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The persistence of the Dutch Black-tailed Godwit population depends largely on high adult survival. Adult survival may be influenced by hunting pressure and land use change in the wintering area, the West African coastal zone. Here we examine hunting pressure on and habitat use of Black-tailed Godwits in West African rice-growing areas. The Black-tailed Godwit is exposed to hunting throughout the core wintering area in West Africa but hunting related mortality does not seem to be the main driver of the ongoing population decline. Habitat use of godwits seems to be governed by the availability of their preferred habitat: (man-made) bare wet soil which is consecutively available in different parts of West Africa throughout the entire wintering period.

Trefwoorden: conservation, flyways, meadow birds, migratory waterbirds, rice growing areas

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Inhoud

Summary

The reproductive success of Black-tailed Godwits is currently extremely low and the main driver of its population decline. The persistence of the Dutch Black-tailed Godwit population seems to depend to a large extent on the high adult survival and the longevity of adult birds. Adult survival may be influenced by hunting pressure and land use change in the West African coastal zone, the key wintering area of the Black-tailed Godwit. In this study we examined how severe hunting pressure on Black-tailed Godwits is in West African rice-growing areas and what types of habitats are being used by godwits during the course of the wintering period. We examined hunting pressure in Casamance and Guinea-Bissau using farmer questionnaires. We examined godwit distribution and habitat use at the beginning of the wintering season by means of an aerial survey. Finally, between August 2008 and January 2009 we used monthly ground surveys to examine godwit phenology and changes in habitat use at different times of the winter season. The Black-tailed Godwit is exposed to hunting throughout the core wintering area in West Africa, but hunting related mortality doesn't seem to be severe enough to substantially influence its population dynamics. Between August and January, peak numbers of Black-tailed Godwits move between different parts of their wintering range. These movements seem to be governed by the availability of their preferred habitat: (man-made) bare wet soil which is consecutively available in different parts of West Africa throughout the entire wintering period. Our results suggest that effective conservation probably should target the continuation of the traditional extensive rice cultivation systems throughout the core wintering area of the Black-tailed Godwit, with the rice growing areas in Guinea-Bissau being of particular importance as this is the only East-Atlantic area that provides suitable habitat in November-December. Important potential threats to Black-tailed Godwits are changes in land use such as the abandonment of the labour-intensive traditional rice cultivation system or large scale irrigation works. A good second is increased access to rifles and/or cheap ammunition which might increase hunting related mortality.

1 Introduction

Background

The decline of the Dutch national population of the Black-tailed Godwit (Teunissen and Soldaat, 2006; Teunissen, 2007) has been largely attributed to developments in breeding areas in the Netherlands (Schekkerman and Müskens, 2001; Wymenga, 1997; Teunissen et al.,2006; Schekkerman, 2008). This is in agreement with recent estimates of adult survival which are similar or even higher than those reported several decades ago (80-97%, Both et al. 2006; Roodbergen et al. 2008; Bruinzeel et al., 2010). Because the reproductive success of Black-tailed Godwits is currently extremely low (Schekkerman et al., 2005), the persistence of the Dutch Black-tailed Godwit population seems to depend to a large extent on the high adult survival and the longevity of adult birds. This may give Dutch conservationists and policy makers the necessary time to design conservation strategies that enhance the recruitment rate of the population. It is therefore important to examine factors affecting adult survival of godwits in their winter staging areas.

Nearly the entire West European breeding population spends the winter in West Africa south of the Sahara. Birds start to arrive in early July (Van der Kamp et al., 2006) and depart again early in January (Van der Kamp et al., 2006; Kuijper et al.; 2006). Most godwits can be found in rice-growing areas between Gambia and Sierra Leone (Altenburg and Van der Kamp, 1985; Beintema and Drost, 1986; Kuijper et al., 2006). Black-tailed Godwits use the same migration route for fall and spring migration. Staging sites along this flyway are almost entirely man-made, such as rice fields, salt pans and wet meadows. Rice-growing areas in Spain and Portugal are currently the most important spring and fall staging sites with estimated peak numbers of 45,000 refueling godwits during spring migration (Lourenco and Piersma, 2008; P. Lourenco in Bruinzeel et al., 2010). Smaller numbers of godwits can be found on a limited number of sites in France, Morocco and Tunisia. The quantity and quality of staging sites along the migration routes and of their wintering haunts have changed significantly during the last decades (Zwarts et al., 2009). Nevertheless they were deemed adequate for godwits to maintain good body condition (Kuijper et al.,2006.).

Hunting pressure may contribute to population declines of long-distance migratory birds such as the Black-tailed Godwit (McCulloch et al., 1992). In their wintering areas, rice grains form an important component of the Black-tailed Godwit diet whenever available. This may result in conflicts with local rice farmers, especially during the period of seedbed preparation. In southern Senegal, in the Casamance area, Van der Kamp et al. (2008) estimated that approximately five per cent of the Black-tailed Godwits foraging in the area they visited in that year had been shot because they damaged the seedbeds of local rice farmers. It is not known whether Black-tailed Godwits do similar damage in other areas and whether godwits are also being persecuted there. In this study we therefore aimed to gather information on hunting in a larger, more representative area of the West African rice growing zone.

Between the planting period and the harvesting period an extensive period exists when no rice grains are available. It is currently unknown whether godwits are present in rice-growing areas during this period and, if so, where they feed and what they feed on. Because no information is available about the habitats and food sources used by Black-tailed Godwits when rice grains are unavailable, it is unknown how changes in land-use in the wintering areas may affect adult survival of Black-tailed Godwits. Since high adult survival is considered to be the main reason why the Dutch breeding population of Black-tailed Godwits has not collapsed completely yet, factors affecting adult survival in wintering areas may have considerable impact on the number of godwits breeding in the Netherlands. In this study we therefore aimed to collect data on habitat use of Black-tailed Godwits. By means of an aerial survey, we estimated population size and distribution and the factors explaining the use of rice growing areas in the core West African wintering habitats of Black-tailed Godwits. By means of

monthly terrestrial surveys we subsequently examined habitat use and preferences of godwits in the period September-December 2008.

Specific research questions were:

1. How severe is the hunting pressure on Black-tailed Godwits in West- African rice-growing areas?
2. How are godwits distributed in the West African coastal zone during the first part of the non breeding season?
3. How does habitat use and preferences of Black-tailed Godwits in their core wintering area change during the winter period and what does this infer about the resources required by them.

2 Methods

2.1 Farmers perspectives and hunting related godwit mortality

Since the recent moratorium on Black-tailed Godwit hunting in France, the only region where active hunting is still being practiced is West Africa. Here hunting is related to the perceived damage Black-tailed Godwits do to the seed beds of rice crops. Van der Kamp et al. (2008) found that in the period 2005-2007, hunters in a cluster of just four villages shot 215 godwits annually. To explore whether these findings may be extrapolated to the entire coastal rice-growing zone we obtained 72 interviews from (groups of) farmers in a rice growing area throughout the wintering range of Black-tailed Godwits in the Casamance and Guinea-Bissau. The interviews were open-ended and semi-structured and covered topics regarding arrival time of godwits, timing of peak numbers, population trend, food sources used by godwits, number of hunters in the rice growing areas and whether and how many godwits were shot by these hunters. All interviews started by having the farmers point out the Black-tailed Godwit in a bird guide to check whether interviewer and interviewee were talking about the same species.

2.2 Godwit numbers and habitat use during the wintering season

In the same areas where farmers were interviewed we surveyed the number of godwits on different types of habitat during the course of the wintering season. In the Casamance, Black-tailed Godwits were counted in September, October, November and December. In Guinea-Bissau godwits were counted in September, November and December. For reference, we compared the phenology of godwit numbers in the wintering period in West Africa with the phenology during the same period in the Portuguese Tagus estuary (data kindly provided by the Tagus Wader Roost Count Group).

During the West African counts we distinguished between a number of different habitat types in which the godwits were observed. For a description of the mangrove rice cultivation system see Van der Kamp et al. (2008). We distinguished between the following habitat types:

1. Mudflats. Natural mudbanks in the estuary outside the mangrove belt.
2. Tanne. Hypersaline, rarely flooded areas generally located between the rice growing area and the mangrove zone.
3. Rice seedbeds. Rice farmers in the Casamance use small seedbeds of 10-30 m2 to germinate their seeds. This is the main habitat where godwits can damage the crop by eating the seeds (Van der Kamp et al. 2008).
4. Not yet cultivated rice fields. After December harvest, rice fields are generally abandoned and overgrown with tall herbaceous vegetation until the next growing season.
5. Bare, recently cultivated rice fields. Just before the planting of the rice, fields are inundated with saline water and cultivated manually (Fig. 1). Planting of these bare fields with rice seedlings generally occurs rapidly (within days) after cultivation.
6. Planted, recently planted rice fields. Fields with small seedlings that generally have a bare appearance (Fig. 1).
7. Fields with growing rice crop. Fields with rice crop that forms a more or less closed vegetation.
8. Harvest location. Rice is generally threshed in the rice growing areas. It is often mentioned that godwits congregate in large groups around such locations to feed on spilt rice.
9. Fields where rice has recently been harvested but that are still wet.
10. Fields where rice has recently been harvested but that are already dry.

The surveys were carried out by I. Ndiaye (Casamance) and H. Monteiro (Guinea-Bissau). In September they were accompanied by L. Zwarts, J. van der Kamp (Casamance) and D. Kleijn (Guinea-Bissau).

Figure 1

A traditional method of preparing rice fields for planting with rice seedlings. Prior to the rice growing season rice fields are overgrown with weeds. The soil in rice fields is overturned and placed in ridges on which the rice is planted. In the back ground recently planted fields can be seen.

2.3 Godwit distribution and habitat choice

To gain insight in the spatial distribution of Black-tailed Godwits in the main wintering areas we performed an aerial survey of the core wintering area, Southern Senegal and Guinea-Bissau, in late August. This also allowed us to get an estimate of the size of the Black-tailed Godwit population that is present in these areas at the start of the wintering season.

Aerial survey

The aerial survey was flown by an experienced pilot (Jan van der Horst) using his own Rallye from which J. van der Kamp and L. Zwarts made the observations. AVGAS was not available at the airports of Ziguinchor and Bissau. Hence it was bought in Dakar and transported by car to Ziguinchor, being the operating base of the aerial count. The survey was done from 23 - 26 August 2008. Heavy downpours and tropical thunderstorms made it impossible to work the days before and after, but the weather was suitable for low altitude flying in a small aircraft during the four counting days. Nevertheless, the flight scheme above Guinea-Bissau had to be adjusted regularly to avoid approaching thunderstorms.

The aerial survey lasted a total of 19 hour and 18 minutes and covered 2761 km. The position, altitude and speed were registered each second by our GPS. The flying route is shown in Fig. 2. The survey covered 559 km above Gambia, 1120 km above southern Senegal and 1082 above Guinea-Bissau. On average 40% of the survey was above or near rice fields and 60% above other habitats such as mangroves, sea or forests. Above longer stretches of non-godwit habitat flying altitude was 200-1000 m. Above habitats where godwits could be

expected (based on earlier surveys, flight and field experience of the observers) surveying was done from an average flight altitude of 150 m. Average flight speed was 161 km/hour, but somewhat lower above the rice fields (156 km/hour). Birds were counted on the right side below the plane, in a strip being 150 m wide.

Prior to this survey topographical maps of the entire coastal zone of Guinea-Bissau had been obtained. Although these maps originate from the 1950s comparisons with the situation in the field to date showed that they generally provide a fair representation of the location and size of rice growing complexes (the actual exploitation of the fields today may have changed considerably though). These maps were scanned and geo-referenced and therefore digitally available. For Guinea-Bissau it was therefore possible to estimate what proportion of the rice growing area had been covered by the aerial survey.

Habitat characterization

During the survey, photographs and GPS fixes were taken of each rice complex (Fig. 3). These photographs were used to determine the proportional area occupied by different type of habitats in the rice growing zone of Guinea-Bissau. This was done for all areas where godwits had been observed and for a selection of locations where no godwits were seen. This selection consisted of a random sample of rice growing complexes from all the main rice growing areas in Guinea-Bissau. We distinguished between habitats in a rather global manner, since from the aerial photographs no details could be obtained, as could be done on the ground (see Section 2.2).

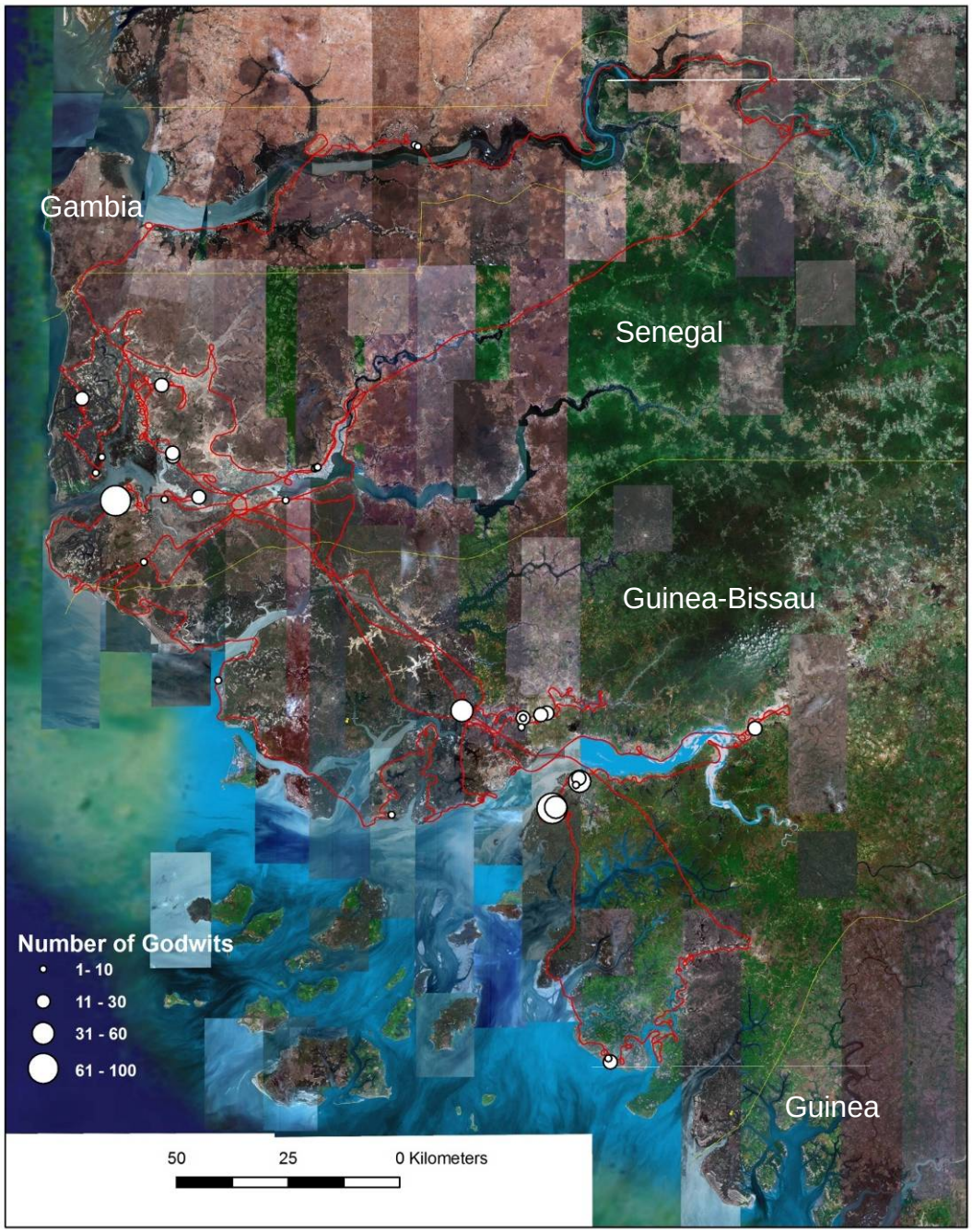

Figure 2

Flying route (red) and the locations of counted Black-tailed Godwits during the aerial survey from 23-26 August 2008. Map from Google Earth.

Figure 3

An example of an aerial photograph of a rice growing complex taken during the aerial survey. Coastal rice fields are usually found in between the villages that are situated on higher levees or further upland (in the forested area on the left of the picture) and the saline rivers of the estuary. Mangrove generally separates the rice growing complexes from the open water. Rice growing complexes may be extensive polders, but also scattered, small rice fields near the small settlements.

The different habitat types that could be distinguished were:

1. Weeds: overgrown, weedy rice fields that were not yet cultivated for the new rice growing season.
2. Bare mud: recently cultivated rice fields that had not yet been planted and were not completely inundated (see Fig. 4 foreground).
3. Bare inundated: rice fields (either cultivated or uncultivated) that were completely inundated and devoid of vegetation (see Fig. 4, background).
4. Planted mud: recently cultivated rice fields that had been planted with rice seedlings.
5. Planted inundated: inundated rice fields in which rice seedlings had recently been planted.
6. Crop: rice fields with an established rice crop.
7. Semi-natural bare soil: bare soil in semi-natural habitats including tidal (e.g. mudbanks) and non-tidal areas (e.g. tanne).
8 Semi-natural vegetated areas: vegetated areas in semi-natural habitats in rice growing areas.

We analysed the relationship between the number of observed godwits and the cover of the different habitat types using log-linear modeling, assuming a Poisson error distribution and a log-link function. As the cover of different habitat types was expressed as a percentage of the total area, estimates of different habitat types are inevitably linked. We therefore analysed the relationship with each habitat type individually and examined whether the cover of specific habitat types were correlated. Overdispersion was accounted for by inflating the Poisson variance by an unknown factor and then using quasi-likelihood to estimate the parameters (McCullagh and Nelder, 1989). All analyses were performed using Genstat 12.1 (Payne et al., 2002).

Figure 4

Black-tailed Godwits feed in loose flocks in the rice fields, mostly in wet sites with a bare ground.

3 Results

3.1 Farmers perspectives and hunting related godwit mortality

Most farmers identified the Black-tailed Godwit correctly when presented with a book showing a number of different wader species. The species they most frequently confused with the godwit was the Whimbrel (*Numenius phaeopus*) which is a common inhabitant of the mangrove zones.

Casamance
Farmers in the Casamance consistently indicated that Black-tailed Godwits start arriving in early July and reach peak numbers by the end of that same month (Fig. 5). When asked whether godwits disappeared during the rice growing season, 27 out 38 farmers said no, suggesting the godwits stayed throughout the winter period. Farmers that said that godwits disappeared during the rice growing season said they did so by the end of August (3 farmers), the beginning of September (4) or the beginning of October (5). When asked whether godwits returned during the harvest season 32 out of 41 farmers said they did not, the remaining farmers mentioned returning godwits in early (2 farmers), mid (4) or late (3) November.

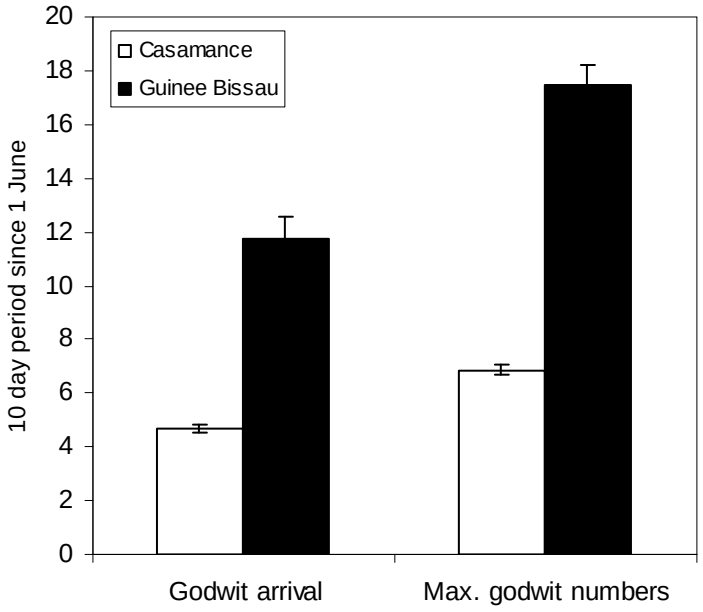

Figure 5
Mean period of arrival and maximum numbers of Black-tailed Godwits (± se) as indicated by farmers in the Casamance and Guinea-Bissau. The 4th and the 6th ten-day period correspond with early and end July; the 12th and 18th ten-day period correspond with the end of September and the end of November, respectively.

As a follow-up of the study by Van der Kamp et al. (2008) farmers in this study were asked how many hunters were active in their area and approximately how many godwits were shot by them. The area that was visited in 2007 (Fintiok-Ouonk) was included in the current survey (Table 1). It showed that the results from this area were not representative for other areas. Eighty-one percent of the shot birds were reported in the rice growing areas between Fintiok and Ouonk and those between Baila and Kartiak. In other areas few or no godwits at all were shot according to the interviewed farmers (Table 1). The total number of Black-tailed Godwits reported as being shot in the period 2005-2008 amounted 1242, or approximately 300 per year.

Guinea-Bissau

Farmers in Guinea-Bissau, although located only 80-160 km south of the Casamance, indicated that Black-tailed Godwits started to arrive in numbers by the end of September and did not reach peak numbers until the end of November. Field observations and the aerial survey carried out before and during farmer interviews in late August and early September showed that godwits were nevertheless present in some areas before the indicated period, albeit in low numbers. Surveys of (parts of) 20 rice growing areas along the north shore of the Rio Geba and both shores of the Rio Mansoa yielded only some 500 birds.

When asked whether the number of godwits had increased, declined or remained stable in recent years, 16 out of 25 farmers answered that godwit numbers had declined, two reported rising and two reported stable godwit numbers. The remaining farmers did not know.

When asked whether Black-tailed Godwits were hunted, 9 of 23 responding farmers answered negative. Eleven interviewees indicated that godwits were part of the range of species that were hunted. Three farmers mentioned that hunting occurred but that they did not know what species were being shot. In seven interviews farmers indicated that hunting in their area was primarily done by people from outside the area such as from Bissau or Europe. One farmer indicated he shot approximately 5 godwits per year. Another farmer mentioned that three - six godwits could be killed per shot. In general, if godwits were shot in Bissau-Guinean rice fields, they were for sports, to be eaten or to be sold but not because they were seen as pest species. Godwits were not much favoured for hunting because of their small size. Hunters preferred apes, gazelles or bigger birds such as pelican, ibis (Fig. 6) and especially francolin species. Some farmers indicated that godwits were only shot if there was a fair chance that a large number of birds could be killed in one shot.

Table 1. The number of hunters and the number of black-tailed godwits shot in July and August according to interviewed farmers in different rice growing areas in the Casamance region.

	Year			
Area	2005	2006	2007	2008
Fintiok-Ouonk				
no. hunters	19	19	19	9
July	300	180	80	60
August	0	65	20	10
Baila-Kartiak				
no. hunters	23	23	23	23
July	60	40	10	25
August	50	30	5	30
Thiobon-Affiniam				
no. hunters	14	14	14	14
July	20	40	10	0
August	0	0	0	0
Diouloulou-Kafountine				
no. hunters	12	12	12	12
July	8	0	12	5
August	0	0	0	10
Baila-Koussabel				
no. hunters	3	3	3	3
July	2	0		0
August	0	0	0	0
Kongoli - Sindialong				
no. hunters	9	9	9	9
July	20	15	4	7
August	8	10	5	9
Marsassoum - Dioba				
no. hunters	7	7	7	7
July	15	6	5	17
August	20	8	7	5
Djibonker-Etome-Nyias-Sia-Brin-Seleki				
no. hunters	12	12	12	12
July	0	0	0	0
August	3	0	0	0
Kaleane-Nia-Balang-Oussouye-Katakalousse-Kabrousse-Diembering				
no. hunters	21	21	21	21
July	0	0	0	0
August	0	0	?	0
Elinkine-Samatite-Diakenewolof-Diakene-Iakenediola-Essaout-Loudiawolof-Kalobone				
no. hunters	22	22	22	22
July	?	0	0	0
August	0	0	?	0
Adeane-Niaguiss-Agnak-Sindone-Baghagha				
no. hunters	11	11	11	11
July	0	0	?	0
August	0	8	?	0
Dianah-Abenne-Kabadio-Niafrang-Diounoung-Baranlir-Bignona-Tenghory				
no. hunters	16	16	16	16
July	0	6	2	0
August	0	0	?	0
Total	**506**	**408**	**150**	**178**

Figure 6

Hunters who had shot two African Sacred Ibis Threskiornis aethiopica *during the survey of one of the rice growing areas in Guinea-Bissau.*

3.2 Godwit numbers and habitat use during the wintering season

In both the Tagus estuary and the Casamance the number of Black-tailed Godwits declined in the period September-December (Fig. 7). In the Casamance, in November and December Black-tailed Godwits were present in very low numbers. In the Tagus estuary considerable numbers of Black-tailed Godwits were present in November and December. However, Icelandic Black-tailed Godwits *Limosa limosa islandica* overwinter in Portugal and probably a large proportion of the birds counted in November and December consists of individuals of this sub-species. In Guinea-Bissau the opposite pattern is visible. In September godwits are present in small numbers, which are subsequently increasing with a clear peak in December.

In the Casamance, in September most of the godwits were observed foraging on the bare soil of recently cultivated but not yet planted rice fields (Fig. 8). The remaining godwits were observed foraging on recently planted rice fields or resting in *tannes*, the hypersaline flats just inside the mangrove zone. In October, the availability of newly cultivated rice fields declines rapidly. During this month, less than 20% of the godwits were observed on rice fields but the few godwits that did use this habitat were seen on bare or recently planted fields. All other birds were observed on *tannes* or natural mudflats in the tidal rivers bordering the rice growing complexes. In November and December, the very few godwits that were observed in the Casamance were all seen on *tannes* or mudflats.

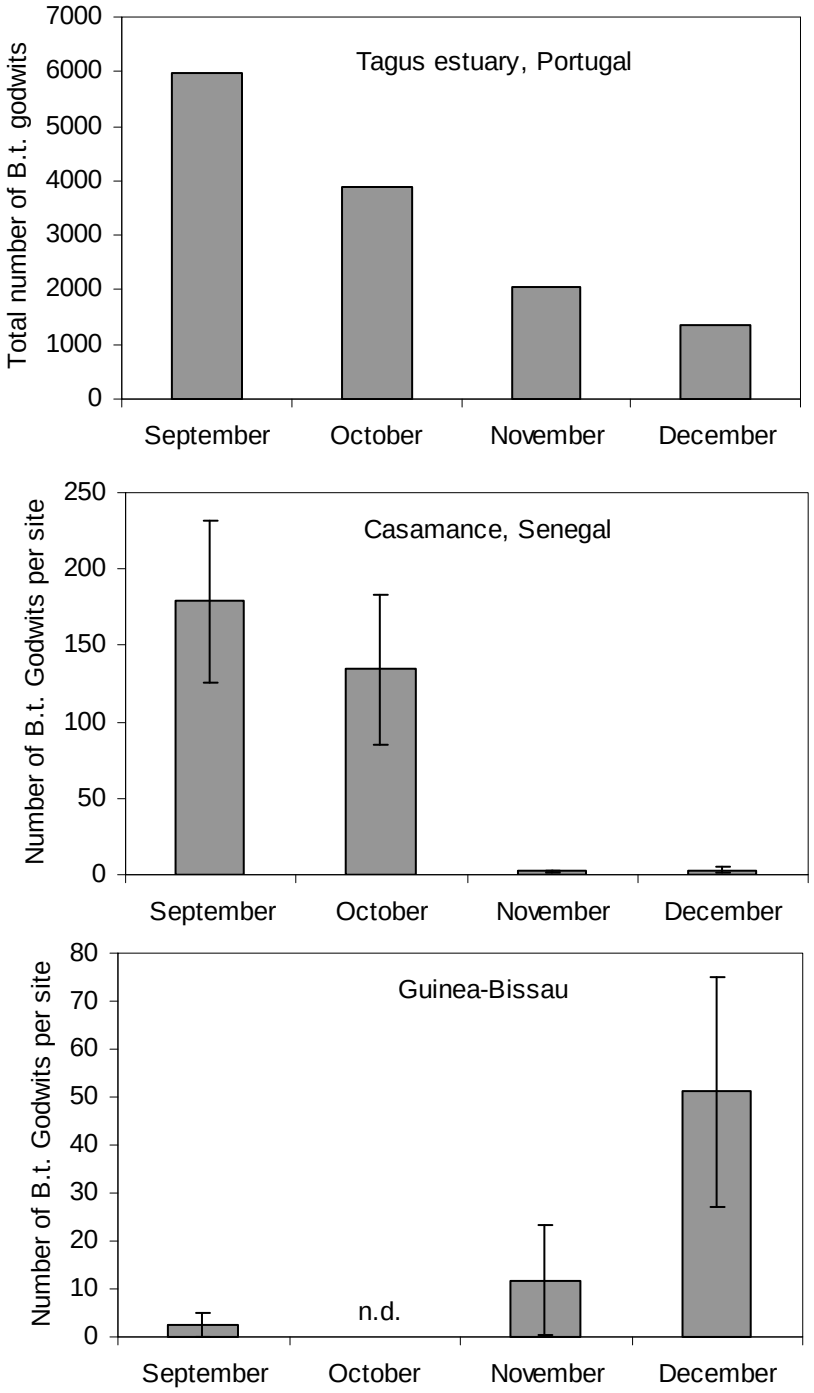

Figure 7

Trends in the number of observed Black-tailed Godwits (mean ± s.e.) at three different staging sites in autumn and early winter of 2008. Counts of the Tagus estuary were collected by the Tagus Wader Roost Count Group. Note the difference in y-axis between the Tagus counts and West African counts. N.d.: not determined.

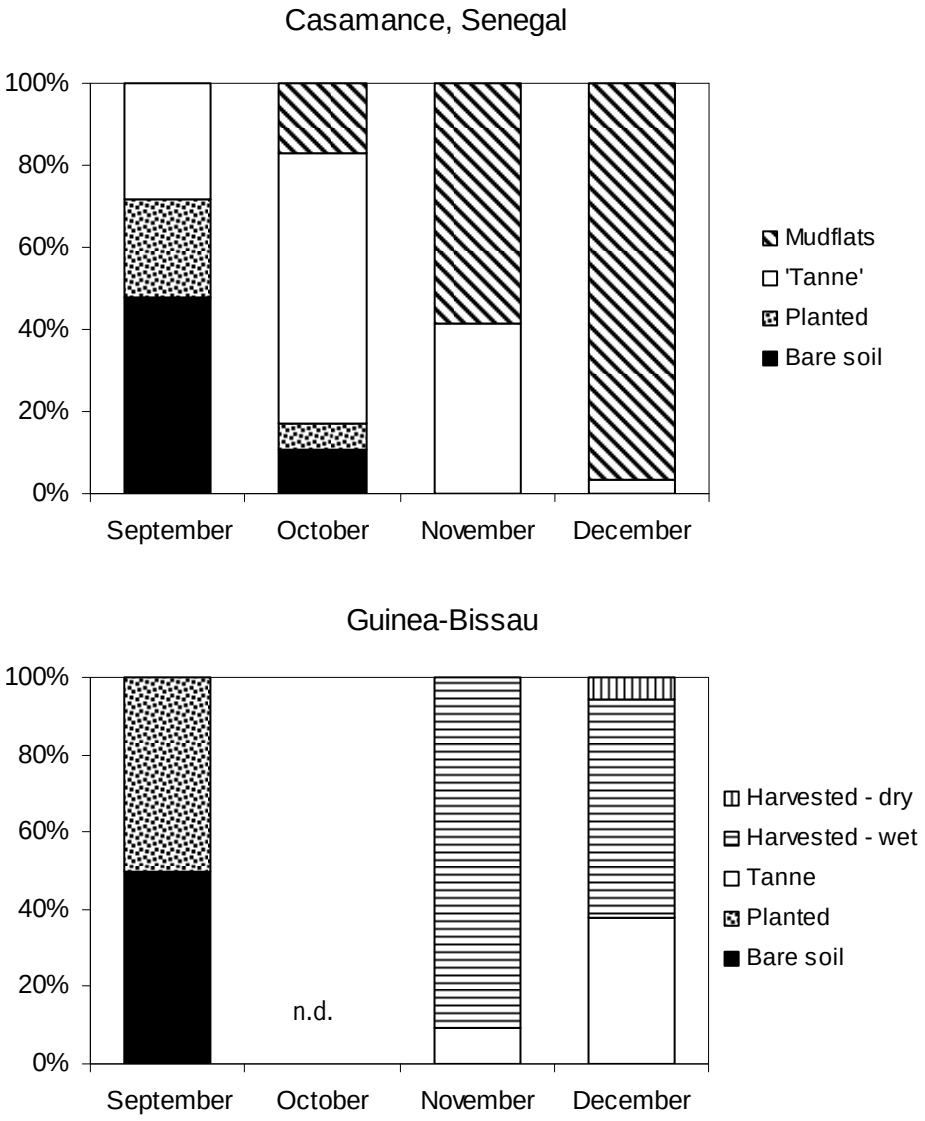

Figure 8

Habitat use of Black-tailed Godwits in the Casamance and Guinea-Bissau in autumn and early winter 2008. N.d.: not determined.

In Guinea-Bissau, in September godwits were primarily spotted on rice fields that were newly cultivated but not yet planted, or on fields with recently planted rice seedlings (Fig. 8). In November and December, Black-tailed Godwits primarily used wet, recently harvested rice fields for foraging and tanne for resting. During our surveys, Black-tailed Godwits were never observed on rice seedbeds. These were plentiful available in September but usually located in or near the villages or situated between trees or palms; all habitats that are avoided by godwits.

3.3 Godwit distribution and habitat choice

During almost 8 hours of low-altitude flying above rice fields in which approximately 1100 km were covered 32 flocks of godwits, with in total 670 birds were observed (Fig. 1). All birds were seen in, or very close to

rice fields. In Gambia, not a single godwit was observed; in the Casamance and Guinea-Bissau 440 and 230 birds were observed respectively.

In Guinea-Bissau, using the digitized topographic maps, we could estimate that 437 km of the survey had been done above rice-growing areas. Given a width of 150 m for the counting strip, an estimated surface area of 6552 ha was covered by the survey. The digitised rice fields measured in total 159.440 ha, but since two topographical maps were lacking, we estimate the total surface at 170.000 ha. Assuming that our survey was representative for the entire rice growing area approximately 5970 godwits ((170.000 ha/6552 ha)*230 godwits) were present in Guinea-Bissau in late August 2008. It must be stressed that the latter estimate is not accurate given the gregarious behaviour of the species and the small sample size (coverage not more than 4%).
The aerial survey covered all main rice growing areas in the Casamance. We estimate the counting trajectories in the Casamance at 370 km or 5550 ha which represents approximately 10-20% of the total rice growing area. Again assuming that our survey was representative for the entire rice growing area, approximately 2200-4400 godwits (440/0.1-440/0.2) may have been present in the Casamance by the end of August. Since we obtained only a few topographical maps of the Casamance our estimate is very rough.

In Guinea-Bissau we quantified the proportional habitat distribution in the 11 rice growing area where godwits had been observed (Fig. 9) and in an additional 127 rice growing areas where godwits had not been observed. We found a strong positive relationship between the number of godwits and the percentage area with recently cultivated bare rice fields ($F_{1, 136}$ = 13.07, P < 0.001) and negative relationships between the number of godwits and the percentage area with vegetated ($F_{1, 136}$ = 12.84, P < 0.001) or bare semi-natural habitats ($F_{1, 136}$ = 10.72, P = 0.001). The area with bare rice fields was, however, correlated with vegetated and bare semi-natural habitats (r = -0.32, P < 0.001 respectively r = -0.22, P = 0.008; n = 138 for both). Figure 10 shows the differences in cover of habitat types between areas with or without Black-tailed Godwit. This comparison does not take the different numbers of observed godwits into account but illustrates clearly that areas with and without godwits differ mainly in the percentage area with bare mud and vegetated semi-natural habitat. This is consistent with field observations that in vegetated and/or overgrown fields fewer waders are present, probably related to food exploitability.

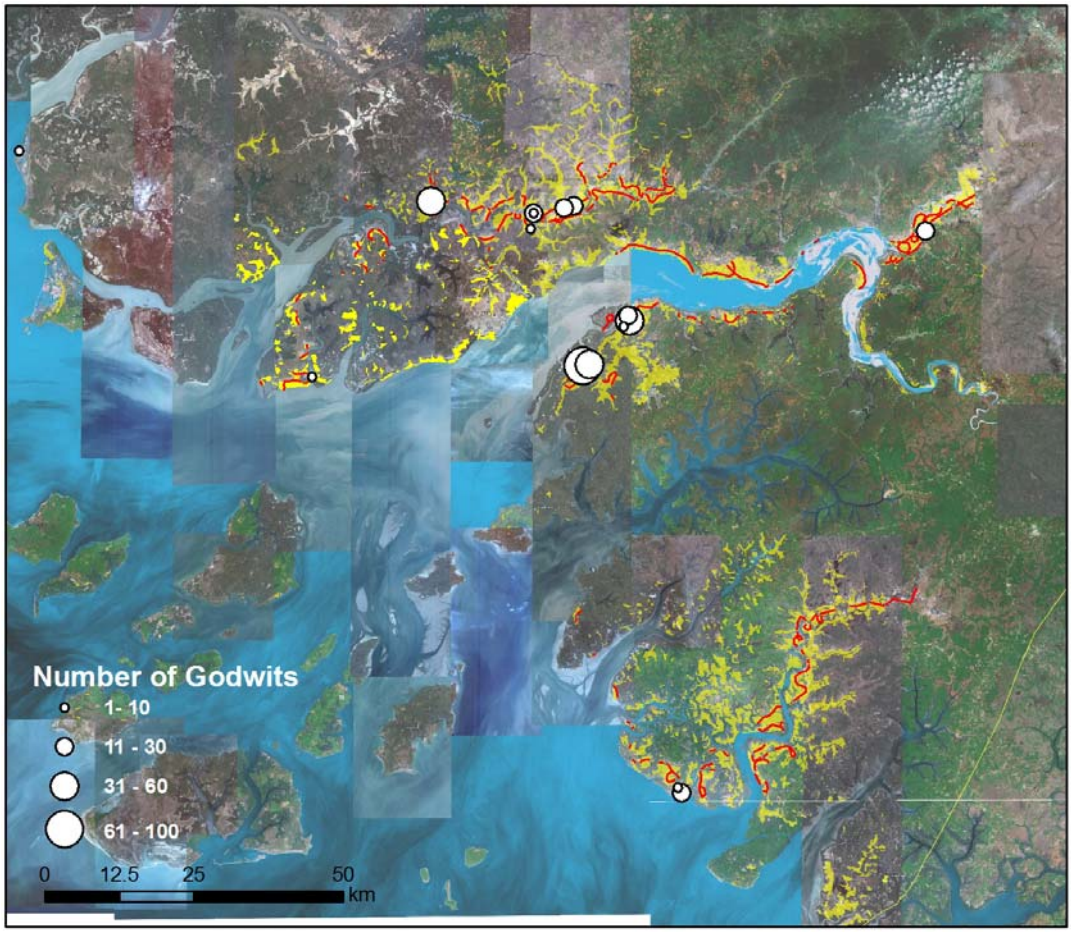

Figure 9

Flying route above Guinea-Bissau if flying at 150 m above a rice field; red (non-counting routes (higher altitude or between rice fields) not shown; but see Fig. 2). The rice fields indicated on the topographical maps of Guinea-Bissau are shown in yellow, as well as the number of counted birds (from Fig. 2). The border of the country is indicated with a green line.

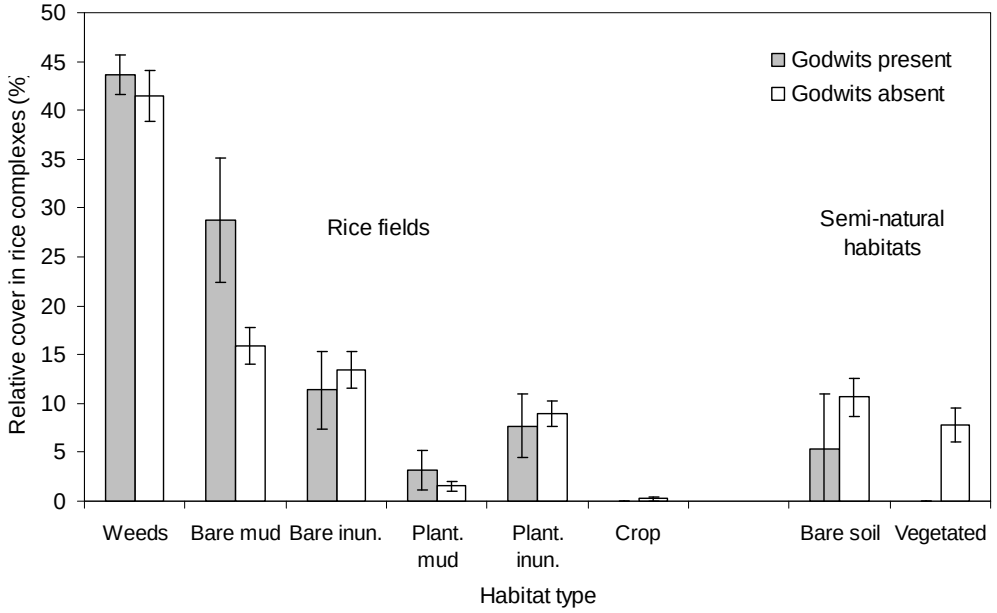

Figure 10

A comparison between the cover (means ± se) of different types of habitat in rice growing areas where godwits had been observed or had not been observed during the aerial survey on 25-26 August 2008. See text for more details on habitat categories.

4 Discussion

Hunting related mortality of godwits in West Africa

This study shows that Black-tailed Godwits are exposed to hunting throughout their core wintering range in West Africa. However, in contrast to some regions in the Casamance, where godwits are shot frequently (Van der Kamp et al., 2008), the current survey shows that the overall number of godwits that are shot annually in the core wintering range is relatively low. In Guinea-Bissau, godwits are generally not shot because they are perceived to cause damage to the crop (they are, however, claimed to do so in the extreme NW of the country, adjacent to the Casamance, cf. Kuijper et al., 2006), but for food, sports (mostly by people from outside the area) or to obtain money. Since godwits are small compared to many other bird species, monkeys or ungulates, they are not considered to be desirable prey species. The high number of shot Black-tailed Godwits reported by Van der Kamp et al. (2008) in the Casamance therefore seems to be a local phenomenon which is not representative for the entire core wintering area of this species.

A relatively low mortality caused by hunting corresponds to the findings of Roodbergen et al. (2008) and R. Kentie (in Bruinzeel et al., 2010) that adult survival rates are currently particularly high (80-97%) and higher than 20-30 years ago (Zwarts et al., 2009). Nevertheless, our survey indicates that currently hunting occurs in virtually every suitable wintering habitat and that godwits are occasionally shot in many of these areas. The possession of firearms is currently prohibited in the Casamance (Van der Kamp et al., 2008). In Guinea-Bissau not many firearms are present due to the general poverty of the rural population. If firearms would become more readily available to the rural population, hunting related mortality of Black-tailed Godwits in their wintering area could rapidly increase, especially in dry years (Zwarts et al., 2009). Low chick survival is the main reason for the decline of the Dutch Black-tailed Godwit population (Schekkerman and Müskens, 2000; Schroeder, 2010) and the high adult survival probably explains why the Dutch breeding population has not collapsed completely yet. For this reason it will be important to monitor (causes of) Black-tailed Godwit mortality on their wintering grounds until conservationists have managed to increase the reproductive output of this species.

Distribution of wintering godwits in the West African coastal zone

In 2008 the phenology of wintering Black-tailed Godwits in the Casamance was similar to those in the rice fields of the Portuguese Tagus estuary and opposite that of those in Guinea-Bissau rice fields (Fig. 7). The results of the farmer interviews suggest that the pattern observed in 2008 is typical for previous years (Fig. 5). A probable explanation for this pattern is that many godwits use the Tagus estuary and/or the Casamance as important stop-over sites before most of them end up in Guinea-Bissau in November and December. Nevertheless, there appears to be considerable variation between individual Black-tailed Godwits in their migration and overwintering strategies, as shown recently by godwits tagged with a GPS-transmitter (www.grutto.nl; RUG/A en W unpublished). As a result, godwits were also present in Guinea-Bissau in September and October and satellite-transmitter studies have recently confirmed the earlier assumption that godwits can fly directly from the breeding grounds to these main wintering areas (Zwarts, 1993; Zwarts et al., 2009; www.grutto.nl).

The relative importance of the three areas in September and October is difficult to assess. It is surprising that in this period so few godwits were counted in the three surveyed areas as godwits have left their northwestern European breeding grounds already two months before. Ninety-five percent of the godwits counted in the Tagus estuary in September and October are considered to be the nominate species (with 90% of the individuals counted in November and December considered to be *Limosa limosa islandica*, J. Alves pers. comm.). This suggests that in September, approximately 6000 godwits were present in the Tagus estuary whereas rough extrapolations of the aerial survey count came at approximately 2200-4400 and 6000 godwits

in the Casamance and Guinea-Bissau at the end of August. The size of the West-European population is estimated at 120.000 birds (Gill et al., 2008) but decreasing rapidly. The three areas are considered to be the main staging and wintering areas for the West-European population but did not contain more than an estimated 10% of the population around September 2008.

A number of factors may explain this low figure. First, we might have missed birds within the counting trajectories. When disturbed, birds generally fly away. However, birds far from the plane may not have been disturbed and stayed on the ground. These birds will not have been counted. Especially in large rice complexes birds may therefore have been missed. We have no information if this may have happened and if so what proportion of birds may have been missed. Second, 2008 was a very wet year, with more rain than in the previous 40 years. Many rice fields, and sometimes entire rice growing complexes were completely inundated. This may have caused the godwits to scatter over a much larger area than in previous dry years. Also, birds may have been using ephemeral habitats outside their normal range, or deteriorated habitats made temporarily more suitable by the exuberant rainfall (e.g. Moroccan coastal marshes, Senegal River Basin). Again, we have no indication whether this explanation is valid or not.

Habitat use of wintering godwits in the West African coastal zone

Godwits preferred to forage in bare wet soils (Fig. 8). This is not surprising and in general agreement with their habitat preferences in other studies and staging areas (Lourenço and Piersma, 2008; Van der Kamp et al., 2008). Interesting, however, is that the current study is the first to demonstrate that also at larger spatial scales Black-tailed Godwits select for their preferred habitat. Areas in which godwits had been observed during the aerial survey were characterized by higher proportions of recently cultivated, bare rice fields, than areas in which Black-tailed Godwits had not been observed. The negative relationships between the number of godwits and the percentage area with vegetated or bare semi-natural habitats was probably caused by correlations of these habitat types. Bare soil is probably the pivotal factor as godwits during the ground survey godwits were primarily seen on this habitat type (Fig. 8). Bare wet rice fields may be particularly suitable to Black-tailed Godwits as these contain relatively high densities of spilt rice grains that are inaccessible to most other bird species (Lourenço and Piersma, 2008). However, because godwits in West Africa also feed extensively on spilt rice just after harvest (Fig. 8, Van der Kamp et al., 2006) it is not clear how much rice seeds remain until the next growing season. Other food items such as plant tubers or animal prey that have become accessible by the soil cultivation may therefore also be important in this phase of the winter period.

Our findings suggest that, rather than staying in one area and using different types of habitat in different parts of the winter period, Black-tailed Godwits track their preferred habitat type across their wintering area. In the Sahel region a steep rainfall gradient runs from north (low) to south (high; Zwarts et al. 2009). This results in their preferred cultivated or harvested rice fields becoming available in successive periods in different parts of the West African coastal zone. By the time the growing rice crop makes the last cultivated rice fields unsuitable for godwit use in one area, the first harvested fields become available in another part of their wintering area. Possible short periods that rice fields are unsuitable across large parts of the godwit winter staging area may be bridged on natural mudflats in the many estuaries of the West African coast. The numbers observed on this type of habitat were low (Fig. 8), but natural mudflats are very extensive and generally poorly accessible by human observers. Their importance may therefore have been systematically underestimated. Intriguingly in this respect, Altenburg and Van der Kamp (1991) found the vast majority of Black-tailed Godwits present in the coastal zone of Guinea-Conakry on tidal flats which are under strong freshwater influence at these latitudes through heavy rainfall with consecutive continental run-off. A dozen years later, however, renewed counts showed a 90% decline, with not more than 1000-2000 birds left (Trolliet and Fouquet, 2004). Their occurrence on tidal flats in more salty waters of Guinea-Bissau has never been established.
Given their preference for terrestrial habitats elsewhere along their flyway (Kuiper et al., 2006) the use of brackish habitat by godwits may be only important during the short period when rice fields are unsuitable as foraging habitat. Elsewhere along the flyway brakish habitats are used very limitedly; in Tunesia however the

saltpans of Thyna (Sfax) are frequently used by godwits in winter and spring (max. 5.000 birds, Kuiper et al., 2006).

Conclusions

Between August and January, peak numbers of Black-tailed Godwits move between different parts of their wintering range. These movements seem to be governed by the availability of their preferred habitat: (man-made) bare wet soils which are consecutively available in different parts of West Africa throughout the entire wintering period. In West Africa only four Critical Sites (regularly hosting >1% of the flyway population; have been identified for the Black-tailed Godwit (Kleijn et al., in prep.) with no Critical Site located in Guinea-Bissau. Conservation efforts that exclusively focus on the protection of these Critical Sites may not be a very effective approach. Effective conservation probably should target the continuation of the traditional extensive rice cultivation systems throughout the core wintering area of the Black-tailed Godwit. The rice growing areas in Guinea-Bissau are probably particularly important as this is the only East-Atlantic site that provides suitable habitat in November-December.

Hunting related mortality is a threat to the Black-tailed Godwits throughout the core wintering area in West Africa but its extent doesn't seem to be severe enough to substantially influence its population dynamics. The potentially most harmful threats to Black-tailed Godwits are changes in land use such as the abandonment of the labour-intensive traditional rice cultivation system or large scale irrigation works. A good second is increased access to rifles and/or cheap ammunition which might increase hunting related mortality.

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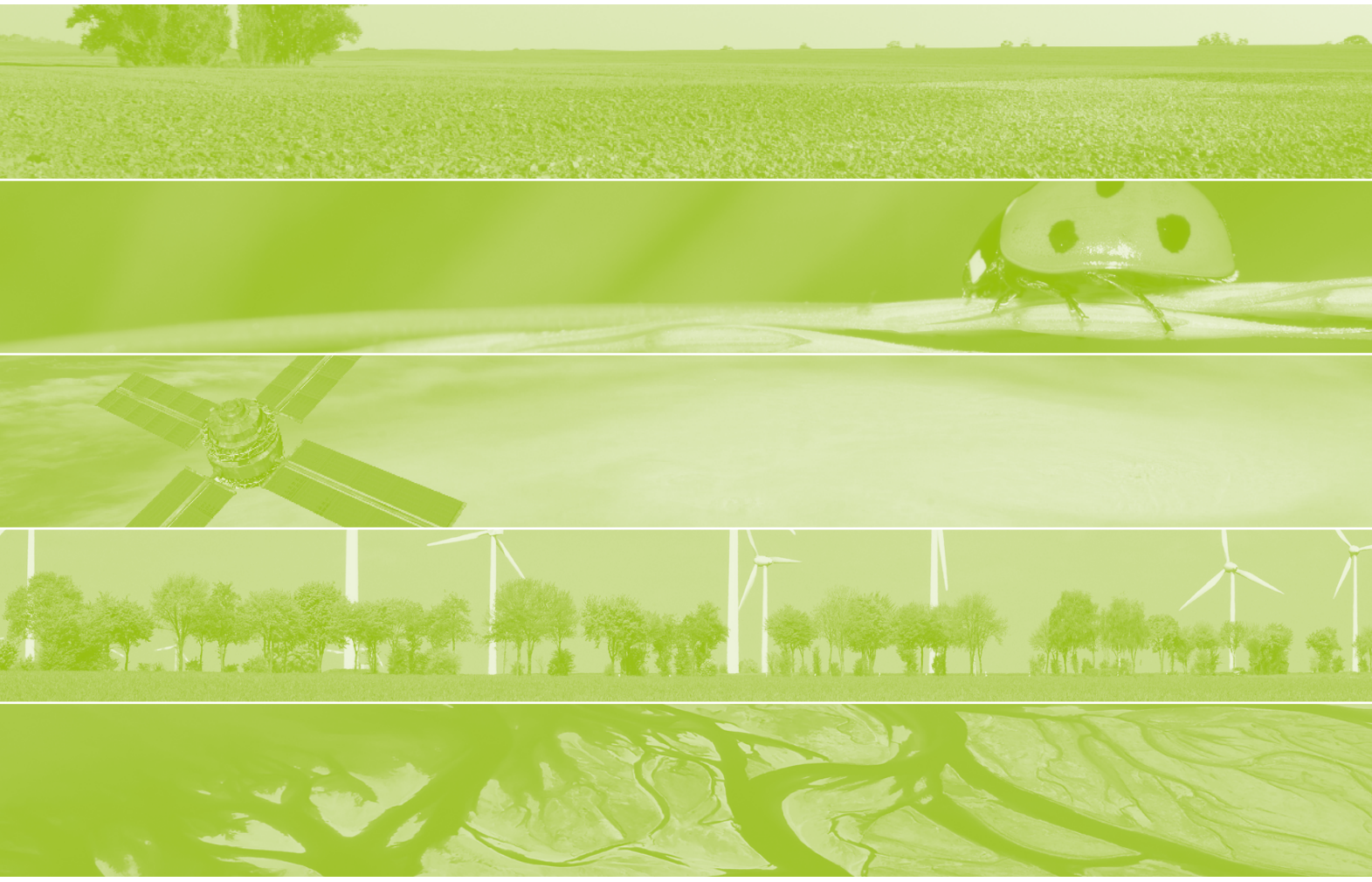

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