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SPECIES**

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**REPORT
EFFECT OF CLIMATE CHANGE ON MIGRATORY BIRD SPECIES
OCCURRING IN POLAND**

*(Grzegorz Rąkowski, Institute of Environmental Protection - State Research Institute,
Warsaw, Poland)*

REPORT

EFFECT OF CLIMATE CHANGE ON MIGRATORY BIRD SPECIES OCCURRING IN POLAND

Introduction

Among the taxa listed in Annexes I and II to the CMS Convention there are almost 200 migratory species encountered in Poland. They include two species of sharks (*Elasmobranchii*): porbeagle (*Lamna nasus*) and spurdog (*Squalus acanthias*) as well as 25 species of mammals (*Mammalia*), including three species of marine mammals: grey seal (*Haliophoca grypus*), common seal (*Phoca vitulina*) and harbour porpoise (*Phocoena phocoena*), in addition to 22 bat species (*Chiroptera*). The other migratory species listed by the CMS Annexes that occur in Poland are birds (*Aves*). As there is relatively little knowledge on the impact of climate change on bats and marine mammals found in Poland, and because most of those species are subject to protective actions and analyses conducted under separate agreements of which Poland is a Party (EUROBATS – in the case of bats and ASCOBANS – in the case of harbour porpoise), this report focuses on the impact of climate changes upon migratory birds which constitute more than 85 per cent of all CMS listed species found in our country.

Impact of climatic factors upon populations of migratory birds nesting in Poland

In order to analyse the impact of climatic factors on migratory birds occurring in Poland only those were selected, from among the species listed in either Annex I or Annex II of CMS, which have been found nesting in Poland over the last 50 years (in the period 1960–2010), together with those that have been nesting only exceptionally or sporadically as well as those that had been nesting within the period analyzed but recently they are no longer found nesting. Species that appear only on passages, for wintering or otherwise very sporadically within the territory of our country were excluded from these considerations. There are altogether 114 species of interest including four which are on the Annex I (ferruginous duck, white-tailed eagle, lesser spotted eagle and aquatic warbler) and the remaining ones listed on the Annex II to CMS. All those species have been analyzed in Table 1. Specific site type was determined for every species, its breeding category (numbers of breeding population), trend of population development and information on the known, possible or probable impact of climate induced changes on bird populations over the last 50 years.

The information on numbers, ranges and population trends as well as on the effect of climatic factors upon the populations of the examined avians were found in the following references:

1. *Atlas rozmieszczenia ptaków lęgowych Polski 1985–2004*, (Atlas of breeding bird distribution in Poland) (A. Sikora, Z. Rohde, M. Gromadzki, G. Neubauer and P. Chylarecki reds.), Bogucki Wydawnictwo Naukowe, Poznań 2007. In Polish.
2. Grabarczyk H., Grabarczyk M.: *Atlas zwierząt chronionych*. (Atlas of protected fauna), Multico Oficyna Wydawnicza, Warszawa 2010. In Polish.
3. Kornatowska B., Rąkowski G., Smogorzewska M, Walczak M.: *Ptaki jako wskaźniki zmian różnorodności biologicznej*. (Birds as indicators of changes in biological diversity), Instytut Ochrony Środowiska – Państwowy Instytut Badawczy, Warszawa 2010 (manuscript). In Polish.

4. Kornatowska B., Rąkowski G., Smogorzewska M, Walczak M., Barszcz A.: *Oddziaływanie zmian klimatu na różnorodność biologiczną w ekosystemach leśnych na przykładzie zagrożonych gatunków ptaków*. (Effect of climate changes on biological diversity in forest ecosystems using vulnerable species as an example), Instytut Ochrony Środowiska, Warszawa 2009 (manuscript). In Polish.
5. *Monitoring ptaków lęgowych. Poradnik metodyczny dotyczący gatunków chronionych Dyrektywą Ptasią*. (Monitoring of breeding birds. Methodical guidelines concerning birds protected under the Birds Directive), (P. Chylarecki, A. Sikora and Z. Cenian reds.), Główny Inspektorat Ochrony Środowiska, Warszawa 2009. In Polish.
6. *Ostoje ptaków o znaczeniu europejskim w Polsce*, (European Bird Sites in Poland), (P.O. Sidło, B. Błaszowska and P. Chylarecki reds.), Ogólnopolskie Towarzystwo Ochrony Ptaków, Warszawa 2005. In Polish.
7. *Ostoje ptaków o znaczeniu międzynarodowym w Polsce*, (International Bird Sites In Poland), (T. Wilk, M. Jujka, J. Krogulec and P. Chylarecki eds.), Ogólnopolskie Towarzystwo Ochrony Ptaków, Marki 2010. In Polish.
8. *Polska czerwona księga zwierząt. Kręgowce*, (The Polish Red Book of Animals. Vertebrates), Z. Głowaciński ed. Państwowe Wydawnictwa Rolnicze i Leśne, Warszawa 2001. In Polish.
9. *Poradniki ochrony siedlisk i gatunków Natura 2000 – podręcznik metodyczny, t. 7–8 Ptaki (część I i II)*, (Protection of Natura 2000 sites and species - methodical guidelines), M. Gromadzki ed., Ministerstwo Środowiska, Warszawa 2004. In Polish.
10. *Ptaki Europy. Przewodnik terenowy*, (Birds of Europe. Field guide). K.A. Dobrowolski i B. Jabłoński eds., PWN, Warszawa 2000. In Polish.
11. Tomiałojć L.: *Ptaki Polski. Wykaz gatunków i rozmieszczenie*. (Birds of Poland. List of species and their distribution), PWN, Warszawa 1972. In Polish.
12. Tomiałojć L.: *Ptaki Polski. Rozmieszczenie i liczebność*. (Birds of Poland. List of species and their distribution), PWN, Warszawa 1990. In Polish.
13. Tomiałojć L., Stawarczyk T.: *Awifauna Polski. Rozmieszczenie, liczebność i zmiany, t. I–II*. (Avifauna of Poland. Distribution, numbers and changes), Polskie Towarzystwo Przyjaciół Przyrody “pro Natura”, Wrocław 2003. In Polish.
14. www.monitoringptakow.gios.gov.pl.

Based on the information given in Table 1, the major types of bird species' reaction to the changing climatic factors were presented in Table 2 and the numbers and percent share of species which are affected by a given type of factors.

Table 1: Effect of climate change on populations of migratory birds nesting in Poland, listed in Annexes I and II of the Convention on the conservation of migratory species of wild animals (CMS)

No	Vernacular name	Latin name	Species listed in the CMS Annex No	Habitat type to which a species is bound	Breeding category	Trend of population	Comments
1.	Batalion/ Ruff	<i>Philomachus pugnax</i>	II	W	FB	Species has not been found to breed in Poland for at least several years.	The numbers in the breeding population of ruff have been drastically declining in this country over the last several years so that the species with a distribution across north-eastern Europe is no longer breeding in Poland. The drop in numbers is attributed to mainly climate induced shift in species range to north-east as well as problems which the species encounters during its passages over the Sahara and Sahel regions.
2.	Bączek/ Little bittern	<i>Ixobrychus minutus</i>	II	W	VSB	-1	The drop in population numbers of the species is occurring across the whole Europe. Probable causes include climate induced unfavourable conditions in its wintering grounds in the Sub-Saharan Africa and on its migration routes as well as drying out of its main breeding sites, such as wide swampy river valleys, what also is indirectly attributed to climate change.
3.	Bąk/ Bittern	<i>Botaurus stellaris</i>	II	W	VSB	+1	The size of breeding population is undergoing considerable fluctuations. The species has recently been found wintering in Poland with ever more increasing frequency due to climate change.
4.	Bekasik/ Jack snipe	<i>Lymnocyptes minutus</i>	II	W	DL	The species has not been found nesting in Poland since about 30 years.	The breeding site in Poland was of insular character located beyond the natural range of species occurrence. Its disappearance results from a shift of the species' European range to north east which, to a great extent, is due to climate warming.
5.	Biegus Zmienny/ Dunlin	<i>Calidris alpina</i>	II	W	FB	The species has not been found to nest in Poland over the last several years.	A systematic drop in the breeding population numbers of this northern species in Poland results from shifting to the north of its natural European range, which to a great extent is caused by climate warming.
6.	Białorzytka/ White-rumped wheatear	<i>Oenanthe oenanthe</i>	II	O, M	SB	0	The species is found in rocky mountains and on ruderal sites. The population numbers fluctuate greatly, and there is no data available on the possible effect of climate change on its

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							populations.
7.	Bielik/ White-tailed eagle	<i>Haliaeetus albicilla</i>	I	W, F	VSB	+1	The species is considered as partly sedentary under the conditions in this country. Owing to mild winters the species is ever more frequently found to winter in Poland which contributes, among other things, to the increase in the domestic breeding population.
8.	Błotniak zbożowy/ Hen harrier	<i>Circus cyaneus</i>	II	W,A	EB	The species has not been found to nest in Poland over the last at least several years.	The species has decreased its numbers in Poland over the last several decades, but there is no data to link this drop with climatic factors. Owing to mild winters the species has been found to winter in Poland more frequently and more numerously.
9.	Błotniak łąkowy/ Montagu's harrier	<i>Circus pygargus</i>	II	W, A	SB	+1	The species has increased in numbers in Poland over the last two decades, but there is no data to link this population increase with climatic factors.
10.	Błotniak stawowy/ Marsh harrier	<i>Circus aeruginosus</i>	II	W, A	SB	+1	There is no data available to link changes in population of the species with climatic factors.
11.	Bocian biały/ White stork	<i>Ciconia ciconia</i>	II	A, S	MB	+1	Due to climate warming the species has increased attempts to winter in Poland, and has speeded up its arrival to the breeding grounds, on average by about 10 days over the last 30 years. It was also found that stork population numbers in Poland are affected by climatic conditions in the African region of Sahel, over which they pass.
12.	Bocian czarny/ Black stork	<i>Ciconia nigra</i>	II	W, F	VSB	+1	Over the 20 th century the breeding population of the species was slowly but constantly increasing, and recently it has become stable. No direct evidence exists to prove the effect of climate change on the number and range of the species.
13.	Brodzicz Piskliwy/ Common sandpiper	<i>Actitis hypoleucos</i>	II	W	SB	0	The species' population numbers are subject to significant fluctuations which is at least partially related to the extent and duration of flooding in the valleys of larger rivers.
14.	Brzeczka/ Savi's warbler	<i>Locustella luscinioides</i>	II	W	SB	+1	The species is distributed across the Central and Eastern Europe, and its range has been

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							expanding since at least the beginning of the 19 th century. No data are available on the effect of climatic factors on the species populations.
15.	Cierniówka/ White throat	<i>Sylvia communis</i>	II	A	AB	0	No data are available on the effect of climatic factors on the species populations.
16.	Cyraneczka/ Teal	<i>Anas crecca</i>	II	W	VSB	-0,5	A decrease in population numbers of this northern species in Poland (especially in its southern part) is due to the shift of the species' natural range to the north in Europe, which to a great extent results from climate warming.
17.	Cyranka/ Garganey	<i>Anas querquedula</i>	II	W	SB	-1	A drop in population numbers of the species in Poland is related to drying out of wide river valleys which provide its most important breeding habitats.
18.	Czajka/ Lapwing	<i>Vanellus vanellus</i>	II	W, A	MB	-1	A drop in population numbers of the species in Poland and Europe is mainly related to increasing human pressures. The Lapwing arrives recently at its breeding grounds at least 20 days earlier than 20-25 years ago. This is probably due to climate warming.
19.	Czapla biała/ Great white egret	<i>Egretta alba</i> (<i>Casmerodius albus</i>)	II	W	ESB	A new species on the Polish avifauna, it has been found nesting in Poland since 1997.	A warmth-loving south-European species, nesting in Poland since 1997, and since that time its range and numbers have been steadily increasing in this country. This results from a shift of its European range to the north which, to a great extent, is due to climate warming.
20.	Czapla purpurowa/ Purple heron	<i>Ardea purpurea</i>	II	W	SPB	The species has been found nesting in Poland since 1956.	This southern species relatively new to the country's avifauna breeds sporadically in the Poland's southern part which is located at the northern edge of its range. This is most probably related to the shift of the species range to the north due to climate warming, though no further expansion of the species has been observed.
21.	Czernica/ Tufted duck	<i>Aythya fuligula</i>	II	W	SB	+0,5	The expansion of the species in Europe and in Poland has been observed since the 19 th century, but it is hard to directly link the latter to the impact of climate change.
22.	Derkacz/ Corncrake	<i>Crex crex</i>	II	A, W,	SB	+0,5	The species numbers in western Europe have been constantly decreasing; however, in Poland

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							and eastern Europe its population has displayed an increasing trend. There is an evidence of a possible effect of climate change on its populations.
23.	Dubelt/ Great snipe	<i>Gallinago media</i>	II	W	VSB	-0,5	The numbers and range of the species normally distributed across north-eastern Europe have been steadily decreasing in Poland, which may be related to shifting of its European range to north-east due to climate warming.
24.	Gadożer/ Short-toed eagle	<i>Circaetus gallicus</i>	II	F	SPB	-0,5	Over the 20 th century there occurred a slow decrease of the species scarce breeding population both in Europe and in Poland. Recently, its Polish population is at the verge of extinction which is ascribed mainly to habitat changes. There is no evidence on the possible effect of climate change on the above trend.
25.	Gajówka/ Garden warbler	<i>Sylvia borin</i>	II	F	MB	0	There is no data on possible effect of climate change on populations of the species.
26.	Gągoł/ Goldeneye	<i>Bucephala clangula</i>	II	W	VSB	+1	Northern species whose numbers in Poland have been increasing since more than a century. There is no evidence testifying to the relation of this increase to climatic factors. Milder winters may favour a more numerous wintering populations of the species in Poland.
27.	Gęgawa/ Greylag goose	<i>Anser anser</i>	II	W	SB	+1	One of the probable causes underlying a considerable increase in numbers of the species in Poland might be a significantly prolonged period of forage availability due to milder winters, shorter periods of water freezing or unfreezing. It is also linked to ever more frequent wintering of the species in Poland.
28.	Głowienka/ Pochard	<i>Aythya ferina</i>	II	W	MB	-0,5	There is no evidence of the effect of climatic factors on the decrease in breeding population numbers in Poland. Warmer winters favour a more numerous wintering population of the species in this country.
29.	Helmiatka/ Red-crested pochard	<i>Netta rufina</i>	II	W	ESB	A new species on the Polish avifauna, it has been found nesting in Poland	A south European species associated with a warmer climate. Its appearance in Poland is most probably related to climate warming and to the shift of its range to the north. The size of

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						since 1986.	the breeding population is subject to significant fluctuations.
30.	Jarzębatka/ Barred warbler	<i>Sylvia nisoria</i>	II	F	SB	0	No information on the effect of climate change on the species populations.
31.	Jastrząb/ Goshawk	<i>Accipiter gentilis</i>	II	F	SB	+1	The species is sedentary under the conditions prevailing in Poland. An increase in the goshawk population is favoured by the increase in winter forage availability due to the increase in population numbers of many bird species wintering in Poland.
32.	Kapturka/ Blackcap	<i>Sylvia atricapilla</i>	II	F	MB	+1	An earlier arrival to breeding grounds was recently found in this bird, which is probably linked to climate warming.
33.	Kania czarna/ Black kite	<i>Milvus migrans</i>	II	F	VSB	-1	A drop in population numbers of the species has been observed in the whole Europe since a century, which is linked mainly with habitat transformations. There is no data on possible effect of climate on the species populations.
34.	Kania ruda/ Red kite	<i>Milvus milvus</i>	II	F	VSB	+1	There is no data on possible effect of climate on the species populations.
35.	Kłaskawka/ Stonechat	<i>Saxicola torquata</i>	II	A	VSB	+1	A warm loving species which spreads its range to the north along with the rise in temperature, this is also valid for Poland.
36.	Kobuz/ Hobby	<i>Falco subbuteo</i>	II	F	SB	+1	In Poland, the species is increasingly observed in winter owing to climate warming.
37.	Kopciuszek/ Black redstart	<i>Phoenicurus ochruros</i>	II	M, S	SB	+1	The species is distributed across western, southern and central Europe. Since the beginning of the 19 th century it has been in expansion and the borderline of its range has been shifting to north east, which may have been related to climate warming.
38.	Krakwa/ Gadwall	<i>Anas strepera</i>	II	W	SB	+1	The increase in population numbers observed in Poland over the last decades does not seem to be directly related to climate change.
39.	Kraska/ Roller	<i>Coracias garrulus</i>	II	F, A	ESB	-1	The species is distributed across southern and south-eastern Europe. Its breeding population is rapidly decreasing in both Poland and Europe what threatens with the total withdrawal of the species from this country. This is related to the

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							prolonged droughts plaguing the African region of Sahel, where the species has its wintering grounds.
40.	Krogulec/ Sparrow hawk	<i>Accipiter nisus</i>	II	F	VSB	+1	Since about 30 years the species has been increasing its population numbers in Poland. The number of individuals wintering in the country has also been increasing what may be linked to climate warming.
41.	Kropiatka/ Spotted crane	<i>Porzana porzana</i>	II	W	SB	-0,5	The population numbers of the species are subject to significant fluctuations and are related to the water level on flooded areas which are their nesting sites.
42.	Krwawodziób/ Redshank	<i>Tringa totanus</i>	II	W	SB	-0,5	The species is distributed mainly across eastern and central Europe. Its numbers and range in Poland have decreased over the last decades. The size of population is depending upon the magnitude and duration of flooding in wide river valleys which are their main habitat types; however, it is the man- made transformation of river valleys which is the major cause for the decrease in population numbers.
43.	Krzyżówka/ Mallard	<i>Anas platyrhynchos</i>	II	W	MB	+0,5	The wintering population numbers increase in Poland owing to climate warming.
44.	Kszyk/ Common snipe	<i>Gallinago gallinago</i>	II	W	SB	-0,5	The species is distributed across northern, eastern and central Europe. Its population numbers over the entire area have been slowly decreasing. There is no evidence to relate this effect to climate changes.
45.	Kulik wielki/ Curlew	<i>Numenius arquata</i>	II	W	VSB	-1	The species is distributed across northern and eastern parts of Europe. The size of population is partly depending upon the magnitude and duration of flooding in wide river valleys which are their main habitat types; however, it is the man-made transformation of river valleys which is the major cause for the decrease in population numbers.
46.	Kulon / Stone curlew	<i>Burhinus oedicnemus</i>	II	W	FB	The species has no longer been found to	A south-European species. The decrease in population numbers is distinct in the whole of

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						nest in Poland over the last several years.	Europe though it does not seem to be linked to climate change but rather to habitat loss due to enhanced human pressures.
47.	Łabędź krzykliwy/ Whopper swan	<i>Cygnus cygnus</i>	II	W	ESB	A new species on the Polish avifauna, it has been found nesting in Poland since 1973.	A north-European species, nesting in Poland only since 1973, and from that time on slowly extending its range and increasing its numbers. The species' expansion to the south occurs in the whole of Europe, but it does not seem to be directly related to climate impacts. Milder winters may seemingly favour the increase in wintering population numbers in Poland.
48.	Łabędź niemy/ Mute swan	<i>Cygnus olor</i>	II	W	SB	+1	The significant increase in the species population numbers in Poland may be due to the considerable lengthening of forage availability period in view of milder winters, shorter periods of water freezing or unfreezing. The same factors cause also more often in the recent years wintering of the species in Poland.
49.	Łęczak / Wood sandpiper	<i>Tringa glareola</i>	II	W	FB	Since at least a decade the species has no longer been found to nest in Poland.	This northern species is no longer found nesting in Poland. The decrease in its population numbers which has been observed in this country over the last decades, was due to a shift to north-east of its European natural border of range, which to a large extent resulted from climate warming.
50.	Łozówka/ Marsh warbler	<i>Acrocephalus palustris</i>	II	A	MB	0	There is no data on possible climate impact upon the species populations.
51.	Mewa Czarnogłowa/ Mediterranean gull	<i>Larus melanocephalus</i>	II	W	ESB	+1	A south European warmth-loving species associated with a warmer climate. It has been nesting in Poland since 1981, and the increase in its domestic population numbers is related to the shift of its range to the north, what may be linked to climate warming.
52.	Mornel/ Dotterel	<i>Charadrius morinellus</i>	II	M, W	EB	The species ceased to regularly nest in the Sudety Mts. after the II World War. Since that time it was found nesting on two occasions only: in	A cold-loving species nesting in the tundra and heathlands of Northern Europe and in alpine zones. It was regularly nesting in the Karkonosze Mts. in the 19 th and the first half of the 20 th century. The extinction of its alpine populations may be due to climate warming.

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						the Tatry Mts. (1988) and in the Karkonosze Mts. (1999).	
53.	Muchołówka białoszyja/ Collared flycatcher	<i>Ficedula albicollis</i>	II	F	VSB	+0,5	The species is distributed mostly across south and eastern Europe. A moderate increase in its population numbers in Poland is most probably related to climate warming and to the shift of its range to the north.
54.	Muchołówka mała/ Red-breasted flycatcher	<i>Ficedula parva</i>	II	F	SB	0	The species is distributed mainly across central and north-eastern Europe. There is no evidence to prove a possible effect of climate change on the species populations.
55.	Muchołówka szara/ Spotted flycatcher	<i>Muscicapa striata</i>	II	F	MB	0	There is no evidence to prove the possible effect of climate change on the species populations.
56.	Muchołówka żałobna/ Pied flycatcher	<i>Ficedula hypoleuca</i>	II	F	SB	0	The species is distributed mainly across northern and eastern Europe. There is no evidence to prove the possible effect of climate change on the species' populations.
57.	Mysikrólik/ Goldcrest	<i>Regulus regulus</i>	II	F	AB	0	In Poland part of the population of the species is non-migrating. There is no data available on the effect of climatic factors on population of the species.
58.	Myszołów/ Buzzard	<i>Buteo buteo</i>	II	F	MB	+1	There is no data available to link changes in population of the species with climatic factors.
59.	Nagórnik/ Rock thrush	<i>Monticola saxatilis</i>	II	O,M	ESB	-0,5	The species inhabits rocks and rocky mountains. There is no data available to link changes in population of the species with climatic factors.
60.	Nurogęś/ Goosander	<i>Mergus merganser</i>	II	W	VSB	+0,5	The species is distributed mainly across northern Europe. Since beginning of the 20 th century it is in moderate expansion in Europe and in Poland, rather not connected with climate change. However, climate factors are influencing number of population wintering in Poland.
61.	Ohar/ Shelduck	<i>Tadorna tadorna</i>	II	W	ESB	+1	Since about 50 years slight but permanent increase of the nesting population in Poland is observed, but it seem to have no connection

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							with the climatic factors.
62.	Orlik grubodzioby/ Spotted eagle	<i>Aquila clanga</i>	I	F	ESB	-0,5	The species is distributed mainly across North-Eastern and Eastern Europe with a continental climate. Poland is situated on the edge of the range of the species. A decrease of Polish nesting population of the species, observed since the beginning of the 20 th century, could be connected with the shift of its range to north-east caused by the climate warming.
63.	Orlik krzykliwy/ Lesser spotted eagle	<i>Aquila pomarina</i>	II	F	VSB	+0,5	There is no data available on the effect of climatic factors on population of the species.
64.	Orzeł przedni/ Golden eagle	<i>Aquila chysaetos</i>	II	M	ESB	+0,5	In Poland it is non-migrating species, inhabiting mainly mountains. There is no data available on the effect of climatic factors on population of the species.
65.	Orzełek/ Booted eagle	<i>Hieraetus pennatus</i>	II	F	FB	The species has not been found to nest in Poland over the last several years.	The range of the species shifts east beyond the boundaries of Poland, but it seems not to have any direct connection with the climate change.
66.	Ostrygojad/ Oystercatcher	<i>Haematopus ostralegus</i>	II	W	ESB	+0,5	There is no data available on the effect of climatic factors on population of the species.
67.	Perkoz rdzawoszyi/ Red-necked grebe	<i>Podiceps grisegena</i>	II	W	SB	0	The species' population numbers are subject to significant fluctuations which is at least partially related to the water level on its nesting grounds.
68.	Perkoz rogaty/ Slavonian grebe	<i>Podiceps auritus</i>	II	W	EB	0	The species is distributed mainly across Northern Europe. In Poland it nests only exceptionally, as the country lies beyond its natural range.
69.	Piecuszek/ Willow warbler	<i>Phylloscopus trochilus</i>	II	F	AB	+0,5	There is no data available on the effect of climatic factors on population of the species.
70.	Pięgża/Lesser whitethroat	<i>Sylvia curruca</i>	II	F	SB	0	There is no data available on the effect of climatic factors on population of the species.
71.	Pierwiosnek/Chiffchaff	<i>Phylloscopus collybita</i>	II	F	AB	+0,5	In the recent years the species has speeded up its arrival to the breeding grounds in Poland, which is probably connected with the climate warming.
72.	Pleszka/ Redstart	<i>Phoenicurus phoenicurus</i>	II	F	SB	+0,5	In years 1968–90 the number of the nesting population of the species in Poland and in

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							Europe has rapidly decreased. This breakdown was probably connected with the drought period in the African Sahel where the wintering places of the species are located. For 20 years the Polish and European population of the species has been slightly increasing.
73.	Płaskonos/ Shoveler	<i>Anas clypeata</i>	II	W	VSB	-0,5	The gradual decrease of the nesting population number of the species in Poland has been caused mainly by draining of the wide river valleys. Climatic factors could have only slight indirect effect on this process.
74.	Podgorzałka/ Ferruginous duck	<i>Aythya nyroca</i>	I	W	ESB	-0,5	The population of the species in Poland and Europe is gradually decreasing, but it seems not to have any direct connection with the climate change.
75.	Podróżniczek/ Bluethroat	<i>Luscinia svecica</i>	II	W	VSB	-0,5	The species is distributed mainly across North-Eastern Europe. In Poland its population number as well as the range are decreasing. It could be connected with the shift of its range to north-east caused by the climate warming.
76.	Pokląska/ Whinchat	<i>Saxicola rubetra</i>	II	A	SB	0	There is no data available on the effect of climatic factors on population of the species.
77.	Przepiórka/ Quail	<i>Coturnix coturnix</i>	II	A	SB	-0,5	The species' population numbers are subject to significant fluctuations. Periodical increases of population numbers of the species are connected with the occurrence of dry and warm summers.
78.	Pustułka/ Kestrel	<i>Falco tinnunculus</i>	II	A	SB	+0,5	There is no data available on the effect of climatic factors on population of the species.
79.	Raróg/ Saker falcon	<i>Falco cherrug</i>	II	A	SB	It is a new nesting species in Poland. For the first time it was found nesting in 1998 in the southern part of the country.	The species is distributed mainly across South-Eastern Europe. Its new nesting place in Poland could be connected with shifting of its range to north-west as a result of climate warming.
80.	Rokitniczka/ Sedge warbler	<i>Acrocephalus schoenobaenus</i>	II	W	SB	0	There is no data available on the effect of climatic factors on population of the species.
81.	Rożeniec/	<i>Anas acuta</i>	II	W	FB	The species has not	The drop in nesting population number of the

No	Vernacular name	Latin name	Species listed in the CMS Annex No	Habitat type to which a species is bound	Breeding category	Trend of population	Comments
	Pintail					been found to nest in Poland at least over a dozen or so years.	species observed in Poland during the last several dozen years was caused by the shift of its range to the north which most probable is the effect of climate warming.
82.	Rudzik/ Robin	<i>Erithacus rubecula</i>	II	F	AB	0	There is no data available on the effect of climatic factors on population of the species.
83.	Rybitwa białoczelna/ Little tern	<i>Sterna albifrons</i>	II	W	VSB	-0,5	The species' nesting population numbers are subject to significant fluctuations. It is at least partially related to the extent and duration of flooding in the valleys of larger rivers constituting the major habitat of the species.
84.	Rybitwa białoskrzydła/ White-winged black tern	<i>Chlidonias leucopterus</i>	II	W	VSB	+0,5	The species is distributed mainly across Eastern Europe. It is showing slight expansion to the west, which could be caused by climatic factors. The nesting population numbers of the species in Poland are subject to significant fluctuations. It is at least partially related to the extent and duration of flooding in the valleys of larger rivers constituting the major habitat of the species.
85.	Rybitwa czarna/ Black tern	<i>Chlidonias niger</i>	II	W	SB	-0,5	The species' nesting population numbers are subject to significant fluctuations. It is at least partially related to the extent and duration of flooding in the valleys of larger rivers constituting the major habitat of the species.
86.	Rybitwa czubata/ Sandwich tern	<i>Sterna sandvicensis</i>	II	W	MB	0	The species is irregularly nesting in Poland on sanbanks in the Vistula River mouth and in the Puck Bay. Its nesting population numbers are subject to significant fluctuations. There is no data available on the effect of climatic factors on population of the species.
87.	Rybitwa rzeczna/ Common tern	<i>Sterna hirundo</i>	II	W	SB	0	The species' nesting population numbers are subject to significant fluctuations. It is at least partially related to the extent and duration of flooding in the valleys of larger rivers constituting the major habitat of the species.
88.	Rybołów/ Osprey	<i>Pandion haliaetus</i>	II	W, F	ESB	-0,5	The species is distributed mainly across North-Eastern Europe. Poland is situated on the edge of its natural range.

No	Vernacular name	Latin name	Species listed in the CMS Annex No	Habitat type to which a species is bound	Breeding category	Trend of population	Comments
							The decreasing nesting population of the species in Poland is probably connected with the shift of its range to north-east under the influence of the climate factors.
89.	Rycyk/ Black-tailed godwit	<i>Limosa limosa</i>	II	W	SB	-1	The species is distributed mainly across Eastern Europe. Some influence on its nesting populations in Poland could have the extent and duration of flooding in the valleys of larger rivers constituting the major habitat of the species. However the main cause of the decrease of its Polish population is the anthropogenic changes in the river valleys.
90.	Samotnik/ Green sandpiper	<i>Tringa ochropus</i>	II	F, W	SB	0	The species is distributed mainly across North-Western Europe. The mild winters favour more often wintering of the species in Poland observed in the recent years.
91.	Sieweczka obrożna/ Ringed plover	<i>Charadrius hiaticula</i>	II	W	VSB	0	The species is distributed mainly across Northern Europe. The species' nesting population numbers in Poland are subject to significant fluctuations. It is at least partially related to the extent and duration of flooding in the valleys of larger rivers constituting the major habitat of the species.
92.	Sieweczka rzeczna/ Little plover	<i>Charadrius dubius</i>	II	W	SB	+1	The species' nesting population numbers in Poland are subject to significant fluctuations. It is at least partially related to the extent and duration of flooding in the valleys of larger rivers constituting the major habitat of the species.
93.	Słonka/ Woodcock	<i>Scolopax rusticola</i>	II	W,F	SB	0	There is no data available on the effect of climatic factors on population of the species.
94.	Słownik rdzawy/ Nightingale	<i>Luscinia megarhynchos</i>	II	F	MB	+0,5	The species is distributed mainly across South-Western and Southern Europe. Poland is located on the edge of its natural range. The slight expansion of the species to North-East could be connected with shifting of its range in Europe as the result of climate warming. Now the species is arriving at his nesting areas in Poland 7 days earlier the 20-25 years ago which most probably is another effect of

No	Vernacular name	Latin name	Species listed in the CMS Annex No	Habitat type to which a species is bound	Breeding category	Trend of population	Comments
							climate warming.
95.	Słownik szary/ Thrush nightingale	<i>Luscinia luscinia</i>	II	F	MB	-0,5	The species is distributed mainly across North-Eastern Europe. The decrease of its range and population numbers in Poland could be connected with shifting of its range in Europe to North-East as the result of climate warming.
96.	Sokół wędrowny/ Peregrine falcon	<i>Falco peregrinus</i>	II	O	ESB	+1	The Polish population of this species is partly non-migrating. Their number in Poland is slightly increasing mainly due to the implemented reintroduction programme.
97.	Strumieniówka/ River warbler	<i>Locustella fluviatilis</i>	II	F	SB	0	There is no data available on the effect of climatic factors on population of the species.
98.	Szablodziób/Avocet	<i>Recurvirostra avosetta</i>	II	W	MB	The species started irregularly nesting in Poland after 1994.	The species is distributed mainly across Western Europe and the Mediterranean Basin. More often breeding in Poland in the recent years could be connected with climate warming and shifting of the range of the species to the north-east.
99.	Szczudlak/ Black-winged stilt	<i>Himantopus himantopus</i>	II	W	SPB	The species started irregularly nesting in Poland after 1998.	The species is distributed mainly across Southern Europe and the Mediterranean Basin. More often breeding in Poland in recent years could be connected with climate warming and shifting of the range of the species to the north.
100.	Szlachar/ Red-breasted merganser	<i>Mergus serrator</i>	II	W	VSB	-1	The species is distributed mainly across Northern Europe and the Mediterranean Basin. The decrease of its nesting population in Poland in the recent years is the result of shifting of its natural range boundary to the north which is most probably the effect of climate warming.
101.	Świerszczak/ Grasshopper warbler	<i>Locustella naevia</i>	II	W	SB	0	There is no data available on the effect of climatic factors on population of the species.
102.	Świstun/ Wigeon	<i>Anas penelope</i>	II	W	FB	The species has not been found to nest in Poland at least over a dozen or so years.	The species is distributed mainly across Northern Europe and the Mediterranean Basin. The decrease of its nesting population in Poland observed during the recent several dozen years is the result of shifting of its natural range boundary to the north which is most probably the effect of climate warming.
103.	Świstunka leśna/ Wood warbler	<i>Phylloscopus sibilatrix</i>	II	F	AB	0	There is no data available on the effect of climatic factors on population of the species.

No	Vernacular name	Latin name	Species listed in the CMS Annex No	Habitat type to which a species is bound	Breeding category	Trend of population	Comments
104.	Trzciniak/ Great reed warbler	<i>Acrocephalus arundinaceus</i>	II	W	SB	1	During the last 40 years the species started breeding in Poland progressively earlier and their breeding season is now much longer increasing re-nesting opportunities. It was shown to be positively correlated with increasing May–July mean temperature.
105.	Trzcinniczek/ Reed warbler	<i>Acrocephalus scirpaeus</i>	II	W	MB	-0,5	During the last 40 years the species started breeding in Poland progressively earlier and their breeding season is now much longer increasing re-nesting opportunities. It seems to be an adaptation to climate warming.
106.	Trzmielojad/ Honey buzzard	<i>Pernis apivorus</i>	II	F	VSB	0	There is no data available on the effect of climatic factors on population of the species.
107.	Turkawka/ Turtle dove	<i>Streptopelia turtur</i>	II	F	MB	-0,5	There is no data available to link changes in population of the species with climatic factors.
108.	Wodniczka/ Aquatic warbler	<i>Acrocephalus paludicola</i>	O	W	VSB	-0,5	The boundary of the range of the species is shifting in Poland to the east which is mainly connected with the drainage of its habitats. The observed fluctuations of nesting population numbers in Poland are connected among others with the amount of the precipitation. One of the causes of the decreasing of the species population in Poland and Europe are the disturbances in its wintering places in West Africa as the result of drought and turning wetlands into the arable areas.
109.	Wójcik/ Greenish warbler	<i>Phylloscopus trochiloides</i>	II	F	SPB	The species is breeding in Poland since 1958 and it is inhabiting only the northern part of the country.	The species is distributed mainly across Eastern Europe. For several dozen years it has been showing moderate expansion to the west. There is no data available on the effect of climatic factors on population of the species.
110.	Zaganiacz/ Icterin warbler	<i>Hippolaris icterina</i>	II	F	MB	-0,5	There is no data available to link changes in population of the species with climatic factors.
111.	Zielonka/ Little crane	<i>Porzana parva</i>	II	W	VSB	0	The size of breeding population is undergoing considerable fluctuations.
112.	Zniczek/ Firecrest	<i>Regulus</i>	II	F	SB	+1	West European species. Its number in the

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		<i>atricapillus</i>					country is increasing, but it seems not to have any connection with climate change.
113.	Żółta/ Bee-eater	<i>Merops apiaster</i>	II	A, O	ESB	+0,5	This south European species increasing its number and range in Poland which very likely is the effect of climate warming.
114.	Żuraw/ Crane	<i>Grus grus</i>	II	W	SB	+1	One of the reasons of strong increase of population number of this species in Poland and Europe over last several decades is the much longer period of food availability due to warmer winters and shorter period of snow cover. Climate warming causes also the acceleration of arrival of the species to the breeding places and delay of the flight time to the wintering places as well as more frequent wintering attempts.

Captions:

Categories of species depending on their attachment to habitat types:

- W: wetland species
- F: forest species
- A: species bound to agricultural landscape
- S: synanthropic species
- M: species bound to mountain habitats
- O: species bound to other specific habitats

Categories of breeding population numbers (according to Tomiałojć and Stawarczyk 2003, modified)

- FB: formerly breeding – species that had been breeding in Poland over the last 50 years but is no longer found as a breeding bird
- EB: exceptionally breeding – single broods were exceptionally found over the last 50 years
- SPB: sporadically breeding – single broods had only irregularly been found over the last 50 years
- ESB: extremely scarcely breeding - size of the country-wide breeding population: 1–300 pairs
- VSB: very scarcely breeding – size of the country-wide breeding population: 300–3,000 pairs
- SB: scarcely breeding - size of the country-wide breeding population: 3,000–30,000 pairs
- MB: species of medium size of breeding population – size of the country-wide breeding population: 3,000–300,000 pairs
- AB: abundantly breeding – size of the country-wide breeding population: 300,000 – 3,000,000 pairs

Population trends (according to Kornatowska et al. 2010):

- 1: clear drop in the breeding population size
- 0.5: lower or less pronounced drop in the breeding population size
- 0: stable breeding population or population fluctuating with no clear trend or lack of sufficient data to determine the population trend
- +1: distinct increase in the breeding population size
- +0.5: lower or less pronounced increase in the breeding population size.

Table 2. Types of bird species reaction to changing climatic factors

Groups of migratory bird species according to their response to climatic factors in Poland	Number of species	Percent share of species
Species which shift their ranges in Europe and in Poland to the north or north-east due to climate warming, include:	27	23.7%
North and north-eastern species decreasing their numbers and ranges or those that are no longer found nesting in this country	14	12.3%
Southern species increasing their numbers and ranges or those which started to nest in Poland	13	11.4%
Species whose populations (fluctuations, drop in numbers) are affected by climatic factors (precipitation volume, duration and extent of spring flooding in river valleys, groundwater level, habitat desiccation).	15	13.2%
Species decreasing their numbers owing to negative effects of climatic changes encountered outside the Polish borders, on migration routes or in wintering grounds	6	5.0%
Species arriving earlier at breeding sites or those which start their breeding season earlier due to climate warming	7	6.0%
Species increasing their wintering frequency and wintering population numbers owing to ever more frequent occurrence of mild winters	16	14.0%
Species for which there is no data on the effect of climatic factors on their populations	47	41.2%

Concluding remarks

Based on the analysis of information on migratory birds nesting in Poland (Table 1) it was demonstrated that climatic factors affect populations, numbers and ranges of as many as 67, or 58.8 per cent of the total number of the examined species. There was no such data for only 48 species (41.2 per cent) what mostly results from the lack of sufficient knowledge and does not mean that the species remain neutral to climatic factors.

The most visible effect of climatic changes on the populations of breeding birds is the shift of their ranges. In Europe, some breeding birds shift their ranges to the north and north-east owing to the advancing warming of climate. In Poland, as a result of this trend, some species bound to a more severe climate would shift their ranges (nesting areas) to the north, north-east or east – beyond the country's borders, or would decrease their ranges and numbers. On the other hand, we are witnessing in this country the appearance of new warmth-loving species from southern Europe, or an increase in their numbers and ranges. The latter was observed in the case of 27 (23.7 per cent) of the species examined.

Ten bird species or more than 10 per cent of the total number of species under analysis disappeared from the Polish breeding avifauna over the period analyzed. As many as seven species out of that group (ruff, jack snipe, dunlin, wood sandpiper, dotterel, pintail and wigeon), which are distributed mainly across northern or north-eastern Europe and bound to a more severe and cold climate, were observed to shift their ranges to the north or north-east outside the borders of Poland. This, according to a specialist opinion, is attributed to climate warming or in other words, the influence of climate change is considered as most likely to be involved in the process. A further species species having north or north-eastern distributions decreased their numbers and ranges in Poland. Thus the joint number of species with north-and/or north-eastern distributions which decreased their numbers and ranges, or were no longer found nesting in Poland, attains 14 which constitutes 12.3 per cent of the total number of analyzed species.

At the same time, nine new breeding species appeared on the Polish avifauna. As many as six of them (great white egret, red heron, red-crested pochard, Saker falcon, avocet and black-winged stilt), which are mainly distributed across southern or southeastern Europe, are expanding their ranges to the north as a result of climate warming. However, except for the great white egret whose populations show a permanent and marked expansion, it is hard to

predict how sustainable will be the expansion of other birds, their populations being at present not very numerous and stable. Seven other species of southern distribution increased their ranges and/or numbers in Poland, thus the joint number of southern species whose numbers and ranges increased or those which started nesting in this country attains 13, what constitutes 11.4 per cent of the total number of the species examined.

Another more distinct effect of climate change on bird populations in Poland is expressed as changes in population numbers of birds breeding in specific habitats in response to variability of climatic (weather) factors. It concerns, in particular, the species which nest in wide river valleys or in other temporarily flooded wetlands. The breeding success of this species group depends to a high degree on the extent and duration of spring inundations in river valleys as well as on the extent of habitat waterlogging and depth of ground water level, which in turn depends mainly on the volume and intensity of spring precipitation as well as on the thickness and duration of snow pack. Owing to a great variability of the latter factors, the numbers of breeding bird populations are subject to significant fluctuations. The above group embracing 15 species (13.2 per cent) covers mostly those birds which nest in river valleys adjacent to river beds or on flooded terraces. These include mainly terns (their breeding populations show highest fluctuation in numbers), plovers as well as some species of ducks.

One of the most distinct features of climate change, under conditions prevailing in Europe, is a relatively high rise in the mean temperature of winter months over the last several decades. That is why many species of migratory birds increasingly undertake successful attempts of wintering in this country or shorten their seasonal migration routes (e.g. instead of flying to Africa they may migrate to southern or western Europe only, or just from the eastern to western part of Poland). In the examined group of breeding birds there are 16 species (14.0 per cent), whose numbers and/or frequency of appearance in wintering grounds in Poland over the last several decades increased markedly (they include mainly anseriforms and birds of prey), though the increase in frequency of appearance of smaller or larger groups or single birds in wintering sites was observed, in principle, in almost all of the species examined.

Among some less known effects of climate induced changes in the nesting bird population in Poland is the decrease in populations of some species migrating over large distances due to climate-induced changes in habitats on migration routes or in wintering sites in Africa (deterioration of habitats due to prolonged droughts). Such a negative effect was observed up to now for 6 (5.3 per cent) of the species examined, including ruff, little bittern, white stork, redstart, roller and aquatic warbler, but the problem is not limited to the above species and requires a further in-depth study.

There is also some knowledge of other undoubted effects of climate-induced changes in breeding bird populations in Poland, though at the moment the detailed documentary information on the above effect is scarce and available only for seven species (6.1 per cent). Such effects cover, among other things, an earlier arrival at breeding grounds, as is the case with e.g. lapwing, blackcap, chiffchaff and nightingale as well as of an earlier start of breeding season (great reed warbler, reed warbler), along with the delay in departure to wintering sites.

The most important effects of climatic changes on migratory populations of birds nesting in Poland are summarized below.

The most important effects of climatic changes on migratory populations of birds in Poland

1. Changes in numbers and species composition of birds breeding in Poland: seven species disappeared and six species appeared on the Polish breeding avifauna due to the impact of climatic factors over the last half a century.
2. Changes in population numbers of domestic breeding species.
3. Changes in distribution of domestic breeding species (in general – shifts of ranges to the north and north-east).
4. Changes in the number of southern breeding species bound to warmer climate, such as great white egret, bee-eater, or stonechat) and in northern and/or north-eastern species, bound to colder climate, such as wood sandpiper, dotterel, jack snipe, pintail and wigeon) including changes in population numbers and ranges.
5. Changes in breeding populations of species migrating on large distances and facing negative effects of climatic changes during migration.
6. Changes in breeding populations of birds wintering in regions particularly exposed to climate change induced negative effects, as e.g. little bittern, roller and redstart.
7. Changes in numbers and distribution of breeding bird populations bound to definite habitat types, as for example with forests (where bird population numbers are increasing, in general) and with wetlands and agricultural landscapes (where population numbers are decreasing in general).
8. Changes in numbers and distribution of breeding populations of birds which belong to certain taxonomic groups (e.g. in general - the increase in birds of prey and owls and the decrease in plovers).
9. Changes in numbers and distribution of breeding populations of birds bound to habitats especially vulnerable to climate change, such as wetlands and river valleys.
10. Changes in time of spring arrival to breeding sites (in general – earlier) and autumn departures to wintering sites (in general – delay), e.g. white stork has recently been arriving in Poland, on average, about 10 days earlier than 30 years ago.
11. Changes in time when species start their breeding season (in general - earlier) e.g. great reed warbler, reed warbler.
12. Changes in number of species wintering within the country as well as in the numbers of wintering populations (in general – the increase in species number and population numbers of mainly anseriforms and birds of prey).
13. Changes in population numbers of specialized species which feed on a particular type of forage, the availability and abundance whereof depends on climatic conditions (e.g. insectivorous species or predatory birds and owls feeding on rodents).
14. Changes and fluctuations in population numbers as well as in the period of commencing their breeding season - in some species nesting in river valleys (as e.g. species of terns and plovers), which depend on the extent and duration of spring flooding and river freshets.
15. Changes in migration routes and their length as well as in wintering sites (a group of the species which traditionally used to migrate to the wintering sites in Africa, may presently winter in the European part of the Mediterranean Basin or in Western Europe thus shortening significantly their migration routes).