Chapter 11
Assessing Bird Exclusion Effects in a Wetland Crossed by a Railway (Sado Estuary, Portugal)

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Abstract Linear transportation infrastructures may displace wildlife from nearby areas that otherwise would provide adequate habitat conditions. This exclusion effect has been documented in roads, but much less is known about railways. Here we evaluated the potential exclusion effect on birds of a railway crossing a wetland of international importance (Sado Estuary, Portugal). We selected 22 sectors representative of locally available wetland habitats (salt pans, rice paddy fields, and intertidal mudflats); of each, half were located either close to (0–500 m) or far from (500–1500 m) the railway line. Water birds were counted in each sector between December 2012 and October 2015, during two months per season (spring, summer, winter, and autumn) and year, at both low and high tide. We recorded 46 species, of which the most abundant (>70% of individuals) were black-headed gull, greater flamingo, northern shoveler, black-tailed godwit, and lesser black-backed gull. Peak abundances were found in autumn and winter. There was no significant variation between sectors close to and far from the railway in species richness, total abundance, and abundance of the most common species. Some species tended to be most

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L. Borda-de-Água et al. (eds.), *Railway Ecology*,
DOI 10.1007/978-3-319-57496-7_11

abundant either close to or far from the railway albeit not significantly so but this often varied across the tidal and annual cycles. Overall, our study did not find noticeable exclusion effects of this railway on wetland birds, with spatial variation in abundances probably reflecting habitat selection and daily movement patterns. Information is needed on other study systems to assess the generality of our findings.

Keywords Aquatic birds · Habitat loss · Human disturbance · Environmental impact · Transportation infrastructures · Zone of influence

Introduction

Linear transportation infrastructures such as roads and railways are increasing worldwide, and this is generally considered a serious threat to wildlife conservation (van der Ree et al. 2015). Transportation infrastructure networks are particularly dense in developed countries, with a recent study showing that in Europe about 50% of the land area is within 1.5 km of a paved road or railway line (Torres et al. 2016). This problem also increasingly affects less developed countries, where most infrastructure and urban development is expected to take place over the coming decades (Seto et al. 2012). Therefore, there is an urgent need to evaluate the impacts of linear infrastructure development on wildlife, and to devise planning and technical solutions to mitigate such impacts (DeFries et al. 2012).

The impacts of linear transportation infrastructures are generally associated with direct mortality caused by animal collisions with circulating vehicles (Loss et al. 2015; Santos et al. 2016), and with barrier effects and the consequent increases in habitat fragmentation and reduced landscape connectivity (Carvalho et al. 2016). However, there may also be widespread indirect habitat degradation, because many animal species avoid using areas close to transportation infrastructures (Forman and Deblinger 2000; Torres et al. 2016). For instance, a recent study showed that many bird species strongly avoided traffic noise, while certain others remaining close to noisy environments exhibited degradation in body condition (Ware et al. 2015). Another study showed that even unpaved roads reduced herbivore densities in a protected area (D'Amico et al. 2016). Most of these studies, however, have focused on roads, either ignoring railways or assuming that roads and railways have largely similar impacts (e.g. Torres et al. 2016). Furthermore, the few studies available are contradictory (see Chap. 6), with some pointing out negative effects of noise, lights and vibrations associated with circulating trains, while others suggest that wildlife ignore or adapt to railway disturbance (Owens 1977; Waterman et al. 2002; Gosh et al. 2010; Li et al. 2010; Mundahl et al. 2013; Wiacek et al. 2015). Thus, more information is needed on the exclusion effects of railways, particularly on the species and ecological conditions associated with the most negative effects.

If railways have strong exclusion effects, their consequences may be particularly serious when crossing wetland habitats. This is because wetlands are declining fast, they are among the most threatened habitats, and the species they support are among the most endangered taxa (e.g. Millennium Ecosystem Assessment 2005; Tittensor et al. 2014); therefore, further habitat degradation due to railways and other transportation infrastructures may have particularly negative consequences. Moreover, wetlands are very productive habitats that are home to large concentrations of wildlife, particularly aquatic birds such as herons, egrets, waders, waterfowl and gulls, among others, many of which are declining and are highly sensitive to habitat loss and degradation (e.g. Kleijn et al. 2014). Despite its importance, there is very little information on the eventual exclusion effects of railways crossing wetlands, with very few studies focusing on aquatic bird species. In one of these studies, Waterman et al. (2002) found significant negative effects of railways on densities of black-tailed godwit *Limosa limosa* and garganey *Anas querquedula*, for noise levels above 45–49 dB(A). In contrast, Owens (1977) observed that geese *Branta* spp. disregarded trains passing nearby, while the single study using a Before-After-Control-Impact (BACI) design found no exclusion effects of a new railway line on a diverse wetland bird assemblage throughout the annual cycle (see Chap. 16). Possibly, the type and magnitude of effects depend on a number of factors related to wetland and railway characteristics, as well as the behaviour and life history traits of the species involved. Therefore, the development of a number of case studies covering a wide range of socio-ecological conditions would be needed to find general patterns.

In this study, we addressed the eventual exclusion effects on birds of a new railway line crossing the upper sector of the Sado Estuary (Portugal). This estuary is a "wetland of international importance" under the Ramsar Convention, and it is included in a Natural Reserve and in the Natura 2000 Network of Special Protected Areas and Sites of Community Importance. The Sado Estuary is inhabited by thousands of wetland birds, particularly from early autumn to spring, with large numbers occurring in the area where the railway line started operating in December 2010 (Lourenço et al. 2009; Alves et al. 2011). The environmental impact assessment study raised the possibility of the railway causing the displacement of these birds, thereby causing potential losses in prime wetland habitat. The study was designed to clarify this issue, aiming at: (1) describing the wetland bird assemblages occurring in the vicinity of the railway, and estimating how wetland bird assemblages varied in relation to proximity to the railway line, in terms of (2) species richness, (3) total bird density, and (4) densities of the most common species. Results of our study were used to discuss the potential exclusion effects of railways crossing wetland habitats.

Methods

Our study was carried out in the Natural Reserve of the Sado Estuary (Portugal), in a 3-km section of the upper estuary crossed by the "Variante de Alcácer" railway. Specifically, we focused in the area known as *Salinas da Batalha* (38° 24′N, 8° 36W), where the railway crosses the Sado River and adjacent wetland habitats through a bowstring bridge (see details in Chap. 7). During the study period

Table 11.1 Number (N) and area (ha) of habitat types in relation to distance categories (<500 and >500 m) from a railway bridge, which were sampled to estimate the exclusion effects on aquatic birds in the Sado Estuary, Portugal

Habitat	Distance (m)	N	Mean area (ha) ± SD	Total area (ha)
Rice paddy fields	<500	6	2.7 ± 1.4	16.6
	>500	5	4.0 ± 1.5	19.9
Intertidal mudflats	<500	3	0.7 ± 0.1	2.2
	>500	2	0.9 ± 0.3	1.7
Salt pans	<500	2	3.2 ± 0.9	6.4
	>500	4	4.5 ± 2.0	18.0

(26 weeks in 2013–2015), the number of trains using the railway increased from 26 ± 4 [SD] trains/day in 2013 to 34 ± 6 trains/day in 2015, and they mostly crossed the line (70%) during the day. The railway is bordered by habitats used by wetland birds, including mainly rice paddy fields, salt pans and intertidal mudflats. Rice paddy fields are particularly important foraging habitats in autumn and winter, outside the crop growing season, when they are partly flooded and occupied by stubbles, which may be used by black-tailed godwits and a number of herons, egrets, ibis, waders and waterfowl species (Fasola and Ruiz 1996; Lourenço and Piersma 2009). Salt pans are also artificial habitats of utmost importance for wetland birds in the Mediterranean region, as they provide important foraging grounds and critical high-tide roost for species foraging mainly on intertidal areas (Paracuellos et al. 2002; Dias et al. 2006). Finally, intertidal flats are critical foraging habitats for waders and some waterfowl species, which in the Mediterranean region are mainly used by wintering birds, and as stopovers during the autumn and spring migration periods (Moreira 1999; Granadeiro et al. 2007). In late spring and summer these habitats tend to be much less used by wetland birds, although they are still important for a few breeding species, such as the purple heron *Ardea purpurea* and black-winged stilt *Himantopus himantopus*.

We counted birds in 11 wetland sectors close to (0–500 m) and 11 sectors far from (500–1500 m) the railway line between December 2012 and October 2015. These sectors were selected to encompass the variety of habitats represented in the study area (Table 11.1), including intertidal mudflats (3.9 ha), rice paddy fields (36.5 ha), and salt pans (24.4 ha). We tried to balance the number and area of habitat types per distance category, but this was only partially achieved due to the local distribution of habitats around the railway bridge (Fig. 11.1). To minimize this problem, we reported and analyzed the data in terms of bird densities, rather than using absolute counts.

In each of the three study years, counts were made during two months in each of the winter, spring, summer and autumn seasons. In each month, counts were carried out both at low and high tide, between two hours before and two hours after peak tide. This design was used to account for the movements of wetland birds during the tidal cycle between foraging and roosting areas, and among foraging areas (e.g. Dias et al. 2006). In each wetland sector, counts were made using the "scanning method," beginning in the plot limit and sequentially covering the entire plot, and

Fig. 11.1 Map of the study area in the Sado Estuary (Portugal), showing the location of the sectors close to (0–500 m) and far from (500–1500 m) the railway, where wetland birds were counted between December 2012 and October 2015

thus minimizing double counts (Bibby et al. 2005). We did not carry out counts on days with adverse weather conditions, such as heavy rain and strong winds.

We used Generalized Linear Mixed Models (GLMM; Zuur et al. 2009) to evaluate how species richness and wetland bird densities varied in relation to the railway line. In order to model species' richness, we used Poisson errors and a log link, while the modelling of bird densities was done on log-transformed data using Gaussian errors and the identity link (Zuur et al. 2009). As fixed effects, we used dichotomous variables coding the distance to the railway line (<500 vs. >500 m) and the stage of the tidal cycle (low vs. high tide), and the interaction between them. We considered random effects on the intercept, including as factors the sector, the sampling month, and the sampling year. Models were fit using the package lmer (Bates et al. 2015) for the R software 3.2.2 (R Core Team 2015).

Results

Wetland Bird Assemblages

Overall, we counted 32,647 individuals of 46 wetland bird species during the surveys ("Annex"). The most abundant species accounted for 71% of the birds observed, and included black-headed gull *Chroicocephalus ridibundus* (21.9% of birds observed), greater flamingo *Phoenicopterus roseus* (20.7%), northern shoveler *A. clypeata* (10.0%), black-tailed godwit (9.6%) and lesser black-backed gull *Larus fuscus* (9.3%). Many more birds were recorded in autumn (47.3%) and winter (22.0%), than in spring (11.9%) and summer (18.8%). This pattern of seasonal occurrence was also observed for the most abundant species, except in the case of flamingos, which were mainly recorded in winter and spring, and godwits, which peaked in autumn and summer.

The distribution of birds was highly concentrated, with about 76% of individuals counted on just eight of the 22 plots surveyed. Many more birds were counted in the tanks of salt pans (64.5%), than in either rice fields (27.2%) or intertidal areas (8.4%). This pattern was also found for most individual species, although there were also several species with peak counts (>75% of observations) in rice fields (e.g. cattle egret *Bubulcus ibis*, purple heron, white stork *Ciconia ciconia*, black stork *C. nigra*, glossy ibis *Plegadis falcinellus*, and lapwing *Vanellus vanellus*). Only a few species were most counted (>50%) in intertidal areas, including mallard *A. platyrhynchos*, grey plover *Pluvialis squatarola*, common sandpiper *Actitis hypoleucos*, and whimbrel *Numenius phaeopus*.

Effects of Distance to Railway

There were no statistically significant effects of distance to railway on species richness, total bird abundance and the abundance of the 12 most abundant species (overall counts >500 individuals) (Table 11.2). The observed patterns of bird distribution in relation to the railway varied markedly across species, and for each it often varied in relation to the tidal cycle and the season (Fig. 11.2). For instance, black-headed gull densities were highest close to the railway in winter, both at low and high tides, while in both autumn and summer, densities were highest far from the railway, particularly at high tide. Also, the densities of the shoveler were highest close to the railway in autumn irrespective of tide, and in winter at low tide, while the reverse was found in winter at high tide. A comparable variation in relation to tide was found for pied avocets *Recurvirostra avosetta*, which in autumn, showed the highest densities close to the railway at low tide, and far from the railway at high tide. In white storks, densities in autumn and winter were always higher close to the railway, while the reverse was found in summer, irrespective of the tidal cycle. Other species had more consistent patterns, albeit not statistically significant, with larger densities tending to be found either close to (e.g. flamingo, dunlin *Calidris alpina*) or far from (e.g. godwit, great cormorant *Phalacrocorax carbo*) the railway.

Discussion

The bird assemblages recorded around the railway line crossing the upper Sado Estuary were comparable to those occurring in other coastal wetlands in Portugal, including a diversity of species such as herons, egrets, ibis, flamingos, gulls, waders,

Table 11.2 Summary results of generalized mixed models (GLMM) relating bird species richness and abundances to distance (Dist) to the railway (<500 vs. >500 m) and tidal cycle (low vs. high tide), while controlling for the random effects of sampling month and sector

Species	Fixed effects				Random effects			
	Inter	Dist	Tide	Dist:Tide	Sector	Month	Year	Residual
Black-headed gull	0.17 (2.34)	−0.002 (−0.02)	−0.009 (−0.22)	0.09 (1.63)	0.031	0.014	<0.001	0.142
Black-tailed godwit	0.05 (1.68)	−0.02 (−0.60)	−0.02 (−0.87)	0.03 (0.84)	0.002	0.002	<0.001	0.049
Black-winged stilt	0.04 (1.44)	0.01 (0.41)	0.002 (0.11)	−0.02 (−0.64)	0.003	0.003	<0.001	0.035
Dunlin	0.02 (1.69)	−0.01 (−0.86)	0.005 (0.39)	−0.01 (−0.80)	<0.001	<0.001	<0.001	0.016
Flamingo	0.08 (1.72)	−0.002 (−0.03)	0.03 (0.94)	−0.04 (−0.92)	0.016	0.002	<0.001	0.084
Great cormorant	0.01 (0.42)	0.02 (0.58)	−0.002 (−0.20)	0.01 (0.73)	<0.001	<0.001	<0.001	0.011
Lesser black-backed gull	0.12 (2.49)	−0.001 (−0.03)	−0.4 (−1.36)	0.03 (0.72)	0.008	0.009	<0.001	0.070
Little egret	0.09 (3.49)	−0.02 (−0.85)	−0.02 (−1.04)	0.03 (1.29)	0.003	<0.001	<0.001	0.026
Pied avocet	0.05 (1.79)	−0.04 (−0.96)	−0.004 (−0.24)	0.03 (1.34)	<0.001	<0.001	<0.001	0.030
Shoveler	0.07 (1.86)	−0.05 (−1.12)	−0.01 (−0.55)	0.02 (0.66)	0.008	0.003	<0.001	0.051
Spotted redshank	0.009 (1.37)	−0.002 (−0.33)	−0.003 (−0.67)	0.004 (0.69)	<0.001	<0.001	<0.001	<0.001
White stork	0.029 (1.99)	0.005 (0.33)	0.01 (0.74)	−0.02 (−0.92)	<0.001	<0.001	<0.001	0.018
Total abundance	0.43 (4.96)	−0.09 (−0.91)	−0.002 (−0.07)	0.02 (0.38)	0.048	0.014	0.003	0.130
Species richness	0.48 (0.05)	0.08 (0.76)	−0.09 (0.29)	0.19 (0.08)	0.368	0.18	0.001	–

Abundance models were fitted on log-transformed data, using Gaussian errors and the identity link. The species richness model was fitted using Poisson errors and the log link. For each model we provide the regression coefficients, the t-value (Z-value in the case of species richness model), and the variance accounted by the random effects

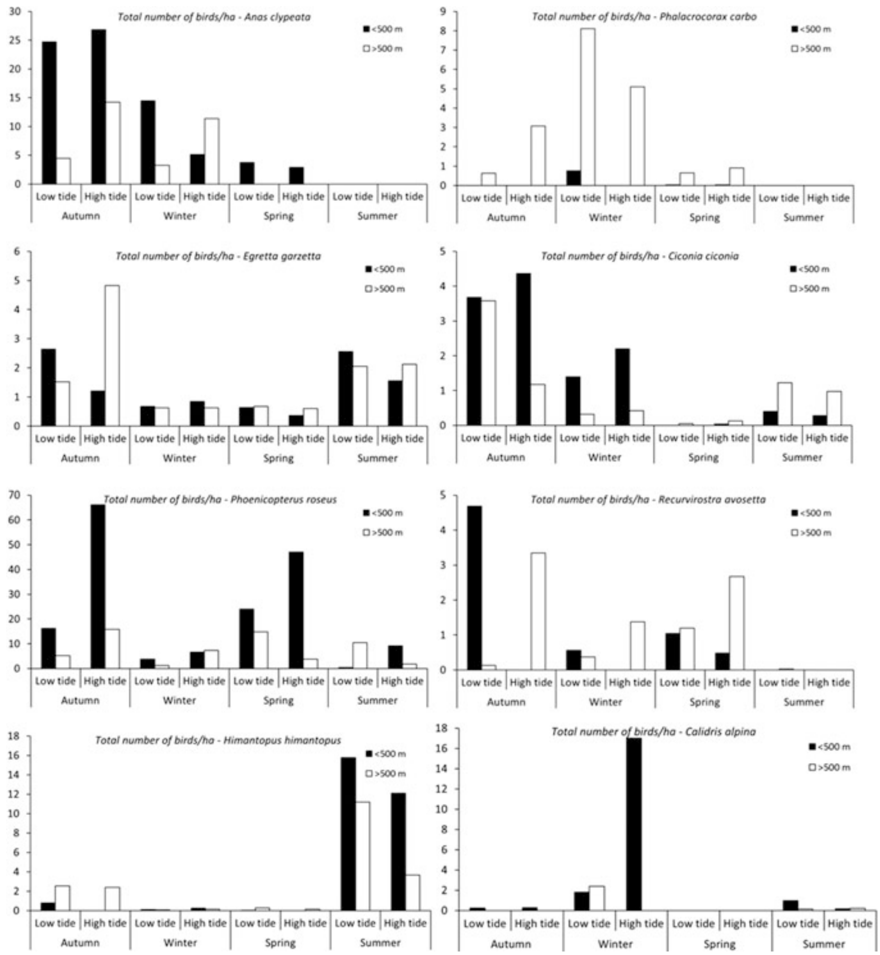

Fig. 11.2 Variation in mean densities (birds/ha) of the most abundant wetland birds counted in sectors close to (<500 m) and far from (>500 m) the railway line, in relation to season and level of the tidal cycle

and waterfowl (Lourenço et al. 2009; Alves et al. 2011). Also, the temporal patterns of species' composition were similar to those of other wetlands, with diversity and abundance of most species peaking during the autumn and, to a lesser extent, spring migration periods, and in winter. There was no evidence that the spatial patterns of bird assemblages were affected by proximity to the railway, with species richness and abundances not showing significant differences in areas close to and far from the railway. Although higher densities of some species were recorded far from the railway on some occasions, there was no consistent pattern due to strong variation across species and seasons, and through the tidal cycle. Overall, we could find no noticeable exclusion effects of this railway line on wetland birds, which is in line

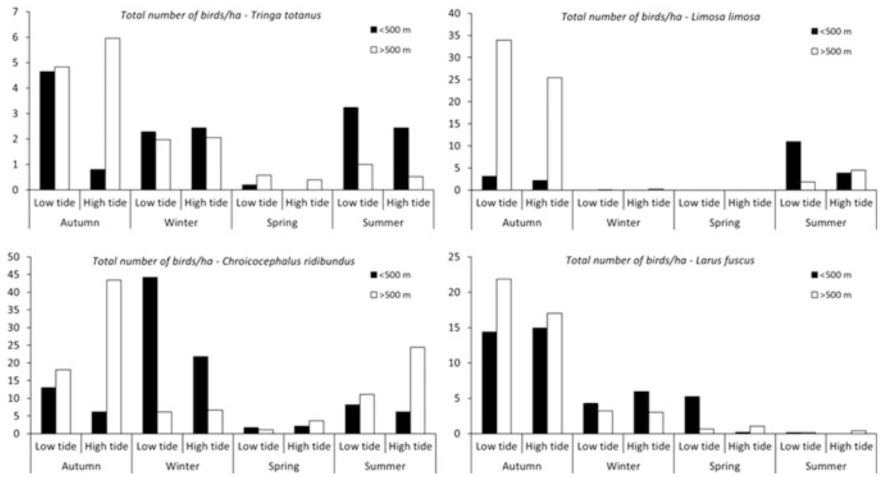

Fig. 11.2 (continued)

with some of the few studies addressing the same issue (Owens 1977, and Chap. 16), but in contrast with another study (Waterman et al. 2002).

Although our study had some limitations and potential shortcomings, it is unlikely that they significantly affected our key conclusions. The main problem is that no information on abundances and bird spatial distribution was available for the period before the construction of the railway line. Because of this, it was impossible to carry out a proper BACI study, which would be essential to fully demonstrate whether or not there were any significant impacts (e.g. Tarr et al. 2010). Nevertheless, our results are still useful to suggest that wetland bird abundances at present are not lower at <500 m from the railway than elsewhere in the estuary, though they cannot be used to make comparisons in relation to the situation before the construction of the railway. Another problem is that our study focused only on species richness and densities, although there might be more subtle impacts due, for instance, to changes in vigilance and feeding activity close to the railway (e.g. Yasué 2006). Although this issue was not dealt with in our study, non-systematic observations of 55 individuals of 18 species did not provide any evidence that birds are more alert close to than there are far from the railway. Finally, we considered a relatively wide area to represent proximity to the railway (<500 m), although exclusion effects may only be apparent at shorter distances from disturbance. This was a constraint required to obtain sufficiently large sample sizes, but observations during the study period suggest that this was not serious because large bird concentrations were often recorded very close to the railway.

The lack of obvious avoidance responses observed in our study may be a consequence of wetland birds tolerating well or eventually adapting behaviourally to human structures and vehicles such as circulating trains, and thus largely ignoring these potential sources of disturbances when selecting foraging and roosting habitats. Studies addressing this hypothesis are scarce, but there is some supportive evidence. For instance, a study showed that the displacement effects of wind farms on pink-footed geese *Anser brachyrhynchus* occurred over relatively short distances (<150 m), and that the negative effects declined markedly in the 10 years after wind farm construction (Madsen and Boertmann 2008). Also, Donaldson et al. (2007) found that waterbirds were more tolerant of human presence in developed than in undeveloped sites, probably reflecting some level of behavioural adaptation to potential anthropogenic disturbance (see also Lowry et al. 2013). In contrast to these studies, however, in Chap. 12, Múrias and colleagues, in a study akin to a BACI design, reported significantly lower shorebird abundances in saltpans close to a new railway that had recently begun to operate. Another study by Burton et al. (2002) reported reduced wader abundances in relation to footpaths, roads and railroads, although this greatly varied across species and human structures. Together, these studies suggest that the exclusion effects of railways on wetland birds may be small in some cases but not in others, and thus drawing generalities would require a larger number of studies covering a wide range of socio-ecological contexts.

Although our study did not find obvious negative effects, the densities of some species were sometimes higher far from (or close to) the railway, although this was not statistically significant and there were inconsistencies across species, seasons, and stages of the tidal cycle. Reasons for this are not certain, but they may be a consequence of spatial and temporal variations in habitat requirements and quality for foraging and roosting, rather than reflecting negative (or positive) effects of the railway. It is well known that waders and other aquatic birds undertake daily movements between foraging and roosting habitats, which are jointly affected by the circadian and tidal cycles, and which induce great variations in bird spatial distributions in estuaries and other wetlands (Dias et al. 2006; Granadeiro et al. 2006). Also, there are changes in the use of habitats through the annual cycle, due for instance, to differences in habitat selection between wintering and migrating birds (Martins et al. 2016), or temporal changes in habitat quality (Lourenço et al. 2009). These factors may underlie, for instance, the observation of avocets concentrating at high densities in intertidal mudflats close to the railway at low tide in autumn, but not in winter, while at high tide they were mainly found in a single salt pan far from the railway in both autumn and winter. Conversely, dunlins were found concentrated in a single salt pan close to the railway in winter at high tide, while at low tide during the same season they were mostly counted in intertidal areas close to the railway and in a salt pan far from the railway. Overall, these results suggest that care should be taken when evaluating the effects of railways on wetland birds, due to the confounding effects resulting from species-specific habitat requirements and preferences, the availability and quality of habitats, and the changes in these factors over the seasonal, circadian, and tidal cycles.

Acknowledgements We would like to thank to Pedro Salgueiro and Luís Gomes for their support in field work. This study was supported by Infraestruturas de Portugal with the contribution of the Portuguese Science Foundation through the Doctoral Grant SFRH/BD/81602/2011 (Carlos Godinho) doctoral grant.

Annex

Wetland birds counted in the study area (Sado Estuary, Portugal) between December 2012 and October 2015. For each species we present the number of birds counted per season, in 11 sectors close to (<500 m) and 11 sectors far from (>500 m) a railway line. We also present the proportion of birds counted in each of the three main habitats represented in the study area: rice fields (rice), intertidal mudflats (intertidal) and salt pans (tanks).

Species		Winter		Autumn		Spring		Summer		Total	Habitat		
		<500 m	>500 m	<500 m	>500 m	<500 m	>500 m	<500 m	>500 m		Rice (%)	Intertidal (%)	Tank (%)
Common shelduck	*Tadorna tadorna*	65		20			20	7	15	127		7	93
Ruddy shelduck	*Tadorna ferruginea*		2							2			100
Mallard	*Anas platyrhynchos*	142	6	6	27	37	54	6		278	9	67	24
Gadwall	*Anas strepera*			2						2			100
Northern shoveler	*Anas clypeata*	490	585	1289	747	166				3277		4	96
Eurasian teal	*Anas crecca*			1						1			100
Black-necked grebe	*Podiceps nigricollis*	105	29	20	45		1			200	3		97
Little grebe	*Tachybaptus ruficollis*	61	94	9	39		7		2	212	1		99
Great cormorant	*Phalacrocorax carbo*	19	528		148	2	62			759		3	97
Western cattle egret	*Bubulcus ibis*	7	14	13	61	10	3	60	320	488	93	1	6
Little egret	*Egretta garzetta*	38	50	96	254	25	51	103	167	784	64	11	25

(continued)

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Species		Winter		Autumn		Spring		Summer		Total	Habitat		
		<500 m	>500 m	<500 m	>500 m	<500 m	>500 m	<500 m	>500 m		Rice (%)	Intertidal (%)	Tank (%)
Great egret	*Casmerodius albus*	6	10	1	13		6			36	64	3	33
Grey heron	*Ardea cinerea*	58	48	49	51	9	8	26	42	291	62	15	22
Purple heron	*Ardea purpurea*							2	9	11	100		
White stork	*Ciconia ciconia*	90	30	201	190	1	7	17	88	624	75		25
Black stork	*Ciconia nigra*		3							3	100		
Glossy ibis	*Plegadis falcinellus*				116		1	260	30	407	100		0
Eurasian spoonbill	*Platalea leucorodia*	18	42	50	97	16	10	10	44	287	18	18	64
Greater flamingo	*Phoenicopterus roseus*	261	343	2061	843	1776	741	235	484	6744	33	0	67
Eurasian coot	*Fulica atra*			4						4	100		
Common moorhen	*Gallinula chloropus*							2	2	4	100		
Pied avocet	*Recurvirostra avosetta*	14	70	117	139	38	155		1	534	1	32	67
Black -winged Stilt	*Himantopus himantopus*	8	7	20	198	1	17	696	594	1541	20	4	76
Common ringed plover	*Charadrius hiaticula*	34	1				1	1	8	45	44	31	24
Kentish plover	*Charadrius alexandrinus*	19	2			5	6	14	8	54	37	9	54
Grey plover	*Pluvialis squatarola*	37	67			8	1			113	14	54	32
Northern lapwing	*Vanellus vanellus*	82	32							114	100		

(continued)

(continued)

Species		Winter		Autumn		Spring		Summer		Total	Habitat		
		<500 m	>500 m	<500 m	>500 m	<500 m	>500 m	<500 m	>500 m		Rice (%)	Intertidal (%)	Tank (%)
Sanderling	*Calidris alba*		1			1			2	4			100
Dunlin	*Calidris alpina*	470	96	13				28	14	621	72	5	23
Curlew sandpiper	*Calidris ferruginea*							2		2			100
Green sandpiper	*Tringa ochropus*	13	7	4	2	2		2	22	52	77	12	12
Common sandpiper	*Actitis hypoleucos*	25	15	4	4	4	1	5	7	65	23	66	11
Spotted redshank	*Tringa erythropus*	118	161	136	431	5	39	142	61	1093	8	15	77
Common Redshank	*Tringa totanus*	4	6		1			6	31	48	18	23	59
Common greenshank	*Tringa nebularia*	2	22	132 4	10	3	68		4	113	4	7	89
Black-tailed Godwit	*Limosa limosa*		11		2374			370	253	3140	2	8	90
Whimbrel	*Numenius phaeopus*								1	1		100	
Common snipe	*Gallinago gallinago*	12	2	2		7				23	100		
Ruff	*Philomachus pugnax*				17			1	10	28			100
Black-headed Gull	*Larus ridibundus*	1649	512	478	2456	95	189	356	1417	7152	20	14	66
Yellow-legged Gull	*Larus michahellis*		1							1			100
	Larus fuscus	256	249	733	1555	136	67	4	20	3020	63	7	30

(continued)

(continued)

Species		Winter		Autumn		Spring		Summer		Total	Habitat		
		<500 m	>500 m	<500 m	>500 m	<500 m	>500 m	<500 m	>500 m		Rice (%)	Intertidal (%)	Tank (%)
Lesser Black-backed Gull													
Little tern	*Sternula albifrons*								16	16			100
Sandwich tern	*Sterna sandvicensis*		7		5					12			100
Common tern	*Sterna hirundo*						2			2			100
Caspian tern	*Hydroprogne caspia*				1				3	4			100
	Sterna spp.				2					2			100
	Unidentified	3	1	7	5				1	17	12	18	71
	Anas spp.			120	14					134		90	10
	Charadrius spp.	2			1					3	67	33	
	Calidris spp.	2								2	100		
	Tringa spp.	2	15		9		29	1	93	149	3		97
	Larus spp.						1			1		100	

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