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Recently created man-made habitats in Doñana provide alternative wintering space for the threatened Continental European black-tailed godwit population

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ABSTRACT

Over the last decades the Continental European population of black-tailed godwits, *Limosa limosa limosa*, has shown steep declines as a consequence of agricultural intensification on the breeding grounds. Although numbers have also declined in their traditional wintering areas in West-Africa, in the Doñana wetlands of southwestern Spain high nonbreeding numbers have persisted. Here we provide a long-term (35 year, 1977–2011) analysis of godwit numbers in Doñana. In fact, from the mid 1990s there has been a steep increase in numbers so that the fraction of godwits along this flyway that winters in Doñana increased from 4% in the late 1980s to 23% in 2011. These changes were not correlated with climatic conditions in Spain, nor in Sahel, but they were associated with changes in habitat availability – mainly an increase in man-made artificial wetlands. Commercial fish-farms and rice fields provide alternative habitats to the original seasonal marshlands for daytime roosting (mainly in the fish ponds) or nocturnal foraging (probably rice fields in addition to fish ponds). For migrating waterbirds, degradations of natural wetlands can thus be compensated by man-made alternative habitats. As the availability especially of such man-made areas is highly sensitive to short-term political/economic driven decision-making, they should be given greater consideration in global conservation plans.

1. Introduction

Long-distance migratory shorebirds are considered good "integrative sentinels" of global change (Piersma and Lindström, 2004) as they are quite vulnerable to climatic and habitat changes worldwide in view of their dependence on widely separated habitats spread across different climate zones of the planet (Piersma and Baker, 2000; Huntley et al., 2006). For instance, large-scale climate and local weather conditions can have strong impacts on habitat availability and may also influence dispersal behaviour and local population size (Newton, 1998; Figuerola, 2007). Models relating birds and climatic variables have predicted that geographical distributions of many species will be affected by climate change (Huntley et al., 2006; Knudsen et al., 2011; Jenouvrier, 2013). Indeed, recent studies have found evidence for shifts towards the northeast in the winter distribution of coastal shorebirds in Europe, a change that appears correlated with increasing mean winter temperatures (Rehfisch et al., 2004; Maclean et al., 2008). Shorebird assemblages in France changed towards an increasing dominance of species that thrive at higher temperatures (Godet et al., 2011). However, in addition to climatic change, habitats are altered at increasing scales and speeds by humans (Rands et al., 2010). Widespread anthropogenic impacts correlate with increased rates of loss of biodiversity and ecosystem services (Hoekstra et al., 2005; Turner et al., 2007; Lee and Jetz, 2008). Worldwide this includes loss and degradation of wetlands, losses which may seem the major driving force in well documented declines in several shorebird populations (Piersma et al., 2001; Baker et al., 2004; Lopes et al., 2005; Dudgeon et al., 2006; van Gils et al., 2006; Goss-Custard et al., 2006; Catry et al., 2011). For many shorebirds, artificial wetlands, such as rice fields, saltpans or fish farm, could provide alternative habitats at least at some stages of the annual cycle (Masero et al., 2000; Elphick and Oring, 2003; Ma et al., 2004; Taft and Haig, 2006; Masero et al., 2010; Sripanomyom et al., 2011; Donglai et al., 2013; Hobson et al., 2013). Not all species are able to exploit these artificial habitats, and species that are more plastic in their habitat choice show more positive population trends than species only occurring in natural habitats (Sánchez-Guzmán et al., 2007; Rendón et al., 2008; Máñez et al., 2010; Sebastián-González et al., 2010; Toral and Figuerola, 2010). Thus, habitat loss and land use changes need to

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be also considered in these ecological models to improve predictions of the impact of global change (Pearson and Dawson, 2003; Dormann, 2007; Mantyka-pringle et al., 2012).

Here we provide an analysis of the results of a long-term monitoring programme (35 years, 1977–2011) on numbers of black-tailed godwits *Limosa limosa* in the Doñana wetlands (south-western Spain). Black-tailed godwits are long-distance migrant shorebirds that during the nonbreeding season use both marine and freshwater natural habitats where they feed on seeds and invertebrates (Sánchez et al., 2006; Alves et al., 2010; Sora and Masero, 2010). However, nowadays they are highly dependent on rice fields (Zwarts et al., 2009; Lourenço et al., 2010a; Masero et al., 2010). The species is listed on the UICN Red list as "near-threatened" (BirdLife International, 2012). The Doñana wetlands are used mainly by the continental population *L. l. limosa* (Márquez-Ferrando et al., 2011) that largely breeds in The Netherlands and traditionally spent the winter mostly in near-coastal freshwater wetlands in West-Africa (Gill et al., 2007; Kirby and Scott, 2009). This population has declined steeply over the last 40 years (Schekkerman et al., 2008). This decline is explained by reduced recruitment caused by changes in land-use on the breeding grounds: previously wet flower-rich meadows with late harvesting dates were turned into intensive croplands where fast-growing grass-varieties are harvested early (Kleijn et al., 2010; Groen et al., 2012; Kentie et al., 2013).

Studies during the non-breeding season mainly done in West-Africa and Iberia had reported important changes in population (Lourenço and Piersma, 2008; Zwarts et al., 2009; Lourenço et al., 2010b; Masero et al., 2010). Nevertheless, in Doñana high numbers still occur (Márquez-Ferrando et al., 2011). In this study we aim to determine whether the Continental European population of black-tailed godwits have experienced changes in numbers in Doñana during the last decades and whether such changes are better explained by climatic or by land use changes.

2. Material and methods

2.1. Study area

The Doñana wetlands (Doñana from here on) cover 108,429 ha in the estuary of the Guadalquivir River (SW Spain). The climate is Mediterranean sub-humid with coastal influence, wet, mild winters and dry, hot summers (García-Novo and Marín-Cabrera, 2005). Doñana is one of the most important wetlands in Europe for migrating and wintering waterbirds along the East Atlantic flyway (Rendón et al., 2008). Of the former vast natural marshes (more than 100,000 ha) that covered both sides of the river at the start of the 20th century, ca. 30,000 ha now remain. Large areas were transformed into saltpans, rice-fields, and other crops, whilst some were transformed into extensive aquiculture in the 1990s (García-Novo and Marín-Cabrera, 2005). As a result of these man-made habitat changes, a complex mosaic of diverse aquatic habitat types of different size and water depth are found: from natural to artificial wetlands, from fresh to hypersaline and from ephemeral to permanent water.

2.2. Methods

We analysed temporal changes in the godwits numbers in Doñana based on a dataset of monthly aerial waterbird counts carried out by Estación Biológica de Doñana-CSIC from 1977 to 2011 (available from http://www-rbd.ebd.csic.es/Seguimiento/seguimiento.htm). Based on the temporal occurrence of godwits we defined two seasons: (i) *winter* that grouped counts from October to December and (ii) *spring migration* that grouped counts from January (when numbers peak as more individuals arrive from their wintering sites in West-Africa; Fig. 1) to March (Zwarts et al., 2009; Lourenço et al., 2010b; Masero et al., 2010). Year refers to the year in which a given winter season have started (e.g., year 1999 includes the counts of October–December 1999 and January–March 2000). Every month one census was done, always early in the morning. Some scheduled counts went missing because of bad weather conditions or other uncontrolled factors. Counts were done by a single observer between 1977 and 1997 who was replaced after one year of duplicate counts by a new observer from 1997 onward. Each aerial survey covered a total of 91,890 ha within Doñana National-Natural Park and the rice fields around the protected area. In the surveyed area we mainly distinguished four main sectors that godwits use, based on the dominant habitat type: (1) natural marshes, (2) Veta la Palma fish farm, (3) rice fields and (4) Bonanza saltpans, the latter three being man-made (Fig. 2). The marshlands included all the seasonal and natural marshes plus other water bodies such as lagoons that did not suffer significant transformations during the last 35 years. As they depend mainly on rainfall, flooding levels are highly variable between seasons (Fig. 3a). Veta la Palma is a private fish farm located between two arms of the Guadalquivir River in the eastern part of Doñana. The fish-ponds were created in 1994 over former natural marshes and has increased the mean flooded area as they keep water all the year (Fig. 3b). It covers 11,300 ha of which 3200 ha are dedicated to extensive aquaculture of brackish water pumped from the river consisting in ca. 45 rectangular ponds (ca. 1000×1000 m) of variable depth (5–50 cm) connected by channels. A small extension is dedicated to rice fields (ca. 500 ha) and the rest is seasonal natural marshes and surface dedicated to extensive cattle farming (www.vetalapalma.es). Rice agriculture in Doñana started in the early 1930s with 277 ha and has increased during the 80s and 90s and reach around 36,000 ha cultivated (Fig. 3c). Nowadays, rice fields also cover the eastern part of the Guadalquivir River (ca. 15,000 ha) out of the survey area. The rice fields stay flooded during winter and dry out by the end of December–January, which are particularly attractive for migratory waterbirds during this season (Rendón et al., 2008; Toral and Figuerola, 2010). The Bonanza saltpans spread over 3008 ha with a flooded area around 1160 ha and stayed stable during our study period (Fig. 3d). It was created in the 15th century for salt production (Martín-López et al., 2011). It constitutes several ponds of different salinity levels where waterbirds roost and forage (Rendón et al., 2008).

Total cultivated rice field area per year was provided by Federacion de Arroceros de Sevilla. The flooded area in Doñana was estimated from Landsat images (MSS, TM and ETM+) from 1984 to 2010 according to Díaz-Delgado (2010). Values for each season were calculated as the average value on the basis of all images available for the corresponding months (with 40 days being the maximum between the date of aerial census and the image used).

2.2.1. Climatic variables

To examine whether the temporal change in godwit numbers can be explained by local climatic conditions, we used rainfall and temperature variables as local weather variables (Fig. 4). Mean values, for both winter and spring passage season were calculated from mean monthly values registered at El Palacio Doñana meteorological station since 1978 (available from http://www-rbd.ebd.csic.es/Seguimiento/mediofisico.htm; *see also* Fig. 4a and b). In addition, we included the Sahel Index, an index based on rainfall anomalies in the Sahel area (available at http://jisao.washington.edu/data/sahel/) (Ali and Lebel, 2009) to summarise climatic conditions in the traditional West-African wintering area of godwits (Zwarts et al., 2009). We used the Sahel index during the rainy season in the Sahel (June–October) where negative values correspond to dry years and positive values to wet years (Fig. 4c).

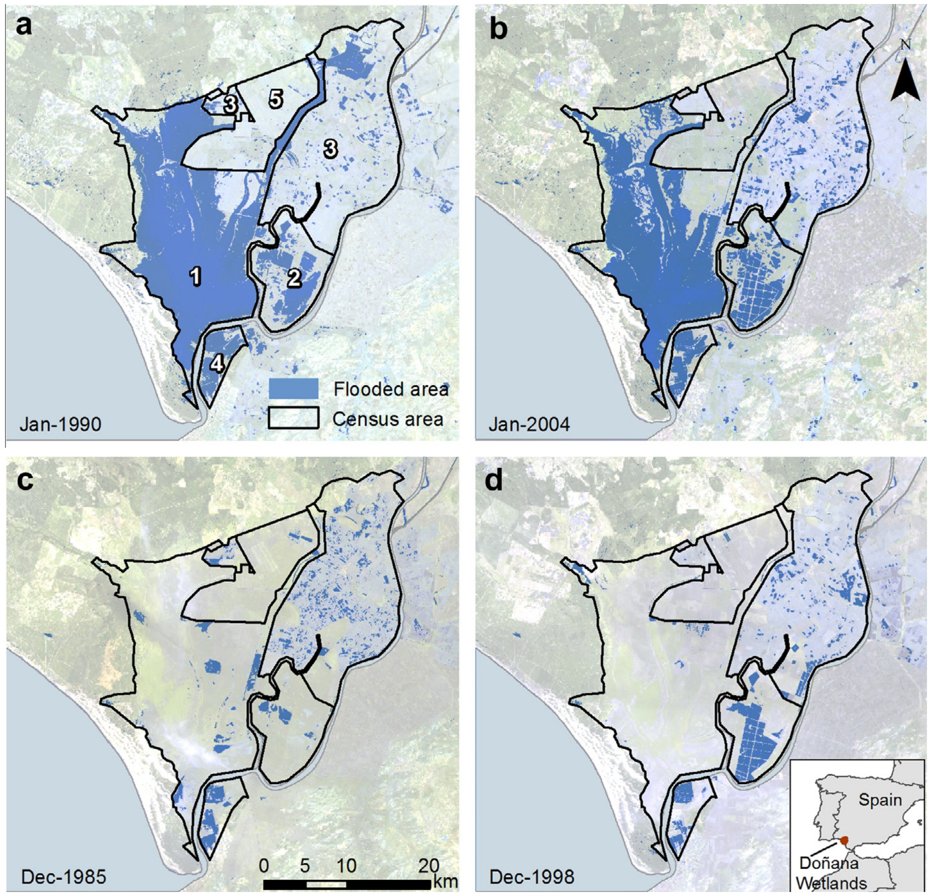

Fig. 1. Map of Doñana area surveyed during the aerial counts and the different sectors based on the habitat type (1: natural marshes, 2: Veta la Palma fish farm, 3: Rice fields, 4: Bonanza Saltpans, 5: Cereals, sunflowers and other crops). Different maps showed the flooded area based on Landsat images on wet (a and b) and dry (c and d) years before and after the notable land-use changes. Note how after the creation of the fish farm, in a dry winter the natural marshes are dry while the fish farm remains flooded.

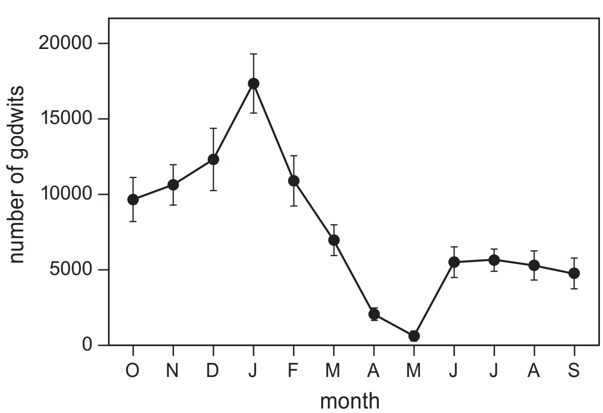

Fig. 2. Monthy variation in the mean godwit numbers of black-tailed godwits in Doñana in the study period 1977–2011.

Previous studies have shown that Sahel Index is a good indicator of winter conditions for European migratory birds wintering in the area (Cotton, 2003; Gordo and Sanz, 2006; Sanderson et al., 2006; Both et al., 2010; Fasola et al., 2010; Ockendon et al., 2012; Tøttrup et al., 2012).

2.2.2. Land-use changes in Doñana

To assess if godwit numbers were related to land-use changes in Doñana, we used the godwits numbers in the untransformed part of the natural marshlands as a "control" to compare with the numbers observed in the transformed areas. We establish two periods: (1) before and (2) after on 1994, a year when the most notable land-use changes in the natural marshes occurred. 1977–1993 was the period before the creation of the fish ponds during which high increase of the rice field occurred. After the creation of the fish farm, in 1994–2011 fish ponds provided a new habitat for waterbirds in Doñana. The extension of rice fields reached highest values at the end of the study period and its oscillation in surface were related to years of drought that may severely reduce the cultivated area. Moreover, we used the extent of anthropogenic flooded areas which increased over time (rice fields and Veta la Palma fish farm), to test whether temporal variations in godwit numbers can be explained by increasing land use changes.

2.2.3. Statistical analysis

The number of missing counts was low (23 out of 210 possible counts: seven for October, three for November, two for December, three for January, three for February and five for March). Whilst the Underhill approach (Underhill and Prys-Jones, 1994) offers a method to impute missing values in count data, we used raw data without data imputation because the black-tailed godwits were recorded in big flocks that did not fit a Poisson distribution due to overdispersion. This would have violated the Underhill method assumptions.

To analyse changes in godwit counts we used Generalized Additive Models (GAMs) with negative binomial error distribution and a logarithmic link function (10 in total, one per each season and two per habitats by seasons). GAMs were used to model the count

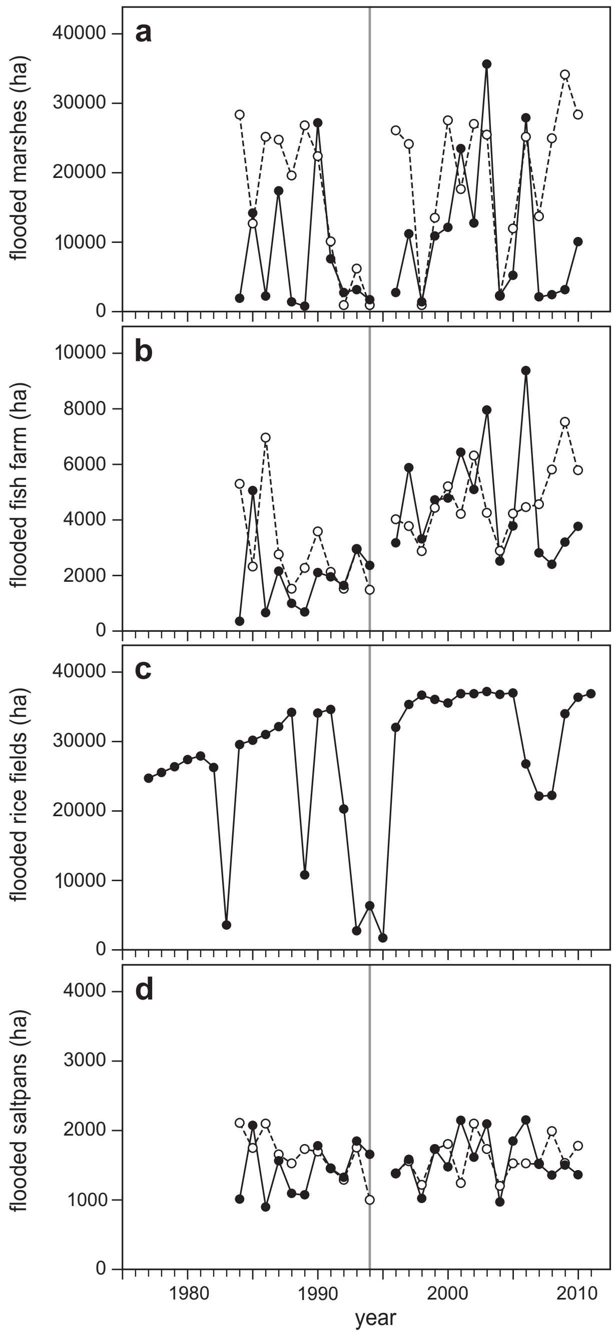

Fig. 3. Mean flooded area in the natural marshlands (a), Veta la Palma fish farm (b), rice field area cultivated by year around Doñana National and Natural Park (c) and mean flooded area in Bonanza saltpans (d) in winter (filled dots) and spring (open dots) by year. The vertical grey line indicate the year that the fish ponds at Veta la Palma were created on former natural marshlands.

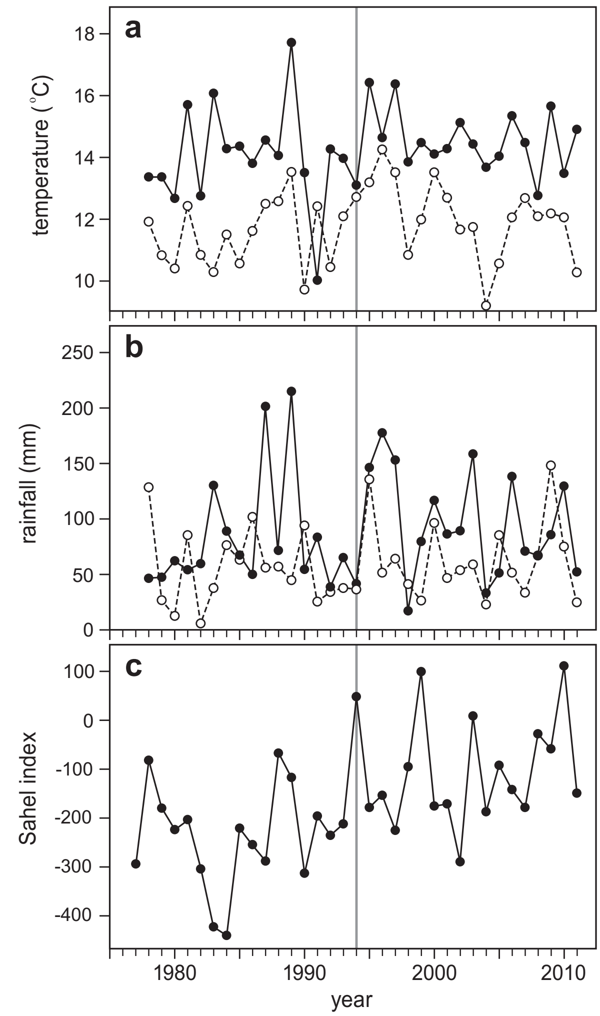

Fig. 4. Annual variation in the mean values of air temperature (a), rainfall (b) during the winter (October–December, filled dots) and spring migration (January–March, open dots) and Sahel Index annual variation (c) during the rainy season (June–October) in the study period 1977–2011.

data which allow versatile analyses of non-linear relationship to accommodate population stochasticity (Zuur et al., 2009; Reed et al., 2011) A first order autocorrelation was added to the analyses when a significant temporal autocorrelation was detected (Zuur et al., 2009). For the models, we consider winter and spring migration mean counts as the response variable and year as smoother. A smoother is a function used to model the relationship between the response variable and the explanatory variable relaxing the assumption of linearity (Zuur et al., 2009). The smoothing parameter was selected by penalized regression using a dimension limit $k = 10$. The theta parameter for the negative binomial distribution was allowed to vary between 1 and 10 and the optimal value selected through the outer iteration method. In addition, to evaluate climatic effects on godwits numbers, we included in the separate GAMs mean seasonal temperature, mean seasonal precipitation or Sahel Index as explanatory linear terms. GAM models were fitted with the mgcv library in R statistical software for MacOS X (R Development Core Team, 2009).

To test for statistical differences in godwits counts *before* and *after* the land-use changes by and between seasons, we used Generalized Linear Mixed Models (GLMMs) with a negative binomial error distribution, where seasonal mean values on godwits counts was the response variable, year was considered as a random factor, and period and season fixed factors. The GLMMs were fitted using the GLIMMIX procedure in SAS 9.2, and the non-parametric Spearman test with JMP 9.

3. Results

The number of godwits in Doñana in winter increased with time ($\chi^2_1 = 20.61$, $P < 0.001$; Fig. 5a). During spring migration number varied between 1,700 and 30,000 individuals, population peaks during the 1985–1990 and 2005–2010 ($\chi^2_{7.18} = 16.29$, $P = 0.03$; Fig. 5b). Neither local climatic conditions, nor the Sahel Index, explained variations godwit numbers in Doñana in winter, but numbers in spring were positively correlated with spring

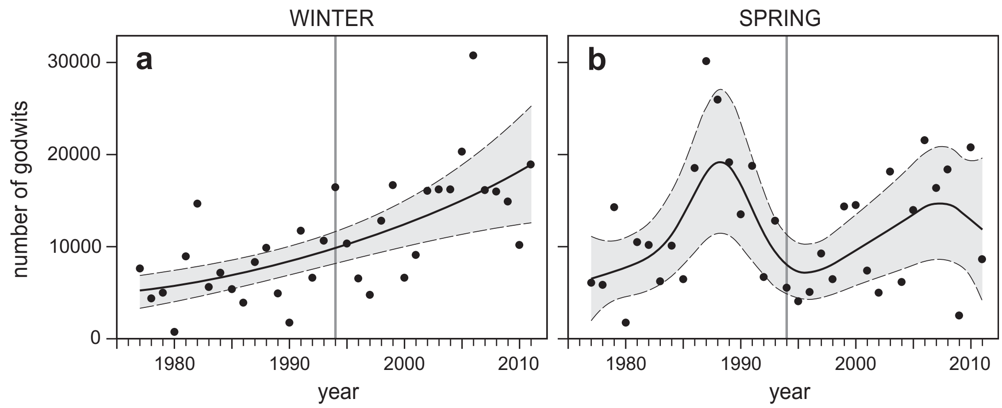

Fig. 5. Smoothed time series plots of mean numbers of black-tailed godwits counted in Doñana in winter (a) and during spring migration (b). The solid line is the estimated smoother and the dashed lines indicate 95% confidence bands. The vertical grey line indicate the year that the fish ponds at Veta la Palma were created on former natural marshland.

Table 1
Results of the GAMs testing the relationship of the environmental variables with the mean number of individuals of black-tailed godwit in Doñana Wetlands in the winter and spring seasons.

	Winter		Spring	
Environmental variables	*Z*	*P*	*Z*	*P*
Temperature	0.75	0.46	2.10	0.04
Rainfall	0.88	0.38	−0.99	0.32
Sahel Index	0.45	0.65	1.81	0.07

Table 2
Results of the GLMM testing for the differences in black-tailed godwit numbers between seasons and period before (1977–1993) and after (1994–2011) main land use changes.

	Estimator	s.e	d.f	*t*	*P*
$\text{Winter}_{\text{before}}$–$\text{Winter}_{\text{after}}$	−0.79	0.19	33	−4.02	<0.001
$\text{Spring}_{\text{before}}$–$\text{Spring}_{\text{after}}$	0.13	0.19	33	0.65	0.52
$\text{Winter}_{\text{before}}$–$\text{Spring}_{\text{before}}$	−0.61	1.16	33	−3.90	<0.001
$\text{Winter}_{\text{after}}$–$\text{Spring}_{\text{after}}$	0.31	0.15	33	2.05	0.05

temperature and a positive trend with Sahel Index was also detected (Table 1).

GMMLs showed that godwit numbers did not differ between seasons ($F_{1,33} = 1.86$, $P = 0.18$), but were larger in the period after considerable land use changes ($F_{1,33=}4.08$, $P = 0.05$). However, the interaction between period and season was significant ($F_{1,33} = 17.87$, $P < 0.01$). This interaction was due to increases in the number of godwits in winter in the period after 1994 ($t_{33} = 4.02$, $P < 0.001$), and no differences in the spring ($t_{33} = 0.65$, $P = 0.52$). Furthermore, before 1994 (1977–1993) godwit numbers were significantly higher in spring than in winter ($t_{33} = 3.90$, $P < 0.001$), whereas afterwards the opposite was the case ($t_{33} = 2.05$, $P = 0.05$) (Table 2).

Different patterns of variation in godwits numbers were found in the different sectors (Fig. 6). While winter numbers in the marshes showed a slight increase ($\chi^2_{2.08} = 10.13$, $P < 0.\ 01$; Fig. 6a), a noticeable increase in godwits numbers occurred in Veta la Palma after the creation of the fish ponds ($\chi^2_{4.15} = 18.96$, $P < 0.001$; Fig. 6b). In the rice fields godwit numbers oscillated ($\chi^2_{8.98} = 150.39$, $P < 0.001$; Fig. 6c) and the saltpans showed low numbers ($\chi^2_{7.18} = 25.68$, $P < 0.001$, Fig. 6d). By contrast, during spring migration, numbers in the marshlands first increased in the 1980s but then dropped during the 1990s. After that, they remained stable during the 2000s, with a small decline during the last three years ($\chi^2_{6.23} = 15.14$, $P = 0.02$; Fig. 6e). No increase in number of godwits in Veta la Palma occurred ($\chi^2_{1.08} = 2.94$, $P = 0.09$; Fig. 6f). Low numbers in the rice fields and the saltpans remained stable ($\chi^2_{8.99} = 114$, $P < 0.001$; $\chi^2_{8.53} = 40.63$, $P < 0.001$, respectively; Fig. 6g and h).

The increase in godwit numbers in winter thus coincided with the creation of the extension of rice fields cultivated and the creation of Veta la Palma fish farms (Fig. 7), but not correlated (Rho = 0.19, $P = 0.35$).

4. Discussion

Previous studies showed that the black-tailed godwits occurring in Doñana belong mostly to continental population *L. l. limosa* (Márquez-Ferrando et al., 2011). Around 1980s the total breeding population of the continental subspecies was estimated at ca. 100,000 pairs (Piersma, 1986; Kirby and Scott, 2009). Equating each part with two migrating adults, an average of ca. 8,000 and 28,000 godwits in winter and spring in Doñana respectively in late 1980s would mean that 4% wintered there and 13% occurred in spring. Almost 20 years later, the continental population was estimated to the only half as large (Thorup, 2006), with a steady decline rate of 5% per year (van Dijk et al., 2010). On this basis, in 2011 the wintering population in Doñana had increased to 23% of the population, a percentage almost 6 times higher than around the late 1980s. The numbers during spring passage, on the other hand, remained stable around at 10% of the population. As a result of the fast decline of the western population by 50% based on counts in the breeding area and by 70% in the West-African wintering areas (Zwarts et al., 2009), such an increase suggests a switch of part of the godwits to winter in Doñana. Given a high individual turnover rate during migration (T. Piersma et al., unpubl. data on satellite-tagged black-tailed godwits staging briefly in Doñana in autumn), the figures likely underestimate the real number of individuals stopping over in southern Spain.

Climatic conditions may affect shorebird phenology and breeding success (Pearce-Higgins et al., 2010), survival and population dynamics (Insley et al., 1997; van de Pol et al., 2010) and dispersal behaviour (Figuerola, 2007), but we failed to find that local climatic conditions affected numbers of wintering godwits in Doñana. Mean winter temperatures ranged between 10 and 18 °C: in Doñana wintering godwits are thus not exposed to either freezing or very high temperatures. Rainfall counts as an important environ-

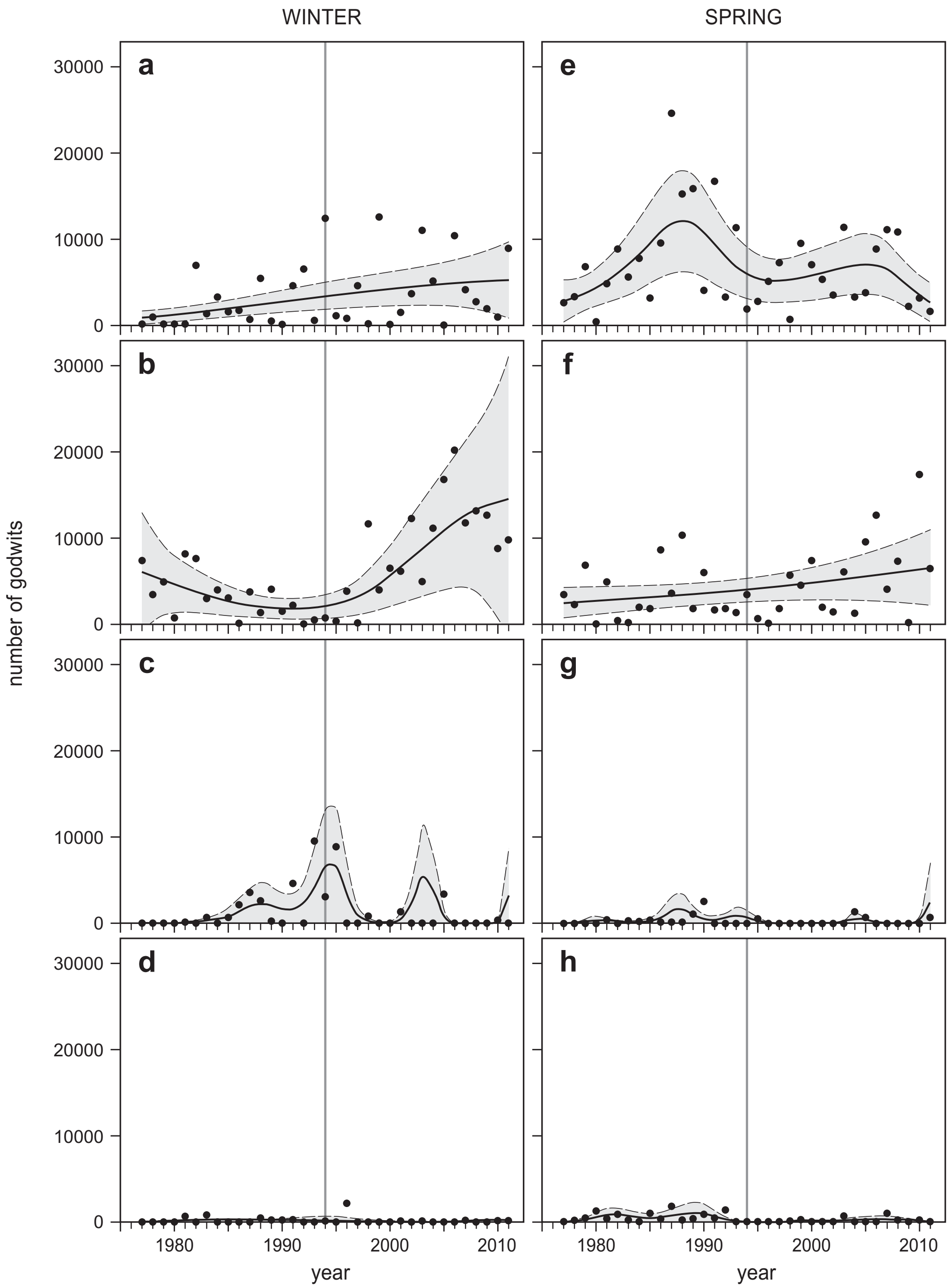

Fig. 6. Smoothed time series plots of mean numbers of black-tailed godwits recorded in Doñana in the natural marshlands (a and e), fish farm (b and f), rice fields (c and f) and saltpans (d and g) in winter and in spring respectively. The solid line is the estimated smoother and the dashed lines indicate 95% confidence bands. The vertical grey line indicate the year that the fish ponds at Veta la Palma were created from what were natural marshlands and after which the rice field area increased.

mental factor limiting bird populations (Newton, 1998), and this is certainly the case in Mediterranean ecosystems (García-Barrón et al., 2011). Nevertheless, we did not find rainfall effects on godwits numbers, which might be explained by the buffering system provided by artificially flooded habitats that offer alternative flooded areas in dry seasons. Regarding the rainfall conditions in Africa, the long periods of drought in the Sahel (25-year period since 1968) could have forced godwits to move to other sites. However, rainfall in the Sahel did not correlate with godwits numbers in Doñana in winter. Rice fields are among the major habitat that godwits use and since the 1960s the increase of irrigated fields in the Sahelian floodplains (Kuijper et al., 2006; Zwarts et al., 2009) could have compensated for the negative effects of drought and could explain the absence of association between both variables in the winter. However, spring numbers positively correlated with Sahel Index and Doñana temperature suggests that conditions in Sahel may affect the presence of godwits in Doñana during northward migration.

Increasing godwits numbers in winter in Doñana were associated with the extent of artificial flooded area in rice fields and in Veta la Palma fish farm. This increase was noticeable in the fish farm after its creation. Kloskowski et al. (2009) have recently

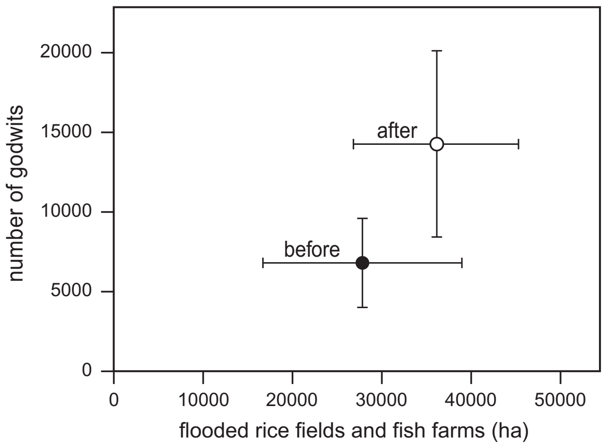

Fig. 7. Mean (±SD) of number godwits and flooded antropogenic area (rice fields and fish farm) in winter season in the period before (1977–1993) and after (1994–2011) main land use changes in Doñana Wetlands.

observed that black-tailed godwits use the aquaculture ponds as alternative habitat especially in dry season when the natural marshes are dry. We speculate that the fish farm might offer predictable resources and safe conditions to the species. First, the fish farm is a private area, free of human and hunting disturbances. Second, water levels in the fish ponds are shallow and stable all year around. Third, in winter, densities of aquatic macro-invertebrates are higher in the fish ponds than in the natural marshes (Kloskowski et al., 2009). Such differences in food abundance were considered as a potential driver of population increase in shorebirds species in Doñana (e.g., avocets *Recurvirostra avosseta*, see also Rendón et al., 2008). The same was found for some waterbird species using the fish ponds during the breeding season, such as slender-billed gulls (*Chroicocephalus genei*) and greater flamingos (*Phoenicopterus roseus*, Amat et al., 2005; Ramírez et al., 2012). On the other hand, the nearby rice fields have rice kernels to offer in winter (Toral and Figuerola, 2010) and might play a complementary role in making the fish ponds more attractive. Recently we observed that black-tailed godwits foraged at night in the rice fields, but that most roosted in Veta la Palma during daytime in the harvesting period (October–November) (unpubl. data). This night-time use may be related with the disturbances caused by hunting activities and/or predator abundance during daylight hours. If so, the morning aerial counts would miss godwits in the habitats where at least part of the foraging takes place.

Therefore, our results suggest that the increase in godwit numbers during the winter is better explained by the increase in land use changes rather than climate effects in Doñana or in West-Africa. Alternative artificial wetlands around the natural marshes could have buffered the system turning into a more predicable wintering site for the species. Unfortunately with the current data available we cannot establish a causal link between both events and future work is required to assess the value of these artificial wetlands as feeding (rather than roosting) habitats for the black-tailed godwits. Other alternative explanations could be related with the degradations of their natural habitats and the new feeding opportunities offered by artificial wetlands along the distribution range that could affect the entire non-breeding distribution of the species.

4.1. Conservation and policy implications

This study increases the current understanding of the non-breeding distribution of the near-threatened black-tailed godwits in Europe, and provides evidence that Doñana is now a key wintering area. Also, our data suggest that land use change rather than climate change might explain their actual non-breeding distribution. Given the increasing loss and degradation of natural wetlands, man-made ecosystems have begun to play a significant role in avian conservation (Masero, 2003; Bellio et al., 2009; Yasué and Dearden, 2009; Ma et al., 2010; Toral and Figuerola, 2010; Ramírez et al., 2012; Navedo et al., 2013). Nowadays, the threatened black-tailed godwit relies almost entirely on human-made habitats. Even these habitats are unprotected and sometimes under threat (Toral and Figuerola, 2010). Any alteration of good management would probably lead to declines of the global population. Therefore, the man-made ecosystems that usually occupy former natural wetlands but on which many threatened species now rely (Tourenq et al., 2001; Elphick and Oring, 2003; Sánchez-Guzmán et al., 2007; Sebastián-González et al., 2010; Toral and Figuerola, 2010) depend to a large degree on policies at the level of the European Union. This includes the willingness to support local farmers to continue extensive types of land management. Also, policy decisions leading to reduce fish-farming and/or rice cultivation in Europe in favour of imports from elsewhere will have negative collateral impacts on wetlands and waterbirds. The use by waterbirds of rice-fields and fish-farms should not be used as an excuse for the destruction of natural wetlands, but rather be used as an argument for the restoration of former wetlands if and when exploitative activities would be discontinued.

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