K. Biermann[1]

[1] *Department of Life and Environmental Sciences, Bournemouth University, Talbot Campus, Poole, Dorset, BH12 5BB, UK*

[2] *Current address: Havering, Church Road, Lympstone, Devon, EX8 5JT, UK.* *johngc66@gmail.com*

Keywords: disturbance, roost, non-breeding season

An application was made during the winter 2014-15 to upgrade the sea defences at Exmouth Pier Head at the mouth of the Exe estuary, UK (Figure 1). No waders occurred in the site. However, waders sometimes roosted at the north-eastern end of the Dawlish Warren Nature Reserve which lies on the opposite side of the estuary's mouth to Pier Head (Fig. 1). Accordingly, there was concern that the construction activities at Exmouth would disturb roosting waders during the winter months when they may sometimes be hard-pressed to balance their energy budget, as exemplified by the European Oystercatcher *Haematopus ostralegus* L. on the Exe estuary itself (Goss-Custard *et al*. 1996) and more widely across its winter range (Goss-Custard & Stillman 2020). Very few birds were thought likely to be disturbed over low tide when the birds were foraging because most of the feeding grounds within the estuary and along the adjacent coast were >1km from Pier Head at which distance the sound would have been greatly attenuated (see below).

Figure 1. Study area. Dawlish Warren Nature Reserve (shaded area) is at the end of a peninsular of sand dunes which extends some 1.75km out from the mainland to the mouth of the river Exe. Only the distal part of its extent is shown here. The black oval shows Exmouth Pier Head. The normal roosts are in Refuge Bay, the main one within this Bay being about 1100m from Pier Head. The Finger Point roost is about 750m from Pier Head. The approximate location of the most often used alternative roosts from Soft Sand Bay (400-500m) towards Warren Point (300m) is shown by the grey oval. Refuge Bay is not in direct line of sound with Pier Head because of intervening high sand dunes.

It was not self-evident, however, that waders roosting in winter in this region of Dawlish Warren would be disturbed by construction work at Pier Head. The main roosts were located within Refuge Bay beyond sand dunes out of direct line of sound and 750-1100m from Pier Head (Fig. 1). Waders roosted only occasionally between Soft Sand Bay and Warren Point where they were much closer to Pier Head and in direct line of sound. Waders in this part of the estuary had been subjected to construction activities for several years from a major housing development nearby, immediately adjacent to the estuary so it is quite likely that most birds in

this part of the estuary would have habituated to such activities by 2015 (Goss-Custard & Stillman 2019). Permission for the work to go ahead over that winter was denied because shorebirds had been recorded roosting in the Soft Sand Bay to Warren Point area on an unspecified number of occasions in unspecified circumstances. Instead, the works were delayed until spring and summer when the risk to the few hundred non-breeding sub-adults remaining on the estuary during the breeding season was regarded as low.

The possible consequences for overwintering shorebirds of being disturbed by the wide variety of human activities carried out on and alongside the coast has generated much research in recent years. Under the legislation current in the winter 2014-15, a certain degree of disturbance could be tolerated as long as it did not contribute to the long-term decline of the population of the species (Article 1 of the Habitats Directive- Council Directive 92/43/EEC); in other words, if it did not affect the demographic rates of *per capita* mortality and reproduction. In winter, disturbance at the roost could decrease the birds' fitness, and thus affect the demographic rates of the population, by increasing their energy requirements (Goss-Custard & Stillman 2019). This could make it more difficult for birds to survive the winter in good condition, to reach the breeding grounds and to breed successfully. Disturbance could also decrease fitness through increased stress levels (Inger *et al*. 2010).

Testing whether the amount of disturbance is sufficient to affect demographic rates – the 'disturbance hypothesis' (Goss-Custard et al. 2019) - is very difficult and probably explains why it has so rarely been done in waders anywhere (Goss-Custard & Stillman 2019). To test the hypothesis requires not only detecting a reduction in fitness during the winter and/or summer in species in which the non-breeding and breeding areas can be very far apart but also being able to ascribe any reduction uniquely to the effect of disturbance which may have happened at another time of year in a distant place (Gill *et al*. 2001; Inger *et al*. 2010). Certainly, testing the disturbance hypothesis was not a practicable option here as time and resources were very limited. Accordingly, a simpler and more practical approach was adopted.

Through its proximity to major conurbations, location in a popular holiday area and ease of access, one might expect that the intertidal feeding grounds of the Exe estuary would be seriously disturbed yet, as measured by the time and energy costs it imposes on birds, disturbance is trivial for both foraging waders (Goss-Custard *et al*. 2019) and foraging wildfowl (Biermann 2020). One reason for this trivial impact is that shorebirds and people on the Exe estuary were largely separated in time and space. For example, many birds left a sandy, rapidly-drying feeding area on the receding tide before people arrived because the birds prefer wet sediments while people prefer dry. Another reason, and one that is over-looked in many studies, is that once birds have left an area because they were disturbed into flight, none remain to be disturbed by people that arrive afterwards, however numerous (Goss-Custard *et al*. 2019). Third, many of the waders on the Exe that were disturbed undertook a flight that they would have made shortly afterwards anyway, so there would have been no additional cost in either foraging time or energy (Goss-Custard *et al*. 2019). Such details must be taken into account if the real impact of disturbance on shorebirds is to be reliably assessed; as we say in the UK, 'the devil lies in the detail', as it might in the small print of an agreement, for example. It requires both intensive and extensive observations to establish just how much birds are actually disturbed, and thus disadvantaged, by people (Biermann 2020).

I visited Exmouth Pierhead in daylight once per day on 13 days and twice a day on two others to record the presence or absence of flocks of waders roosting between Soft Sand Bay and Warren Point. Most observations were made within ±2.5 hrs of high water over one Neap and Spring series of 15 days, 17th - 31st January 2015. Counts of individual birds could not be made at the distances involved, so numbers were estimated approximately by eye. One or two persons were walking around Warren Point during three of the 17 visits. There were no people present on 10 of the remaining 14 days when waders were absent and on all three days when waders were present. No other potential sources of disturbance were recorded during the study.

Either none or very few (<10) roosting waders were present on the 14 visits when the predicted height of high water varied from 2.9m to 4.0m. In contrast, 500 to 2-3000 waders of several species, though mainly Oystercatchers, roosted between Soft Sand Bay and Warren Point on the three visits when the predicted height of high water was 4.3m or 4.4m. The birds arrived at the roosts about an hour before high water and left from one to three hours afterwards. Eight visits at other stages of tide found only an occasional Turnstone *Arenaria interpres* or Dunlin *Calidris alpina* to be present.

There was already a number of small businesses on Pier Head that operated machinery and quite noisy vehicles. The potentially most disturbing sound arising from the proposed construction work at Pier Head was considered to be pile-driving. The volume from pile-driving declines logarithmically with distance from source (Fig. 2). Based on Wright *et al.* (2000), English Nature advised that the probability of disturbing shorebirds would increase from 0 to 1 over the range 55-70db. The birds were therefore considered likely to be at risk of being disturbed at distances of <`1000m (Fig. 2). Both the large distance and the attenuation of sound due to the sand dunes between Refuge Bay and Exmouth suggests that it would have been unlikely for shorebirds at either roost site within Refuge Bay to have been affected by work at Pier Head. In contrast, there was a risk that birds roosting around the north-eastern end of the Warren, including Soft Sand Bay, would be disturbed.

Figure 2. Sound level from pile-driving expected at different distances from Exmouth Pier Head. Data collected under comparable conditions to the present study by Teignmouth Maritime Services Ltd (pers. comm.). The lower dotted line shows the minimum distance at which the sound might start to disturb shorebirds while the upper line shows the level at which it would certainly do so. dB = 115.9±0.43 – 8.92±0.079 ln(meters). The letters indicate the distances from Pier Head of the roosts on Dawlish Warren: T = the tip of the peninsular, directly opposite Pier Head; SSB = Soft-Sand Bay; FPO = Finger Point; MR = the main roost in Refuge Bay.

This pattern of roosting at the eastern end of Dawlish Warren was consistent with our experience since 1976. On most tides, the birds spend the entire high tide period in Refuge Bay where they are largely disturbance-free: signs, fences and enraged bird-watchers deter most potential human disturbers. The birds normally quit Refuge Bay only when the roosts become submerged by the tide, departing during the hour before high water. Many fly the 200-250m to the vicinity of Soft Sand Bay from where they can return on the receding tide to the exposing

roost sites in Refuge Bay from about one hour after high water. If any birds that remain in Soft Sand Bay for longer than this were to be disturbed by activities on Exmouth Pierhead, the energy cost of returning to Refuge Bay would have been trivial as the distance back to Refuge Bay is so small.

The study showed, then, that shorebirds that vacate Refuge Bay for the eastern end of Dawlish Warren would become vulnerable to disturbance from construction activities on Pier Head only when the high tide exceeded 4.1 or 4.2mOD. Chi-square test for independence was run to test if there was a statistically significant relationship between shorebird presences in the Soft Sand Bay area and high tides greater than 4.2m. Results of this analysis were significant X^2 (1, N = 17) = 10.12, p = 0.001. Shorebirds were more likely to be on Soft Sand Bay when high tide was greater than 4.2 than when it was lower. When the water level was lower, they remained in Refuge Bay.

In the event, construction at Pier Head was not allowed during the first few months of 2015, so it is only possible to explore what would have happened if it had been. Pile driving would have taken place in daylight (8am to 5pm) and only on weekdays since Pier Head is close to residential properties. High tide on Spring tides occur on the Exe in the morning and evening. That winter, all the evening high tides occurred more than one hour after 5pm so there was no risk of birds being disturbed by pile-driving at the end of the working day.

Of the three occasions when birds would have had to roost at the eastern end of Dawlish Warren at the start of the working day, one occurred at the weekend when no pile-driving would have occurred. On the other two days, one hour after high tide occurred at 8:45am (Thursday 22nd) and the other at 9:30am (Friday 23rd). Therefore, to avoid any disturbance occurring within ±1hr of high water when roosting birds would not have been able to return to Refuge Bay, it would have been necessary to delay pile-driving for only a very short time. With an 8am start to the working day, the delay would have been 1.75hr and 2.50hr respectively, assuming that potentially disturbing construction work began immediately. This represents a maximum of 4.25 hrs over the 90 working hours of the 10 weekdays studied. At the very least, construction could have taken place during all the remaining 85.75 working hours of that fortnight without risk of disturbing roosting birds in the vicinity of Soft Sand Bay at a time when they could not have returned to Refuge Bay.

The same calculation was made for the whole of February and March 2015 when construction was requested but not permitted. There was only one day in each month when pile-driving would have risked disturbing roosting birds within ±1hr of high tide. One was Friday 20th February until about 08:45 and the other was Monday 23rd March until about 09:45. Even if pile-driving could have started immediately at 8am, the aggregate delay over the entire two months would have been 2.5hrs out of the 360 working hours available.

The conclusion is that, if rational decisions that are fair to both sides in any such debate are to be made, we must always be alert to the possibility that, as is so often the case with this issue, the devil really does lie in the detail. It is essential that the circumstances in which disturbance is likely to occur must always be investigated in depth.

We are very grateful to Teignmouth Maritime Services Ltd for providing data for Figure 3 and to Myles Blood Smyth of Exmouth Mussel Company and Humphrey Sitters for helpful suggestions.

Biermann, L., 2020. Assessing the impacts of human disturbance on wildlife: insights from wildfowl on the Exe Estuary. Doctoral Thesis (Doctoral). Bournemouth University.

Gill, J. A., Norris, K., & Sutherland, W. J. 2001. Why behavioural responses may not reflect the population consequences of human disturbance. *Biological Conservation* 97: 265–268.

Goss-Custard, J.D., Durell, E.A. le V. dit, Goater, C.P., Hulscher, J.B., Lambeck, R.H.D., Meininger, P.L. & Urfi, J. (1996). How Oystercatchers survive the winter, The *Oystercatcher: from individuals to populations.* (Ed. J.D. Goss-Custard), pp. 133-154. Oxford University Press, Oxford.

Goss-Custard, J.D., Hoppe, C.H., Hood, M.J. & Stillman, R.A. 2019. Disturbance does not have a significant impact on waders in an estuary close to conurbations: importance of overlap between birds and people in time and space. *Ibis* 162: 845-862. *doi:* 10.1111/ibi.12769.

Goss-Custard, J.D. & Stillman, R.A. 2019. How new science should affect the application of protection measures for UK estuarine shorebirds In: Humphreys J. & Clark. R. (eds) Marine Protected Areas: Evidence, Policy and Practice, Elsevier.

Goss-Custard, J.D. & Stillman, R.A. 2020. How manual cockle-raking may affect availability of cockles *Cerastoderma edule* for oystercatchers *Haematopus ostralegus* in the Dutch Wadden Sea. Report to the Province of Fryslân. Accessed at: *https://rijkewaddenzee.nl/wp-content/uploads/2021/01/BUG2842-Province-of-Fryslan-Wadden-Sea-Final-2020-08-21.pdf*

Wright, M.D., Goodman, P. & Cameron, T.C. 2010. Exploring behavioural responses of shorebirds to impulsive noise. *Wildfowl* 60: 150–167.

Figure 1

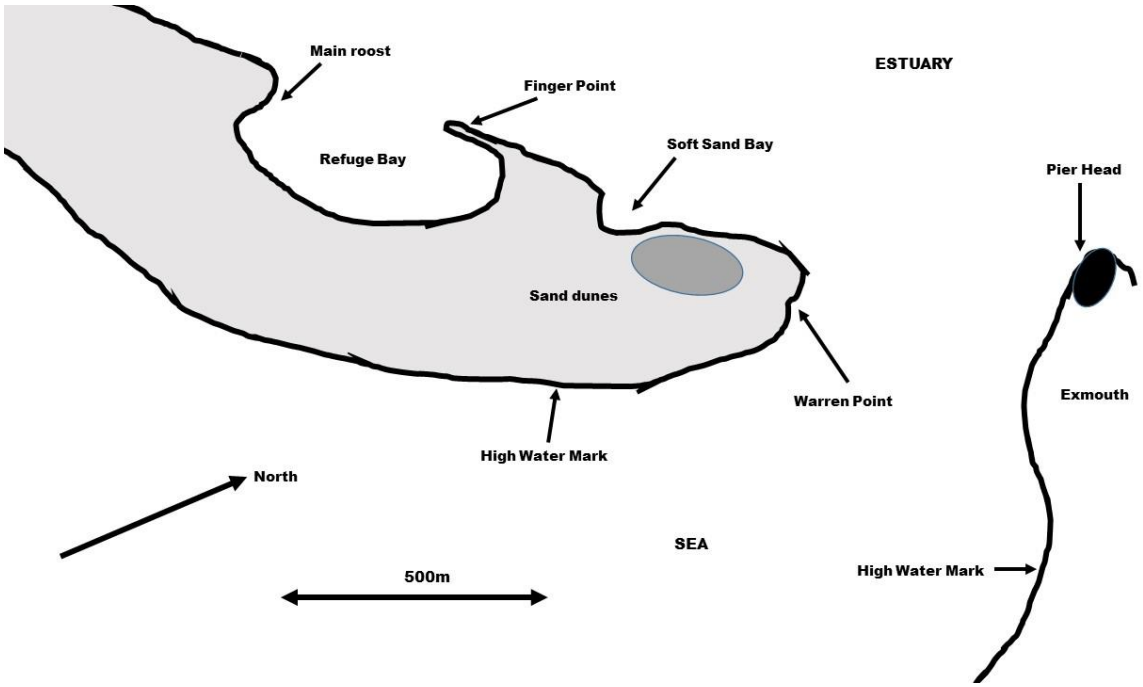
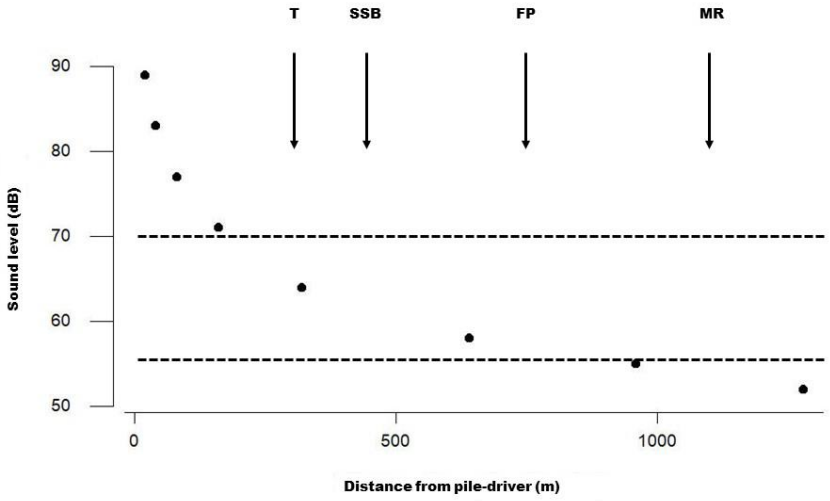

Main roost
ESTUARY
Finger Point
Refuge Bay
Soft Sand Bay
Pier Head
Sand dunes
Warren Point
Exmouth
High Water Mark
North
SEA
500m
High Water Mark

Figure 2


T
SSB
FP
MR
90
80
70
60
50
Sound level (dB)
0
500
1000
Distance from pile-driver (m)