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Alterra-report 2148
ISSN 1566-7197

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Commissioned by the Ministry of Economic Affairs, Agriculture and Innovation. BO-10-003-010 Ecological networks

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The identification of Critical Sites and the effectiveness of Ramsar and IBA site designation for the conservation of migratory waterbirds

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Alterra-report 2148

Alterra, part of Wageningen UR
Wageningen, 2011

Abstract

Kleijn, D., S. Nagy, S. Delany, O. Nasirwa, T. Dodman, P. Goedhart, 2011. *African winter population trends of European waterbirds - The identification of Critical Sites and the effectiveness of Ramsar and IBA site designation for the conservation of migratory waterbirds*. Wageningen, Alterra, Alterra-report 2148. 30 blz.; 3 fig.; 4 tab.; 28 ref.

Flyway conservation is an important priority of the Dutch Nature Conservation Policy. The African Waterbird Census (AfWC) is a standardized, annual site-based waterbird survey and probably represents the largest African wildlife monitoring database. This report uses the AfWC data to identify critical staging and wintering sites for European waterbird species in Africa. It examines quantitatively whether the Ramsar or IBA (Important Bird Area) designation of sites contributes to the conservation of wintering waterbird populations in Africa. Finally the strengths and weaknesses of the AfWC for monitoring waterbird populations and evaluating the impact of conservation efforts are discussed.

Keywords: Flyways, Migratory birds, Nature Conservation Policy, Monitoring

Photo on cover: Waterbirds at the IBA site 'La Petite Cote', Senegal. Photo by Paul Robinson.

ISSN 1566-7197

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Alterra-report 2148
Wageningen, february 2011

Inhoud

1 Introduction

There is increasing evidence that long-distance migratory bird species are suffering larger population declines than short-distance migrants or resident birds (e.g. Böhning-Gaese, 1992; Sanderson et al., 2006; Hewson and Noble, 2009). Potential causes for the declining populations of long-distance migrants include deterioration or loss of staging areas (Niles et al., 2009), habitat loss or deterioration on the wintering grounds (Böhning-Gaese, 1992), hunting pressure in various parts of the flyway (McCulloch et al., 1992) and climate change (Both et al., 2010). Conservation action on the breeding grounds alone is therefore rarely sufficient to halt the population declines of long-distance migrants. Additional action in staging areas and wintering areas is required (Sanderson et al., 2006).

In the southern parts of the flyways of palearctic long-distance migrants two important and partly complementary conservation strategies are in place from which migratory birds may benefit. First, sites designated under the Ramsar convention on Wetlands may benefit from 'the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world'. The Ramsar convention, to which the 159 contracting parties are committed, specifically targets waterbirds that make use of wetlands for breeding, foraging, staging or wintering. The regular observation of at least 1% of the flyway population of species is an important criterion for identification and designation of Wetlands of International Importance. Second, sites designated as Important Bird Areas (IBA's) by BirdLife International may benefit from an increasing focus for site conservation by local stakeholders. Although lacking a legal mandate, the recognition as IBA's may result in enhanced legal protection under national and international Protected Area designations (Arinaitwe et al., 2005). IBA's are selected to hold either significant numbers of one or more globally threatened species, are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species or have exceptionally large numbers of migratory or congregatory species (Fishpool and Evans, 2001). So far, it is has not been demonstrated whether the designation of sites as Ramsar or IBA has any conservation impact on the birds using these sites (Castro et al., 2002).

The estuaries and numerous wetlands in the Netherlands are an important component of the East Atlantic Flyway of waterbirds in particular (Piersma and Everaarts, 1996; Van Eerden et al., 2005). Birds may use the extensive areas with wet grasslands, marshes, mudflats and tidal areas for breeding, as stop-over or staging areas or for wintering. The Dutch government recognizes that the conservation of entire flyways, rather than just those sections of a flyway that lie within the national borders, is required to effectively protect bird populations. Flyway conservation is therefore an important priority of the Dutch Nature Conservation Policy (Biodiversiteit werkt: voor natuur, voor mensen, voor altijd - Beleidsprogramma biodiversiteit 2008-2011, EL&I (former LNV). To be able to effectively conserve species at the flyway level, it is essential to know which key sites and habitats are used by these species. Only then it will be possible to target conservation initiatives to sites, countries or regions that are most important as staging or wintering areas. For waterbird species that have a high priority in Dutch conservation policy (henceforth 'Dutch priority species'), we have fair knowledge of their European breeding grounds, stop-over and wintering sites, but in the African part of the East-Atlantic flyways, a relative lack of consistently collected and curated data makes it more difficult to identify key sites and monitor bird population trends (Bennun, 2000).

The data collected for the African Waterbird Census (AfWC, e.g. Diagana and Dodman, 2007) probably represents the largest African biodiversity database for which data have been collected in a standardized way. It currently holds 197,043 records of 341 subspecies, species and species groups from 1631 sites from 44 countries. The AfWC is a standardized site-based waterbird survey. The basis of the survey is an annual count in mid-January (the mid-winter counts of the Northern temperate regions) supplemented by an annual count in July. The AfWC provides strategic input to the activities of partner organizations, particularly the Red Data Book of IUCN, and Birdlife International's Important Bird Areas (IBA) programme. The AfWC also helps to implement Waterbird Species Action Plans such as those developed by the European Commission and the African-Eurasian Waterbird Agreement (AEWA). The AfWC is used to identify and monitor sites that qualify as Wetlands of International Importance under the Ramsar Convention on Wetlands and provides the basis of the triennial 'Report on the Conservation Status of Waterbirds in the Agreement Area' prepared for AEWA by Wetlands International. (e.g. Wetlands International, 2008). Despite the large size of the database, it's temporal coverage is relatively poor with many sites being surveyed only occasionally. Likewise, the spatial coverage is relatively poor considering the size of the continent or compared to the survey intensity in Europe.

Here we use the AfWC data to identify critical staging and wintering sites for Dutch priority waterbird species in Africa. Specifically we examine which African sites regularly hold 1% of the flyway population of these species and which sites do this for multiple species. Furthermore we examine quantitatively whether the Ramsar or IBA designation of sites contributes to the conservation of wintering waterbird populations in Africa. To this end we test whether trends in the number of observed birds in sites designated as Ramsar or IBA differ from trends in sites without any designation. Finally we evaluate the strengths and weaknesses of the AfWC for monitoring waterbird populations and for evaluating the impact of conservation.

2 Methods

Species
We restricted the study to waterbird species listed in Annex I of the European Community Council Directive 79/409/EC on the conservation of wild birds. Annex I of this so-called Birds Directive lists species that are considered particularly vulnerable or rare, or requiring special conservation measures. This selection was amended with waterbird species listed on the Dutch Red Databook of breeding birds (Van Beusekom et al., 2005). A full list of the selected 46 species is given in Appendix 1. Eighteen of the selected species winter in Europe or at sea and are therefore not included in the Critical Site identification. If data was available for these species in the AfWC, they were included in the analysis of the impact of Ramsar and IBA site designations.

Critical Site Identification
In December 2009, the Wings-over-Wetlands project coordinated by Wetlands International produced a draft list of sites holding at least 1% of the flyway population of all waterbird species for which there was sufficient information. For the Critical Site Identification we only used data for flyway populations that are linked to the Netherlands (Appendix 1).

Data
For each of the selected species and for the period 1987-2007, we extracted plot names, country, geographic coordinates, year and number of observed birds for all mid-January counts available in the AfWC database. We obtained the names, geographic coordinates and designation dates of all African Ramsar sites designated prior to 2006 from the Ramsar Sites Information Service (http://ramsar.wetlands.org/; accessed November 2009). Using GIS (ArcView 3.3; ESRI, Redlands, CA) we checked which count plots were located in the direct vicinity of Ramsar sites. Cross-referencing count plot names with Ramsar site names yielded a list of the count plots that were located inside Ramsar sites. From Birdlife International, we obtained a GIS shapefile indicating the location of most African IBA's as polygons and some as geographic points indicating the centre of the IBA. All AfWC count-sites that were located in a IBA polygon or within 10 km of an IBA point were listed as IBA count-sites. Of the total of 6326 count plots that were part of this analysis, 252 plots were located in Ramsar sites and 485 in IBA sites. The average number of counts per species was 685 (se 125.4) which were made in an average number of 260 (se 45.7) different sites. More detailed information on the number of observations per species, country or designation type is given in Appendix 2. Countries were assigned to a region (North- West-, Middle-, East- and Southern Africa, see Appendix 3) to test whether trends in observed counts differ between regions.

Analysis
Because the temporal and spatial distribution of the counts varied markedly per bird species we performed separate analyses for each species, rather than performing a general analysis across species. The AfWC does not contain zero counts because observers generally do not report species that were absent during their survey. For most species the distribution of the observed counts is heavily skewed with maximum observed counts up to 580 000. The usual Poisson assumption for analyzing bird counts is then not appropriate and we therefore log-transformed all bird counts and used standard regression models assuming normal error distribution in our analyses. In all analyses, only those species were included for which residual error degrees of freedom (df) was larger than 9 and the range of years available for trend estimation was more than 7.

Trends were estimated from log transformed count data in a plot by year table. These tables have many missing observations, and the coincidental inclusion of a plot with for example a large area, and therefore potentially large counts, may have a considerable impact on the estimated trend. It is therefore customary to correct for plot effects by including a fixed plot effect in the regression model. However, Ramsar and IBA designation is linked to the plot level and is therefore completely aliased with fixed plot effects. Since we were especially interested in the plot designation we included random plot effects in the regression model. These random plot effects are assumed to follow a normal distribution with zero mean and some variance. The regression model then becomes a so-called linear mixed model (LMM) with multiple error strata. To correct for differences in the number of observed counts per country the fixed factor country was included in every model. Since information on the size of the plots was generally absent, this correction term could not be included in the analyzes. The linear trend was estimated by including a linear year effect. So the basic model was Log(counts) = plot + country + trend in which plot is a random effect. Note that in this model the trend is estimated across Africa. These estimated trends were compared to currently available population trend estimates compiled by Wetlands International (2006) which are based on sources additional to and including the AfWC data.

The factors Ramsar and/or IBA designation were added to the basic model to test whether the level of counts depends on the designation of the plot. We furthermore tested whether Ramsar or IBA designation influenced the trends in the observed number of birds using the model Log(counts) = site + country + IBA + Ramsar + trend + trend.IBA + trend.Ramsar, with site being a random factor and country, Ramsar and IBA being fixed factors. In this model, the interaction term trend.IBA tests whether trends in count sites with IBA (but not Ramsar) designation differ from count sites without any designation. Likewise, trend.Ramsar tests whether trends in count sites with Ramsar (but not IBA) designation differs from sites without any designation. The time since site designation as Ramsar or IBA may affect the designation effect. Designation dates were available for Ramsar sites but not for IBAs. We therefore added the Ramsar age, relative to the year 2007, to test for this effect. The interaction between Ramsar and trend, and between IBA and trend, were added to test whether the trends differed among the plot designations. The IBA.Ramsar.trend interaction was not significant for all but one of the tested species and was therefore omitted from the analyses.

Initial analyses showed that, in general, species trends were similar in different regions. The region.trend interaction, which tests whether trends differ among regions, was not significant for 22 of the 24 species for which interactions could be calculated. Also, the region.Ramsar.trend interaction, which tests whether the difference in trend between Ramsar and none Ramsar plots differs between regions, was not significant for 21 of the 22 species. Moreover the region.IBA.trend interaction was not significant for 22 of the 24 species for which these interactions could be calculated. We therefore omitted the factor region from the analyses.

Results for factors country and site are not presented as they are not of interest to the research questions. All models were fitted using standard facilities in GenStat (Payne et al., 2002).

3 Results

Critical Site Identification
Critical Sites for species' flyway populations with breeding or staging areas in the Netherlands are mainly found in the western Mediterranean and western parts of Africa (Figure 1, Table 1). Countries with the highest number of Critical Sites were Mali, Mauritania, Morocco and Senegal. Other countries hosted five or fewer Critical Sites for the so-called Dutch Priority species. In terms of Critical Sites for different bird species, Mauritania, Morocco and Senegal clearly outranked the other countries with Critical Sites for nine or more different species (Table 1). Seventeen Dutch Priority waterbird species contributed to the identification of Critical sites in Africa but this was not distributed evenly over these species. Almost a third of the site qualifications as Critical Sites (i.e. > 1% of the flyway population) were based on the numbers of Garganey and Kentish Plover. About three-quarters of the Critical Sites were based on the observed numbers of just eight species. Besides Garganey and Kentish Plover, these were Purple Heron, Sandwich Tern, Black-tailed Godwit, Gull-Billed Tern, Ruff and Eurasian Spoonbill.

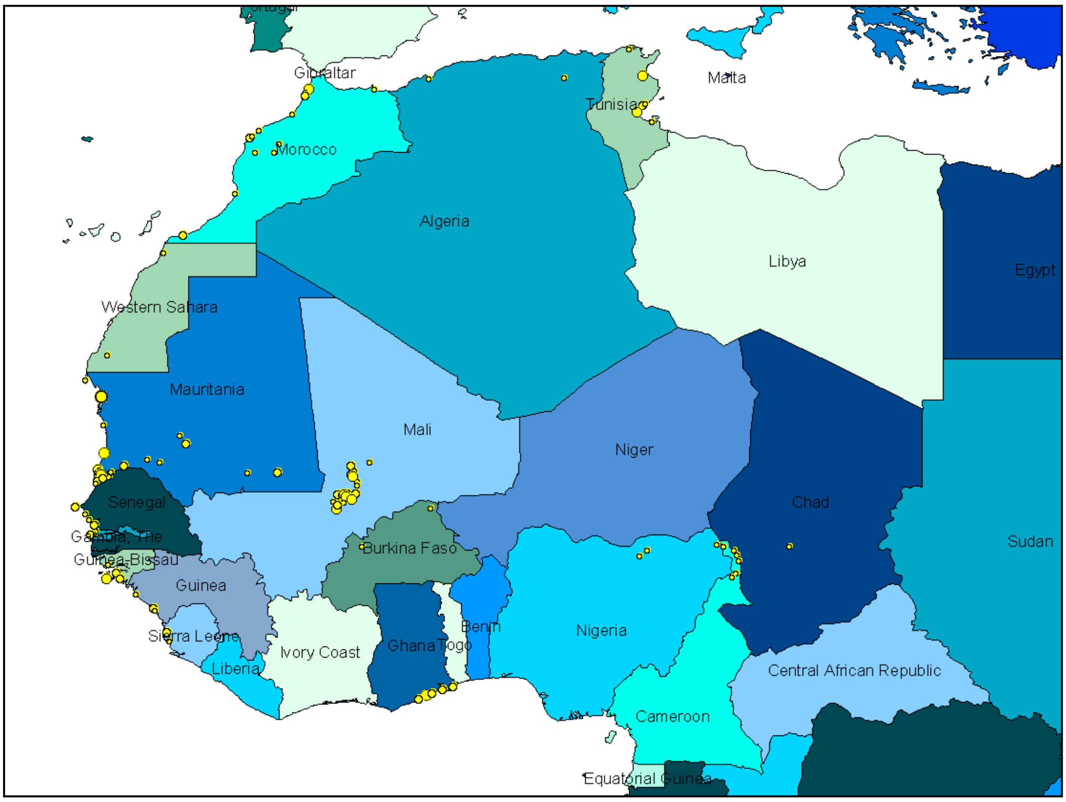

Figure 1
Sites regularly containing at least 1% of the flyway population of Dutch endangered waterbird species. The size of the bubbles indicate the number of species for which these sites serve as Critical Sites (range 1-6). For clarity, the small number of sites in southern Africa (see Table 1) have not been depicted. For an overview of the flyway populations used for site identification see appendix 1.

Table 1: A summary of the number of African Critical Sites for Dutch Priority waterbird species per country and per species.

	Algeria	Burkina Faso	Came-roon	Chad	Gambia	Ghana	Guinea	Guinea-Bissau	Madag-ascar	Mali
No. Critical Sites	**2**	**2**	**4**	**3**	**3**	**5**	**3**	**4**	**4**	**20**
No. Different species	**1**	**2**	**1**	**1**	**3**	**5**	**2**	**3**	**1**	**5**
Anas querquedula		1	4	3						13
Ardea purpurea		1								11
Calidris alpina										
Charadrius alexandrinus	1							4		
Charadrius hiaticula										
Chlidonias niger						2				
Himantopus himantopus										
Limosa limosa					1					7
Philomachus pugnax										6
Platalea leucorodia										
Recurvirostra avosetta							3			
Sterna albifrons					1	1	1			
Sterna caspia									5	
Sterna hirundo						5				
Sterna nilotica						1		1		1
Sterna sandvicensis					2	4				
Tringa totanus								3		

	Mauri-tania	Morocco	Nami-bia	Nige-ria	Sene-gal	Sierra Leone	South Africa	Tunisia		**Total**
No. Critical Sites	**16**	**16**	**3**	**3**	**10**	**2**	**1**	**6**		
No. Different species	**11**	**9**	**2**	**1**	**9**	**2**	**1**	**4**		
Anas querquedula	7			3						**31**
Ardea purpurea					1					**13**
Calidris alpina		1								**1**
Charadrius alexandrinus	2	9				1		3		**20**
Charadrius hiaticula		1								**1**
Chlidonias niger			1		1					**4**
Himantopus himantopus		4						1		**5**
Limosa limosa	2	1			2			2		**15**
Philomachus pugnax	5				1					**12**
Platalea leucorodia	6	4			4					**14**
Recurvirostra avosetta	1	1			3					**8**
Sterna albifrons	2									**5**
Sterna caspia										**5**
Sterna hirundo	1									**6**
Sterna nilotica	3	1			3			2		**12**
Sterna sandvicensis	2	1	4		1		1			**15**
Tringa totanus	1				1	2				**7**

We could estimate African winter population trends for 26 migratory waterbird species. For Black Tern, Mediterranean Gull and Golden Plover no trends could reliably be calculated because of lack of data. Eight species from five different families showed significant positive trends across Africa whereas only Northern Pintail showed significant negative trends (Table 2). All species were observed in higher numbers in count plots in Ramsar sites than in count plots in non-designated sites. For sixteen species this difference was significant. Twelve species were observed in significantly higher numbers in count plots in IBA sites compared to those in non-designated sites.

On average, species with more unfavourable WPE4 population status (see Table 2) also had more unfavorable trend estimates in this study (Figure 2). However, even species with the most unfavorable population trend class (Declining) had positive trend estimates in this study.

The observed number of individuals of Common Teal and Black-winged Stilt showed significantly more positive trends in count plots located in Ramsar sites than in count plots in non-designated sites (Table 3). For the other species, differences in trends between the two plot types varied widely but were never significant. Averaged over all species, trends in counted birds did not differ significantly between Ramsar sites and non-designated sites (Figure 3; paired t-test, $t_{28} = 0.06$, $p = 0.951$). Little Bittern, Black-tailed Godwit, Pied Avocet and Common Sandpiper showed significantly more positive trends in count plots in IBA sites than in count plots in non-designated sites. Contrastingly, trends of Northern Shoveler and Caspian Tern were significantly more negative in IBA sites than in non-designated sites. Averaged across all species, winter population trends were somewhat higher in count plots in IBA sites than in non-designated sites but this difference was not significant (Figure 3; $t_{28} = 1.35$, $p = 0.187$).

Twenty-four per cent of the 252 count plots in Ramsar sites were located in sites that had been designated before 1998 whereas 57% were in Ramsar sites designated after 2002. For most of the species, the number of observed birds increased with increasing age of the Ramsar sites. Interestingly, significant relationships were generally restricted to duck and wader species while none of the tern and gull species showed significant relationships (Table 4).

Table 2. Estimated African winter population trends of endangered European migratory waterbirds and the number of observed birds in count plots in Ramsar sites and IBA's relative to non-designated sites (negative percentages indicate that less birds were observed in non-designated sites than in designated sites). p values indicate whether trends differ significantly from zero or whether the number of observed birds in designated sites was significantly higher than in non-designated sites. WPE4 trend gives the trend class given by Wetlands International (2006).

Scientific name	English name	WPE4 trend	Year	*p*	IBA (% diff)	*p*	Ramsar (% diff)	*p*
Anas acuta	**Northern Pintail**	DEC	-3.46	**0.008**	-8.38	0.717	-54.81	**0.008**
Anas clypeata	**Northern Shoveler**	STA/DEC	-0.18	0.875	-48.16	**0.005**	-66.93	**0.000**
Anas crecca	**Common Teal**	DEC	4.38	**0.003**	-36.70	0.112	-51.91	**0.039**
Anas querquedula	**Garganey**	DEC	4.91	0.118	-34.70	0.276	-76.19	**0.020**
Ardea purpurea	**Purple Heron**	STA/DEC	-0.73	0.394	-26.17	**0.004**	-31.66	**0.022**
Calidris alpina	**Dunlin**	STA	9.61	**0.001**	-44.83	0.150	-76.62	**0.004**
Casmerodius albus	**Great (White) Egret**	STA/INC	1.67	0.053	-39.71	**0.000**	-30.87	**0.042**
Charadrius alexandrinus	**Kentish Plover**	DEC	4.56	0.098	-61.39	**0.005**	-53.41	**0.047**
Charadrius hiaticula	**Great Ringed Plover**	DEC	0.74	0.584	-50.58	**0.000**	-64.21	**0.000**
Chlidonias niger	**Black Tern**	DEC	-	-	-	-	-	-
Egretta garzetta	**Little Egret**	INC	1.06	0.122	-31.44	**0.000**	-51.19	**0.000**
Gallinago gallinago	**Common Snipe**	STA/DEC	-1.74	0.513	18.72	0.542	-	-
Himantopus himantopus	**Black-winged Stilt**	STA	4.16	**0.000**	-34.49	**0.000**	-31.86	**0.030**
Ixobrychus minutus	**Little Bittern**	DEC	2.76	0.112	9.25	0.633		
Larus melanocephalus	**Mediterranean Gull**	STA	-	-	-	-	-	-
Limosa lapponica	**Bar-tailed Godwit**	STA/DEC	1.50	0.637	-60.25	0.085	-83.27	**0.000**
Limosa limosa	**Black-tailed Godwit**	DEC	-0.07	0.977	-35.36	0.196	-46.66	0.138
Nycticorax nycticorax	**Black-crowned Night-Heron**	DEC	-2.51	0.072	8.46	0.612	-18.86	0.459
Philomachus pugnax	**Ruff**	DEC	3.40	**0.006**	-30.20	**0.013**	-39.77	**0.018**
Platalea leucorodia	**Eurasian Spoonbill**	INC	4.42	**0.016**	-61.80	**0.008**	-61.13	**0.040**
Pluvialis apricaria	**Eurasian Golden Plover**	STA	-	-	-	-	-	-
Recurvirostra avosetta	**Pied Avocet**	STA	0.61	0.689	-50.15	**0.001**	-54.36	**0.019**
Sterna albifrons	**Little Tern**	DEC	-5.77	0.066	-23.14	0.533	-32.69	0.479
Sterna caspia	**Caspian Tern**	STA/INC	3.61	**0.014**	-34.79	**0.026**	-31.71	0.147
Sterna hirundo	**Common Tern**	STA	-3.58	0.296	-23.69	0.518	-52.58	0.172
Sterna nilotica	**Gull-billed Tern**	STA/DEC	11.20	**0.002**	-22.25	0.477	-38.97	0.315
Sterna sandvicensis	**Sandwich Tern**	STA	-0.10	0.963	-17.17	0.428	-9.10	0.749
Tringa hypoleucos	**Common Sandpiper**	STA/DEC	-0.28	0.717	-0.83	0.924	-21.89	0.097
Tringa totanus	**Common Redshank**	DEC	7.42	**0.001**	-59.87	**0.016**	-57.13	**0.039**

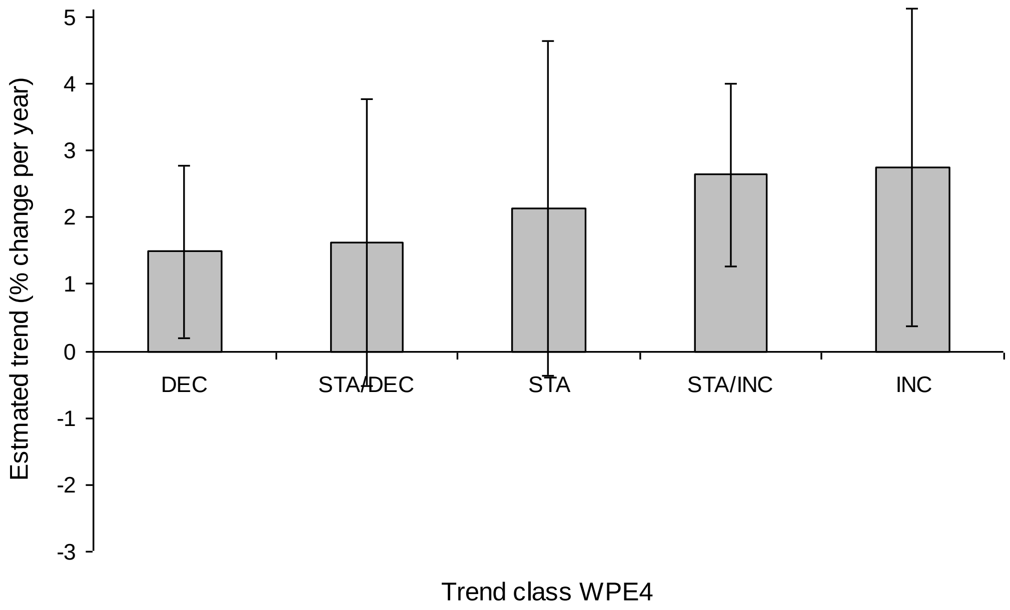

Figure 2

A comparison of the population trends estimated in this study and trends based on independent sources given in Wetlands International (2006, Waterbird Population Estimates 4). Bars indicates means ± se's. DEC-Declining, STA- Stable, INC - Increasing.

Table 3. Trends in the number of observed European migratory waterbirds in count plots located in Ramsar sites, IBA's or non-designated areas (regular). P-values indicate whether rends in Ramsar sites or IBA's differ significantly from trends in non-designated sites.

English name	Regular	Ramsar	*p*	IBA	*p*
Northern Pintail	-3.80	-0.69	0.332	-4.50	0.773
Northern Shoveler	1.28	4.50	0.265	-3.83	**0.020**
Common Teal	1.55	13.02	**0.005**	4.24	0.384
Garganey	-2.31	5.75	0.309	7.06	0.121
Purple Heron	-0.79	-5.31	0.059	0.42	0.468
Dunlin	10.43	3.40	0.234	14.31	0.483
Great (White) Egret	0.95	0.39	0.819	2.69	0.291
Kentish Plover	7.08	10.64	0.568	1.61	0.243
Great Ringed Plover	0.72	-3.45	0.166	2.00	0.626
Black Tern	-43.72	-30.55	0.108	-13.15	0.292
Little Egret	0.56	-1.07	0.330	2.29	0.192
Common Snipe	-1.65	2.24	0.565	-3.54	0.671
Black-winged Stilt	2.27	9.69	**0.001**	4.61	0.138
Little Bittern	-0.36	-9.72	0.082	16.61	**0.000**
Mediterranean Gull	8.65	-48.45	0.839	17.46	0.669
Bar-tailed Godwit	3.95	8.73	0.433	-4.79	0.119
Black-tailed Godwit	-4.34	-7.08	0.574	5.84	**0.021**
Black-crowned Night-Heron	-1.61	-10.84	0.302	-4.02	0.409
Ruff	3.18	0.86	0.455	4.38	0.631
Eurasian Spoonbill	0.64	2.94	0.572	7.14	0.079
Eurasian Golden Plover	8.18	3.72	0.766	0.93	0.707
Pied Avocet	-2.00	-4.54	0.481	4.50	**0.027**
Little Tern	-8.47	-1.72	0.426	-5.79	0.674
Caspian Tern	7.95	6.23	0.582	1.02	**0.013**
Common Tern	-4.25	12.68	0.087	-11.58	0.353
Gull-billed Tern	12.02	28.39	0.104	7.06	0.509
Sandwich Tern	-0.79	0.44	0.759	-0.22	0.879
Common Sandpiper	-1.61	2.28	0.111	1.58	**0.031**
Common Redshank	6.53	12.17	0.243	4.88	0.697

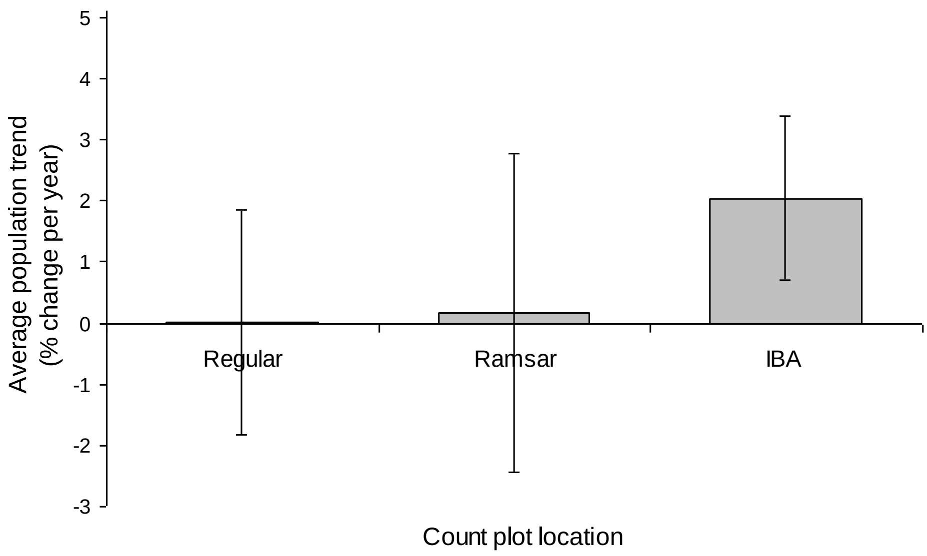

Figure 3
Across species average population trends observed in count plots located in Ramsar sites, IBAs and non-designated sites (regular). Bars indicate means ± se's.

Table 4. The relationship between the age of Ramsar sites relative to 2007 and the average number of birds that were observed per count plot.

English name	Change with Ramsar age (%.year^{-1})	*p*
Northern Pintail	8.98	**0.000**
Northern Shoveler	11.44	**0.000**
Common Teal	11.71	**0.000**
Garganey	12.76	**0.002**
Purple Heron	3.87	**0.000**
Dunlin	9.24	**0.000**
Great (White) Egret	3.79	**0.001**
Kentish Plover	6.88	**0.002**
Great Ringed Plover	7.14	**0.000**
Black Tern	9.08	0.516
Little Egret	5.52	**0.000**
Common Snipe	5.24	**0.004**
Black-winged Stilt	3.02	**0.007**
Little Bittern	-0.75	0.480
Mediterranean Gull	-65.37	0.158
Bar-tailed Godwit	7.02	**0.011**
Black-tailed Godwit	9.90	**0.000**
Black-crowned Night-Heron	1.49	0.330
Ruff	4.32	**0.002**
Eurasian Spoonbill	3.54	0.093
Eurasian Golden Plover	6.14	0.135
Pied Avocet	5.86	**0.001**
Little Tern	1.43	0.597
Caspian Tern	1.70	0.199
Common Tern	3.90	0.202
Gull-billed Tern	1.60	0.544
Sandwich Tern	0.32	0.835
Common Sandpiper	1.55	0.100
Common Redshank	4.77	**0.032**

4 Discussion

Critical Site Identification

Countries situated along the Atlantic coast of North-Western Africa were found to host the most important sites for Dutch priority waterbird species wintering in Africa. Morocco, Mauritania, Senegal and Mali hosted the largest number of Critical Sites. However, Morocco, Mauritania and Senegal hosted Critical Sites for almost twice as many species as Mali and more than twice as many species as any of the other countries (Table 1). The identification of Critical Sites depends on how well wintering birds in a country have been surveyed. For example the core wintering area of the West-European Black-tailed Godwit population is located in the coastal rice fields of Guinee-Bissau (Kleijn et al., 2010), yet no Critical Sites have been identified for this species in this country (Table 1) because these sites have not been counted as a part of the AfWC.

The selection of the key conservation areas for Dutch priority waterbird species was largely based on a small selection of eight waterbird species that were regularly observed in sites in concentrations that exceeded 1% of their flyway populations. Although care should therefore be taken with the extrapolation of the findings, the identified region generally agrees with findings of other studies that include both the current and other migratory bird species breeding in Europe (Zwarts et al., 2009) and recent satellite transmitter studies (Black-tailed Godwit, www.grutto.nl; Purple Heron, www.followthebird.org). The reason why coastal countries in North-Western and West Africa were highlighted in this analysis may be because sites in these countries are important both as stop-over and as wintering sites. While the core African wintering areas may differ between species, most species do have to pass through Morocco, Mauritania and Senegal to reach their wintering grounds.

Population trends

The population trends estimated in this study were more positive than expected (Figure 2). Zwarts et al. (2009) also noted that population trends of Garganey and Black-tailed Godwits on key winter staging areas in Africa were more positive than population trends estimated from the European breeding grounds. Given the much lower observer density in Africa compared to Europe, it seems unlikely that the trend estimates in Africa are actually a reflection of increasing population numbers. Overestimations of population trends might arise from the skills and/or the equipment of the observers improving over time, resulting in better detection of individuals and species (e.g. Jiguet, 2009; Kery et al., 2009). A second, more ecological explanation is that bird numbers in high quality wetland sites, where most AfWC count plots are located, are buffered by bird numbers in low quality sites in the wider countryside surrounding these wetlands. These so-called buffer effects have been found to influence large scale population regulation of Icelandic Black-tailed godwits wintering in the UK (Gill et al., 2001) and could obscure actual population trends. Furthermore, the AfWC data did not include zero counts. This reduced sample size and therefore the accuracy with which population trends were estimated. To be able to accurately respond to threats to winter staging areas and population and distributional changes of migratory waterbirds, it is important that we investigate the cause of the mismatch between trends estimated on wintering and breeding grounds.

Trends in Ramsar sites, IBA's and non-designated sites

So far, no systematic attempt has been made to measure and evaluate the effect that Ramsar designation has had in terms of conservation benefits for sites (Castro et al., 2002). Similarly, as far as we are aware, no systematic evaluation has been made of the impact of IBA designation on bird population trends. We found mixed benefits for migratory waterbird species of both Ramsar and IBA designation of sites on the African continent. Significant differences between trends in designated and non-designated sites were positive with the exception of Northern Shoveler and Caspian Tern in IBA sites. Averaged over all species, however, winter population trends were not more positive in count plots in Ramsar sites or IBA's compared to those in non-designated sites. Assuming that they occurred equally at all sites, the processes that potentially introduced bias in estimates of species population trends did not affect the results of trend comparisons in different types of sites. During the study period, human population growth in Africa has been accompanied by significant changes in land-use. From the perspective of birds, the increasing area of arable land, livestock numbers and deforestation are resulting in ever increasing degradation of their habitats (Buchanan et al., 2009; Zwarts et al. 2009). Ramsar sites and IBAs are not based on a regulatory regime and have no punitive sanctions for violations of, or defaulting upon, treaty commitments (Adaman et al. 2009). Nevertheless, Buchanan et al. (2009) revealed that fifty-seven percent of IBAs fell within or overlapped Protected Areas (although few of them target waterbirds) and vegetation in IBAs was less disturbed than that outside IBAs. Castro et al. (2002) found that Ramsar-designated sites experienced a strong increase in protection efforts (due to increased awareness about the importance of these sites, increased conservation funding, increase participation by local stakeholders in conservation, and reduction of threats) and that this effect was particularly strong in the developing world. For these reasons, if anything, we would have expected to find bird population trends that were less negative in designated sites compared to non-designated sites.

On the other hand, designation of both Ramsar sites and IBAs is often inspired because of the presence or abundance of a particular species and conservation efforts may be targeted to that species. It is not unreasonable to assume that conservation efforts would benefit waterbird habitat in general, and therefore waterbird populations in general. However, if the requirements of the targeted species are very specific, the benefits to other bird species might be limited. Furthermore, our failure to find benefits of site designation for all but two species could have been caused by the statistical power of tests which was not very high for many of the individual species because of low sample size (Appendix 2). This may have prevented the trends for more species from differing significantly between designated and non-designated sites. However, also across the 29 species, trends were not more positive in designated sites compared to non-designated sites despite the good sample size here. Ramsar designation does not appear to provide any guarantees for conservation benefits (Adaman et al., 2009). The similar trends in Ramsar sites, IBAs and non-designated areas might therefore also accurately reflect a failure of two important conservation tools to deliver benefits to European migratory waterbirds in Africa.

It is difficult to interpret the generally higher numbers of birds observed in Ramsar sites and IBAs compared to non-designated sites. A logical explanation would be that bird numbers and densities are higher because this is a key criterion for the identification of both Ramsar sites and IBA's (Fishpool and Evans, 2001). Because we could not include plot size in the analyzes we cannot exclude the possibility, however, that differences were caused by count plots in designated sites being larger than plots in non-designated sites. The positive relationship between Ramsar age and the number of observed birds for many of the species could be explained by improved site conditions as a result of conservation efforts after designation. Alternative explanations that (also) explain the observed patterns are (1) sites with higher bird numbers being designated earlier than sites with lower bird numbers and (2) larger count plots in sites that were designated first.

Conclusions
The Dutch Nature Conservation Policy Plan (Biodiversiteit werkt: voor natuur, voor mensen, voor altijd - Beleidsprogramma biodiversiteit 2008-2011 EL&I (former LNV) has identified the sustainable conservation of flyways as a key priority. The findings of this study suggest that, if areas in the African part of the flyway of Dutch priority waterbird species should be prioritized for conservation initiatives, the string of countries consisting of Morocco, Mauritania, Senegal and Mali should be on top of the list. If the Dutch want to boost the conservation of the wintering habitat of migratory birds breeding in or migrating through the Netherlands, it will be most effective if they assist the local institutions and individuals that are trying to protect the key wetland sites in these countries. An added benefit will be that other species that critically depend on these sites (and

that are sometimes much more endangered than those investigated here) will probably benefit from these initiatives as well.

The findings of this study make clear that there is a general lack of data associated with the observed number of birds which makes it difficult to interpret the observed species trends. We currently have no idea whether and how the quality of critical sites is being threatened by changes in land-use, climate or hunting intensity. We don't know why estimated trends in wintering areas are more positive than trends in breeding areas and we can't interpret the apparently poor performance of conservation initiatives such as Ramsar or IBA designation. We don't know whether trends in count-plots are representative of trends in other, perhaps less important waterbird wintering habitats, that nevertheless may play an important role for wintering waterbirds in Africa. These problems can only be solved by basic field work, which is currently ongoing in Morocco and Senegal.

This study found only limited positive effects of Ramsar and IBA designation on migratory waterbird numbers in their wintering habitats in Africa. Ramsar and IBA are the two main conservation tools in Africa that may contribute to the objectives of the Convention on Migratory Species, to which the majority of European countries are signatory. The AfWC is probably the most extensive wildlife monitoring database that is currently available, and the efforts of the mostly volunteer observers who collected data under often adverse conditions and in remote areas are commendable. Nevertheless, lack of data associated with bird counts (e.g. zero counts, plot size, habitat characteristics) made it impossible to interpret the observed trends and effects of conservation initiatives. Effective monitoring may help determine population trends and thereby conservation status of species, to prioritize key conservation sites, to infer (causes of) changes in habitat conditions (Donald, 2001) and to evaluate the effectiveness of conservation policies (Donald et al., 2007). Our findings therefore highlight the importance of improving the monitoring efforts on the African continent. It will only be possible to accurately measure and predict changes in numbers and threats to their survival when this is done throughout the flyway of each priority waterbird species.

Acknowledgements

We are grateful to the all observers who collected the data, often under harsh conditions. We thank Birdlife International for kindly providing the digitized IBA boundaries. Comments on previous drafts of the manuscript by, and discussions with Gerard van Dijk and Lincoln Fishpool significantly benefited the report. This study was made within the framework of the Project 'Ecological Networks BO-10-003-010' funded by the former Dutch Ministry of Agriculture, Nature Conservation and Food Safety (now the Dutch Ministry of Economic Affairs, Agriculture and Innovation (EL&I)).

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Appendix 1. An overview of the selected waterbird species, whether they have been used to identify Critical Sites in Africa and whether they have been included in the trend analyses of African wintering populations. Selected species were either listed on Annex I of Birds Directive and/or listed in the Dutch Red Databook. Information on flyway population, breeding range and wintering range are from Delany & Scott 2006.

Species	English name	Subspecies and Population	Breeding range	Wintering, or core non-breeding range	Critical sites in Africa?	Trend estimates in Africa?
Waterbird species wintering in Europe						
Actitis hypoleucos	**Common Sandpiper**	N, W & C Europe (bre)	North, West & Central Europe	W Africa, few W & SW Europe, Mediterranean	no	yes
Anas acuta	**Northern Pintail**	NW Europe (non-bre)	N Europe, W Siberia	NW Europe	no	yes
Anas clypeata	**Northern Shoveler**	NW & C Europe (non-bre)	N, NW & Central Europe	NW & Central Europe	no	yes
Anas crecca	**Common Teal**	**crecca,** NW Europe (non-bre)	North & NW Europe	NW Europe	no	yes
Anser erythropus	**Lesser White-fronted Goose**	N Europe, W Siberia (bre)	N Scandinavia, W Siberia	SE Europe, Caspian	no	no
Branta leucopsis	**Barnacle Goose**	N Russia, E Baltic (bre)	N Russia, E Baltic, S North Sea	N Germany, Netherlands	no	no
Bucephala clangula	**Common Goldeneye**	**clangula,** NW, Central Europe (non-bre)	N, NW Europe	NW, Central Europe	no	no
Cygnus columbianus	**"Bewick's Swan"**	**bewickii,** NW Europe (non-bre)	Arctic N Russia	NW Europe	no	no
Cygnus cygnus	**Whooper Swan**	N mainland Europe (bre)	Scandinavia, N European Russia	NW & Central Mainland Europe	no	no
Gavia arctica	**Black-throated Diver, Arctic Loon**	**arctica**	N Europe & W Siberia	Coastal NW Europe, Mediterranean, Black & Caspian Seas	no	no
Gavia stellata	**Red-throated Diver, Red-throated Loon**	NW Europe (non-bre)	Arctic and boreal West Eurasia, Greenland	NW Europe	no	no
Larus marinus	**Great Black-backed Gull**	NE Atlantic	Coasts NW France, Ireland, Britain, Iceland E to Scandinavia, White Sea	E Atlantic coast S to Iberia	no	no
Mergus merganser	**Goosander, Common Merganser**	**merganser,** NW & C Europe (non-bre)	Scandinavia Baltic, W Russia, Britain	NW, Central Europe	no	no
Mergus serrator	**Red-breasted Merganser**	NW & C Europe (non-bre)	N & NW Europe, Iceland, E Greenland	N NW & Central Europe, Iceland	no	no
Pluvialis apricaria	**Eurasian Golden Plover**	**apricaria**	Britain, Ireland, S Scandinavia, Germany, Baltic States	NW Europe	no	yes
Podiceps auritus	**Slavonian Grebe, Horned Grebe**	**auritus,** NW Europe (large billed)	NW Europe	Coastal NW Europe	no	no
Podiceps grisegena	**Red-necked Grebe**	**grisegena,** NW Europe (non-bre)	E Europe	Coastal NW Europe	no	no
Sterna paradisaea	**Arctic Tern**	N Eurasia (bre)	Europe N of France, Scandinavia, Russia N of Arctic Circle	Antarctic Ocean	no	no

Appendix 1. Continued

Species	English name	Subspecies and Population	Breeding range	Wintering, or core non-breeding range	Critical sites in Africa?	Trend estimates in Africa?
Waterbird species wintering in Africa for which no Critical Sites have been identified						
Botaurus stellaris	**Eurasian Bittern, Great Bittern**	**stellaris,** W Europe, NW Africa (bre)	W Europe, Tunisia, Algeria, Morocco	W Europe, Mediterranean, Sub-Saharan Africa	no	no
Casmerodius albus	**Great (White) Egret**	**albus,** W, C & E Europe, Black Sea & E Mediterranean (bre)	W, C & E Europe, Black Sea & E Mediterranean (bre)	Partial migration to S & W Europe & N Africa	no	yes
Egretta garzetta	**Little Egret**	**garzetta,** W Europe, NW Africa	Ireland, UK, SE to Italy, Algeria, Tunisia, Morocco	Breeding range to W Africa	no	yes
Gallinago gallinago	**Common Snipe**	**gallinago,** Europe (bre)	N Europe	South & West Europe & West Africa	no	yes
Ixobrychus minutus	**Little Bittern**	**minutus,** W Europe, NW Africa	W Europe, Algeria, Tunisia, Morocco	Sub-Saharan Africa	no	yes
Larus melanocephalus	**Mediterranean Gull**	Europe, SW Asia	Most on Ukrainian Black Sea + scattered through C, S & W Europe & E to Azerbaijan	Black Sea, Mediterranean, NW Europe, NW Africa	no	yes
Larus minutus	**Little Gull**	N, C & E Europe (bre)	N Scandinavia, Baltic States, W Russia, Belarus, Ukraine	W Europe, NW Africa	no	no
Limosa lapponica	**Bar-tailed Godwit**	**lapponica**	High Arctic Scandinavia, N Russia, Whiite Sea & Kanin	Coastal W Europe & NW Africa	no	yes
Nycticorax nycticorax	**Black-crowned Night-Heron**	**nycticorax,** W Europe, NW Africa (bre)	W, C & S Europe, NW Africa	Sub-Saharan Africa, Mediterranean	no	yes
Porzana porzana	**Spotted Crake**	Europe & W Asia (bre)	Europe & W Asia	S Europe, Africa, mainly in E & S	no	no
Porzana pusilla	**Baillon's Crake**	**intermedia,**	S & C Europe, N Africa	Poorly known: Mediteranean basin, Africa	no	no
Waterbird species wintering in Africa for which Critical Sites have been identified						
Anas querquedula	**Garganey**	W Africa (non-bre)	Europe, W Siberia	West Africa	yes	yes
Ardea purpurea	**Purple Heron**	**purpurea,** SW & NW Europe, NW Africa (bre)	Italy, Mallorca, Iberia, France, Netherlands, Germany + NW Africa	Sub-Saharan (mainly West) Africa	yes	yes
Calidris alpina	**Dunlin**	**alpina**	N Scandinavia, N Russia, NW Siberia	W Europe, Mediterranean N & W Africa	yes	yes
Charadrius alexandrinus	**Kentish Plover, Snowy Plover**	**alexandrinus,** E Atlantic, W Mediterranean	Coastal W Mediterranean & W Europe N to Sweden	Coastal SW Europe NW & W Africa	yes	yes
Charadrius hiaticula	**Great Ringed Plover**	**hiaticula**	Iceland, Baltic, S Scandinavia to Britain, Ireland, France	W Europe, Mediterranean, N Africa	yes	yes
Chlidonias niger	**Black Tern**	**niger**	W, C & S Europe, W & C Asia E to Altai Mts	Coastal W & C Africa to Namibia	yes	yes
Himantopus himantopus	**Black-winged Stilt**	**himantopus,** W & SW Europe, W Africa	SW Europe & NW Africa	Most W Africa, + SW Iberia	yes	yes

Appendix 1. Continued

Species	English name	Subspecies and Population	Breeding range	Wintering, or core non-breeding range	Critical sites in Africa?	Trend estimates in Africa?
Limosa limosa	**Black-tailed Godwit**	**limosa,** W Europe (bre)	W Europe E to 20 E	NW & W Africa: Morocco, Senegal E to Mali, Niger	yes	yes
Philomachus pugnax	**Ruff**	W Africa (non-bre)	N & Central Europe, NW Russia, W & C Siberia	W Africa	yes	yes
Platalea leucorodia	**Eurasian Spoonbill**	**leucorodia,** E Atlantic	Coastal W Europe	W Mediterranean & W African coast	yes	yes
Recurvirostra avosetta	**Pied Avocet**	W Europe (bre)	NW Europe, W Mediterranean, NW Africa	Atlantic coast S to Mauritania, Senegal, Gambia	yes	yes
Sterna albifrons	**Little Tern**	**albifrons,** W Europe (bre)	W Europe-NW Africa	W & SW Africa	yes	yes
Sterna caspia	**Caspian Tern**	Madagascar (bre)	Madagascar, Europe & Aldabra Group (Seychelles)	Madagascar, Europe & Aldabra Group (Seychelles)	yes	yes
Sterna hirundo	**Common Tern**	**hirundo,** S, W Europe (bre)	S, W Europe	West African seaboard	yes	yes
Sterna nilotica	**Gull-billed Tern**	**nilotica,** W Europe & W Africa (bre)	W & SW Europe, NW & W Africa S to Mauritania	Mauritania E to Nigeria & Chad	yes	yes
Sterna sandvicensis	**Sandwich Tern**	**sandvicensis,** W Europe (bre)	Coasts of W & N Europe	Mostly W & NW African coasts S to South Africa	yes	yes
Tringa totanus	**Common Redshank**	**totanus,** E Atlantic (non-bre)	Fennoscandia, Baltic, W Central Europe	E Atlantic: Britain S to W Africa, W Mediterranean	yes	yes

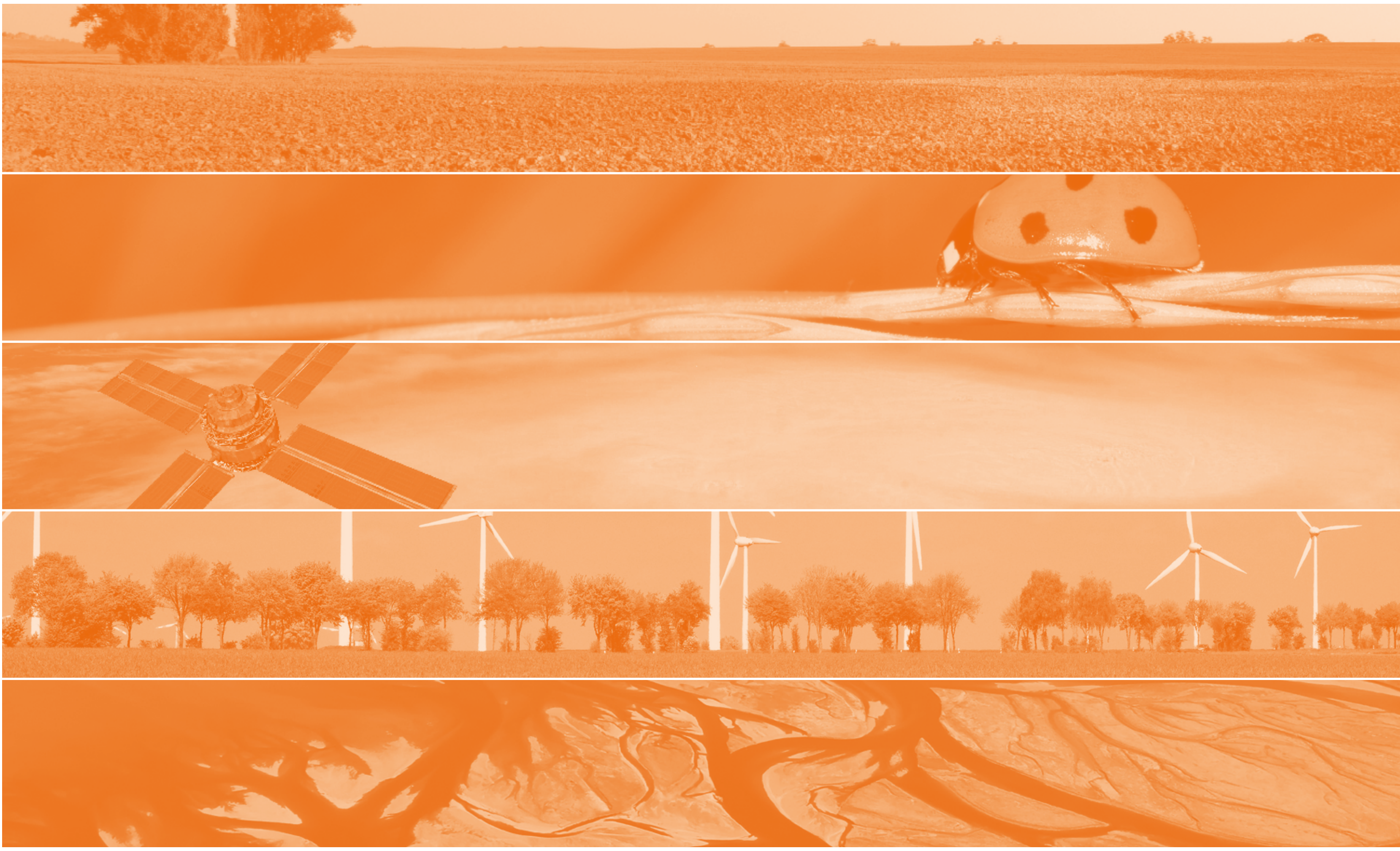
Appendix 2. A summary of the AfWC data available for the analyses for the different endangered European waterbird species. Years indicate the maximum range in years.

	Number of							
Species	years	countries	counts	sites	IBA- Ram-	IBA+ Ram-	IBA- Ram+	IBA+ Ram+
Northern Pintail	21	6	783	287	203	52	22	10
Northern Shoveler	21	8	1183	391	279	71	28	13
Common Teal	21	4	612	234	178	33	17	6
Garganey	19	7	380	183	64	41	64	14
Purple Heron	19	11	988	402	208	91	73	30
Dunlin	19	4	295	118	70	32	9	7
Great (White) Egret	19	19	1349	561	292	136	88	45
Kentish Plover	18	4	353	169	111	36	14	8
Great Ringed Plover	19	12	954	347	182	123	10	32
Black Tern	14	2	58	15	3	7	0	5
Little Egret	21	18	2644	942	587	194	101	60
Common Snipe	19	5	214	90	55	28	4	3
Black-winged Stilt	20	17	2291	829	478	197	107	47
Little Bittern	16	2	134	62	44	12	1	5
Mediterranean Gull	9	1	32	16	13	1	1	1
Bar-tailed Godwit	19	4	184	64	26	20	6	12
Black-tailed Godwit	19	6	398	177	78	41	45	13
Black-crowned Night-Heron	17	3	391	166	110	45	1	10
Ruff	20	13	1743	667	359	140	116	52
Eurasian Spoonbill	19	3	249	95	57	26	6	6
Eurasian Golden Plover	15	1	89	35	26	5	3	1
Pied Avocet	19	8	716	307	180	98	7	22
Little Tern	14	3	177	60	28	20	1	11
Caspian Tern	20	8	657	220	96	88	11	25
Common Tern	16	5	178	80	32	38	3	7
Gull-billed Tern	14	3	325	115	50	43	1	21
Sandwich Tern	19	7	492	172	86	58	6	22
Common Sandpiper	19	17	1638	621	404	171	14	32
Common Redshank	19	5	369	127	75	32	11	9

Appendix 3. A comparison of the statistics of the same model terms in a Linear Mixed Model (LMM) with count-plot as a fixed variable and a Linear Model (LM) with count-plot as a random variable.

	LMM				LM			
	Year	IBA. Year	Region.Year	Region. IBA.Year	Year	IBA. Year	Region.Year	Region. IBA.Year
Northern Pintail	**0.009**	0.678	0.299	0.162	**0.006**	0.851	0.308	0.181
Northern Shoveler	0.876	0.056	0.608	0.555	0.864	**0.007**	0.513	0.274
Common Teal	**0.004**	0.243	0.765	0.320	**0.001**	0.849	0.949	0.661
Garganey	0.117	0.086	0.446	0.167	0.123	0.151	0.456	0.065
Purple Heron	0.394	0.581	0.668	0.510	0.397	0.483	0.114	0.913
Dunlin	**0.001**	0.286	0.379	0.117	**0.002**	0.534	0.287	0.101
Great (White) Egret	0.054	0.264	0.147	0.496	**0.023**	0.852	0.083	0.682
Kentish Plover	0.095	0.232	0.330	0.618	0.140	0.127	0.392	0.488
Great Ringed Plover	0.563	0.953	0.074	0.120	0.609	0.803	0.149	0.079
Black Tern								
Little Egret	0.123	0.151	0.055	0.140	**0.040**	0.105	**0.023**	0.527
Common Snipe	0.518	0.281	0.112	0.754	0.596	0.196	0.221	0.243
Black-winged Stilt	**0.000**	0.084	0.210	**0.018**	**0.000**	0.237	0.288	0.054
Little Bittern	0.102	**0.001**			**0.013**	0.071		
Mediterranean Gull								
Bar-tailed Godwit	0.635	0.163	0.308	0.678	0.807	0.137	0.395	0.685
Black-tailed Godwit	0.977	**0.022**	0.593	0.341	0.816	0.068	0.381	0.197
Black-crowned Night-Heron	0.070	0.304			**0.022**	0.098		
Ruff	**0.007**	0.562	0.840	0.527	**0.002**	0.479	0.795	0.570
Eurasian Spoonbill	**0.018**	0.081	0.904	0.585	**0.008**	0.436	0.947	0.613
Eurasian Golden Plover								
Pied Avocet	0.667	**0.042**	0.333	0.314	0.881	0.535	0.767	0.668
Little Tern	0.064	0.731	0.663	0.194	0.249	0.483	0.516	0.933
Caspian Tern	**0.013**	**0.033**	**0.001**	0.416	**0.009**	**0.016**	**0.006**	0.149
Common Tern	0.294	0.894	0.177	0.156	0.315	0.960	0.253	0.058
Gull-billed Tern	**0.003**	0.753	0.746	0.938	0.224	1.000	0.889	0.858
Sandwich Tern	0.965	0.586	0.314	0.197	0.934	0.990	0.189	0.163
Common Sandpiper	0.739	**0.003**	**0.000**	**0.001**	0.055	**0.045**	**0.001**	0.075
Common Redshank	**0.001**	0.490	0.367	0.678	**0.001**	0.232	0.328	0.637

Note: Regions include West Africa - Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Ivory Coast, Gambia, Ghana, Guinea Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo; North Africa - Algeria, Egypt, Libya, Morocco, Tunisia; East Africa - Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Seychelles, Sudan, Tanzania, Uganda; Central Africa - Congo, Gabon; Souther Africa - Angola, Botswana, Madagascar, Malawi, Namibia, South Africa, Swaziland, Zambia, Zimbabwe.



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Meer informatie: www.alterra.wur.nl