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Results of the Pan-European census of wintering Great Cormorants in Europe, January 2003

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Introduction

The development and strong increase in breeding pairs of the Great Cormorant race *Phalacrocorax carbo sinensis* during the 1980s and 1990s is well documented (van Eerden *et al*. 1995, Marion 1997, Trolliet 1999) due to regular national censuses of colonies in the continental core breeding areas (cf. Bregnballe *et al*. 2003, Marion 1997, 2003a, Martincova & Musil 2003, Mellin & Mirowska-Ibron 2003, Røv *et al*. 2003).

In contrast, only scattered information exists about the number and distribution of the migrating and wintering population of Great Cormorants in Europe. So far published estimates for the North-West and Central European population showed a great range: for example estimated numbers for 1995 varied between 440,000 (Marion 1997) and 700,000 Cormorants (Veldkamp 1996) while Trolliet (1999) calculated 805,000 to 1,150,000 Cormorants wintering in whole Europe (including Russia and Iceland) by multiplying the number of known European breeders by the factor 3.5 to 5.

To improve this situation, the Wetlands International Cormorant Research Group (CRG) decided to organise a Pan-European census. The aim was to get a better picture about the actual population size and distribution of wintering cormorants in Europe. Besides obtaining national records in a coordinated and standardised way, the surplus of the action is seen in the possibility of data aggregation on a higher level, taking into account the mobility of migrating birds due to environmental conditions. Migration over the continent is mainly driven by climatic factors (low temperature, freezing of surface waters) and accessibility / availability of food. The plan to count all cormorant night roosts simultaneously (inland and sea coasts) in all European countries and North Africa was scheduled for mid January 2003.

Preliminary results of the census have been presented already at the CRG meeting in Odessa in 2003 (Marion & Parz-Gollner 2003). After finalizing data collection decision was made to present the full result of the 2003 European Census in the proceedings of the Wetland International Cormorant Research Group meeting held at Villeneuve, Switzerland, in 2005.

Methods

Standard waterbird counts – well established in the European birdwatching community to collect bird-census-data in wetland habitats - normally are conducted during the daytime. This counting scheme is not so appropriate when assessing the total numbers of Great Cormorants in a specific region during the winter or the migration period. This is because the birds frequently move between foraging and loafing sites during their daily activities and there is a strong risk of either missing birds or double-counting individuals. This applies especially in areas with a lot of scattered waterbodies or along smaller river sections which are difficult to overview. As a result of these inaccuracies and depending on the amount and type of waterbodies controlled, it has also been calculated that counting Great Cormorants using the standard waterbird count technique could underestimate regional numbers of birds and that this counting error would vary greatly according to specific local situations (e.g. Jackson *et al*. 2006, Worden *et al*. 2004).

To get an accurate count of wintering cormorants one can take advantage of the communal roosting habit of the species. In practice, this means that coordinated cormorant counts should best be made by controlling roost sites simultaneously either at dawn or, (better) in the late afternoon, starting a few hours before dusk and counting all incoming birds.

Coordination of counting date

For summing up data collected on a national level to get a Pan European census-result the harmonisation of a specific counting date was essential. Ideally all counts should take place on a specific weekend (option of an alternate date within a week only).

Two European coordinators have been named to be responsible for building up contacts and giving advice to national coordinators (Coordinator for North- and Western Europe and North Africa: Loïc Marion; coordinator for Central- and Eastern Europe: Rosemarie Parz-Gollner).
The delimitation of these two areas (Figure 1) was not only chosen for practical reasons but globally corresponds to the two main migrating routes of Cormorants: the western European flyway up to or crossing France and partly Italy to the Mediterranean and the central European flyway via and to the Balkan countries, the Black Sea and beyond. Germany was entirely attributed to Central Europe for commodities in spite of the fact that part of its Cormorants migrate via France or Italy. Part of the birds from Denmark also migrates through central Europe. Countries of former USSR (except Kaliningrad on the Baltic sea) and Turkey have been excluded, because they receive very small number of wintering birds from Western or Central Europe and their own breeding population migrates out of the studied area (Middle East up to Egypt). Iceland and Greenland have not been taken into account as well due to their largely non-migratory status. Available data for these areas have been evaluated in a wider context in the Working Group-1 report of the EU-project INTERCAFE (Carss & Marzano 2012 in prep.).

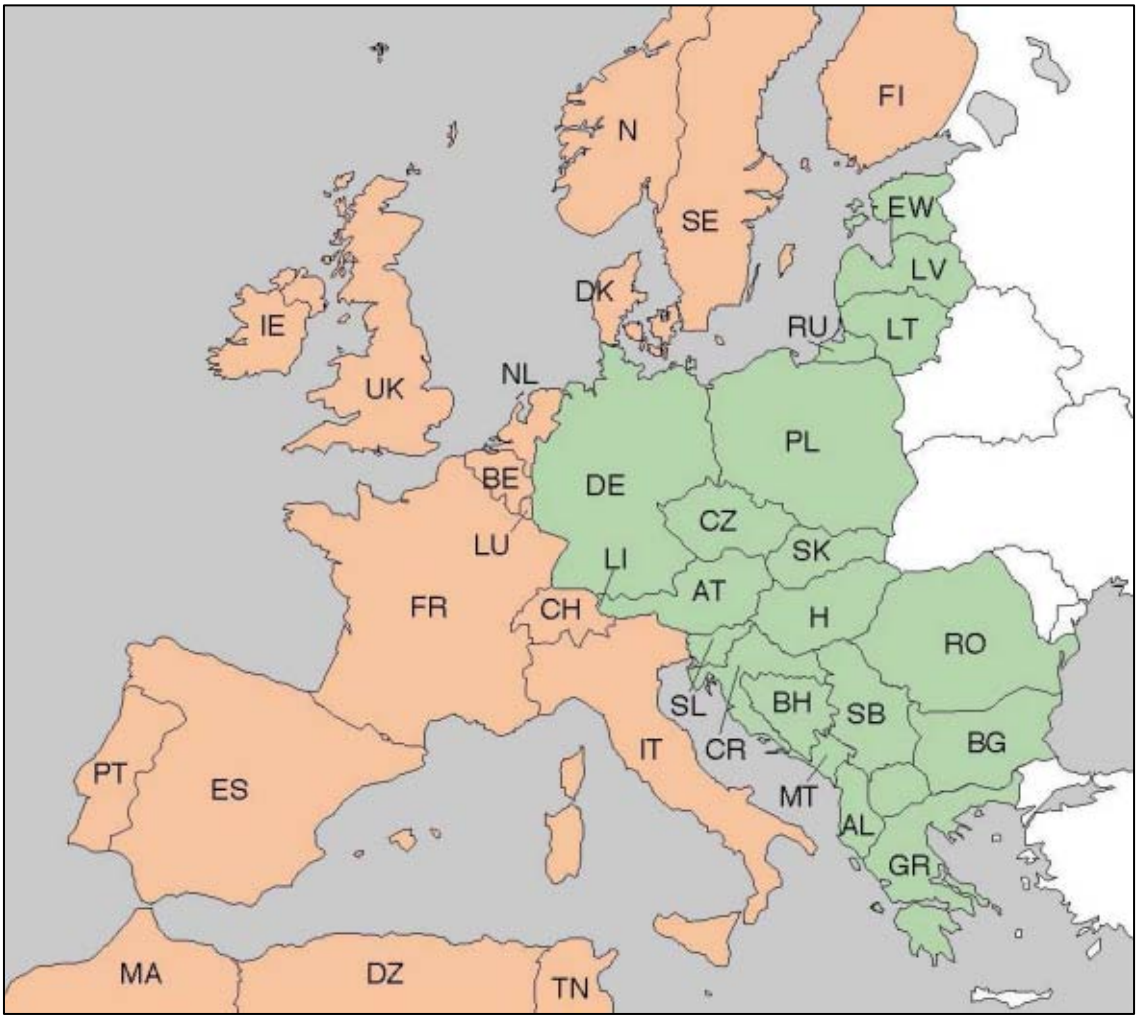

Fig. 1 *Division of Europe in a Northwestern-Atlantic/western Mediterranean part (red) and Central/Eastern European countries (green); for country codes see also Tab.1, Tab.2.*

A national coordinator in every country was named to organise a national counting team (Tab.1). On a national level all relevant roost sites were listed with corresponding geographical coordinates. At least one person for every location or roost site was needed to count Cormorants because all sites in the country should be controlled simultaneously on one specific counting date.

Data collection
Ideally each roost count was reported on standard forms indicating the name and the coordinates of the site, time and duration of the count and the name of the observer. Additional information about type of

roost, activity of the birds, environmental parameters and accuracy of counting has also been recorded where possible.
To harmonise data collection a counting form was designed and together with advisory notes distributed over the CRG-website. In some countries forms had to be translated to the national languages by the help of national coordinators. In some countries already existing counting schemes were only slightly modified or could be perpetuated.

Data aggregation
Data collection and summing up of counting results in every country on a national level was made by the national coordinators. In a second step the total number of wintering Great Cormorants and the national map of distribution of the roosts was addressed via the national coordinator to the two European coordinators, who finally were responsible to get to the level of the European synthesis. In case of roost sites being located on borderlines between two neighbouring countries, it was in the responsibility of the European coordinator to take care of the correct allocation of Cormorant numbers with respect to a Pan-European synthesis (e.g. island Karsibor / Stettiner Haff bordering Poland and Germany, Lake Constance bordering Switzerland, Austria and Germany or various sites along the Danube in Eastern countries etc.).

It was agreed, that only counting results from the specific year 2003 should be taken for the overall synthesis. In case of missing data, best estimates about Cormorant numbers approved by national coordinators have been given or data from literature were cited.
Additional support was kindly given by IWC handing over results of cormorant numbers stored in the IWC central database at Wetlands International for January 2003 (Simon Delany, pers. comm.).

Data classification for synthesis (accuracy 0-4)
In general final results per country were classified depending on the quality of data available. In a stepwise process data aggregation for every country was made in the following way (Tab.2):
(4) RC = result based on **roost counts** on a national level; all/most known sites in the country have been controlled; figures include also a certain rate (%) accounting for individuals missing; results are given and confirmed by national coordinators.
(3) RC+ = result of **roost counts plus best estimate** (including partly day-counts) given by national coordinator for sites missing on a national level; results are confirmed by national coordinators.
(2) IWC = International waterbird counts, based on **day-counts**; in case no roost count data at all could be obtained, the results of IWC were taken and presented here as a result on a national level; however, preferably results were obtained by consulting the responsible IWC national coordinator directly.
(1) Pers. comm. or **Lit**. = if countries could not participate in the census, given estimates for the number of cormorants via personal contacts or references to published data were used
(0) = no recent data available, only rough estimate.

Data presentation
Several countries have published results of the count at the national level. In this publication we have worked out the distribution of the species first at a country level, showing the big picture across Europe. Roost counts were merged on to the level of 50x50 km squares, thus showing the overall pattern of distribution.

Weather conditions
In January 2003 the weather in many parts of Europe was characterised by extreme cold, long lasting temperatures below zero and lots of ice and snow cover all over central and Eastern Europe. The majority of stillwater bodies in middle and eastern Europe and even the Danube delta was frozen over several weeks lasting until mid January. Especially counting teams in eastern countries had to bear the challenge doing fieldwork under these extreme weather conditions. As a result of these severe winter conditions a significant shift southward in the distribution pattern of wintering cormorants over the continent could be observed.

Participating countries, counting teams
Beside national coordinators named in the list below hundreds of volunteers participated in this action doing the fieldwork. Without their highly appreciated engagement this census would not have been possible! We want to thank all the members of the counting teams for joining the project and for their contribution to the data collection. Altogether about 3000 roosts were counted and ca 3500 people were actively involved in the counting which involved 38 countries all in all.

Tab. 1 *National coordinators of the Pan-European Cormorant winter census, January 2003*

North-West Europe and North Africa *(coordinator: Loïc Marion)*

Code	Country	National coordinator	Organisation
FI	Finland	T. Asanti	Finnish Environmental Inst. SYKE
DK	Denmark	T.Bregnballe, J. Sterup	NERI
NL	The Netherlands	S. van Rijn, J. Nienhuis	Rijkswaterstaat RIZA, SOVON
BE	Belgium	J.Y. Paquet, K. Devos	Centr. Ornith. (Aves) & Inst. Natuurbehoud
LU	Luxembourg	R. Poess	Eco Top
UK	United Kingdom	P. Cranswick	Wildfowl & Wetlands Trust (WWT)
FR	France	L. Marion	University of Rennes CNRS-SESLG
CH	Switzerland	V. Keller	Swiss Ornithological Inst. Sempach
IT	Italy	S. Volponi	University of Ferrara INFS
ES	Spain	J.C. del Moral	Ornithological Spanish for Ornithology (SEO)
PT	Portugal	P. Mota	Portuguese Nature Conservation Inst.
TN	Tunisia	M. Azafzaf	Tunisian Group for Ornithology (GTO)
N	Norway	N. Rov	Norwegian Inst. for Nature Research
SE	Sweden	L. Nilsson	Ecology Center Lund, Swedish WI waterfowl
IE	Ireland		Data from literature
MA	Morocco	P. Isenmann	Data from literature or pers. comm.
DZ	Algeria	M. Smart	Data from literature or pers. comm.
LY	Libya	M. Smart	Data from literature or pers. comm.

Central- and Eastern Europe *(coordinator: R. Parz-Gollner)*

Code	Country	National coordinator	Organisation
EW	Estonia	V. Lilleleht, L. Luigujoe	Estonian Ornithological Society
LV	Latvia	J. Baumanis	Lab. of Ornithology, Inst. of Biology
LT	Lithuania	L. Lozys, R. Zydelis	Institute of Ecology of Vilnius University
RU	Kaliningrad	G. & D.Grishanov, I. Nigmatoullinne	BirdLife Kaliningrad
PL	Poland	S. Bzoma, R. Gwiazda	Dep. of Fish Resource, Gdynia; Polish Academy of Sciences
CZ	Czech Republic	R. Martincova, P. Musil	Czech Environmental Insp.; Charles University, Prague
SK	Slovakia	Josef Ridzon	BirdLife Slovakia
DE	Germany	T. Keller, J. Wahl	DDA, Dachverband Deutscher Avifaunisten
AT	Austria	R. Parz-Gollner	Univ.of.Life Sciences BOKU Vienna
FL	Liechtenstein	G. Willi	RENAT, Liechtenstein
H	Hungary	S. Farago	West Hungarian University of Sopron
SL	Slovenia	B. Stumberger	DOPS Bird Life Slovenia
BH	Bosnia Herzeg.	I. Dervovic	Data from literature /2005
CR	Croatia	T. Mikuska, M. Schneider-Jacoby	Nature Park Kopacki Rit, Euro Natur
SB	Serbia	M. Tucakov, D. Barjaktarov	Natural History Museum, Belgrade
MT	Montenegro	D. Barjaktarov	Natural History Museum, Belgrade
AL	Albania		Data from literature
RO	Romania	B. Kiss	Danube Delta Institute, Tulcea
BU	Bulgaria	I. Nikolov, S. Dalakchieva	Bulgarian Ornithological Centre
GR	Greece	V. Liordos, S. Kazantzidis	Megara Forest Service

Results

North-western Europe and North Africa
In this part of Europe the total number of Cormorants in January 2003 was estimated at 396 400 that is 72% of the wintering Great Cormorants in Europe and North Africa at that moment (Table 2). The traditional marine area of *Phalacrocorax carbo carbo* has been poorly covered (only a rough estimate derived from the number of breeders in Norway, a partial count of night roosts in Great Britain and estimates from day counts in feeding areas in Northern Ireland and Ireland). The wintering populations of these countries originate essentially from their local breeding populations (only little migration from continental Europe in eastern England), and these breeding populations are considered much less migratory than the continental subspecies *Ph. c. sinensis* (e.g. Marion 1997).

The wintering area of the continental subspecies *sinensis* has been well covered in its southern part, particularly in the two most important European countries in winter, France and Spain, which totalled 41% of the birds and 77% of all roosts counted in 2003 in Northwest Europe and North Africa.
The third most important country for the wintering of continental subspecies, Italy, was only partially counted but best number for the wintering population was estimated as accurate as possible (S. Volponi pers.com.). Contrary to the northern countries, these southern countries have only a very small breeding population (3500 pairs in France in 2003, Marion 2003a, 900 pairs in Italy in 1999, Volponi & Addis 2003, 42 pairs in Spain, Lekuona 2003), and most of their wintering Cormorants came from northern countries, particularly from Denmark, The Netherlands, Germany, Poland and Sweden.

The other Northwest continental countries are holding much smaller wintering populations of *Ph. c. sinensis* and, with the exception of Belgium, Switzerland and Luxembourg were only partially covered by roost site counts. So including the given estimates for this area the wintering populations has been roughly estimated to 42,000 Cormorants in the present synthesis.
In North Africa, the wintering population was small in Morocco and Libya, largely decreasing in Tunisia, and no actual data from Algeria could be obtained. All together a maximum of 19,400 Cormorants for this region has been estimated.

In total 396,400 cormorants have been summarized from counts plus given estimates for the North-West Europe and North African wintering area and more likely less if we consider that some countries may have been overestimated (e.g. Portugal, Tunisia).

Central and (south)-eastern Europe
In this part of Europe the total number of Cormorants was estimated at 152,200 (Table 2). This corresponds to 28% of the wintering Great Cormorants in Europe and North Africa in January 2003. The most important countries harbouring more than 10,000 Cormorants in this area were Germany (38,000), Poland (15,000), Croatia (11,000), Bulgaria (14,000) and Greece (23,500).

Due to a serious cold spell, many inland waters in Eastern Europe were completely frozen over, which led to the complete leave of wintering Cormorants. Only near large open water bodies as were found locally in the eastern Baltic, along the Black Sea and parts of the lower Danube foraging waters were left partially open. The majority of inland waters that is almost all lakes, slow flowing rivers and shallow stretches of coastal waters were entirely frozen over. In the north-eastern part of the wintering range this was particularly apparent by very few birds present in the Estonia, Latvia, Lithuania and Kaliningrad (240). More to the south mainly riverine habitat was used by Cormorants wintering in Czech Republic (7600), Slovakia (6000), Slovenia (4000), Austria (3500), and Romania (5000). In the latter country only the area south of Danube delta was free of ice.

The upstream and midstream parts of the Danube and its tributaries were used by a relatively large number of Cormorants as well (> 35,000), although not directly obvious if one considers the country totals. However, numbers in these countries have to be considered with caution as they were only partially counted (Bosnia Herzegovina, Croatia, Serbia, Montenegro) or not counted at all (Albania).

In this part of Europe all subspecies are believed to be of one origin, that of the continental subspecies *sinensis* (Marion & Le Gentil 2006).

Tab. 2 *Number of wintering cormorants in Europe and North Africa in January 2003. Presented per country are the overall number, subspecies involved and accuracy level of the counts*

code	country	number	subspecies	accuracy	remarks
N	Norway	70000	cc	1	estimate from breeders only
UK	United Kingdom	23000	cs cc	3	partial night roosts counts + day counts + estimate
IE	Ireland	4880	cc	2	estimate from day counts
SE	Sweden (south)	3000	cs	2	counted night roosts + estimate
FI	Finland	3040	cs	3	counted in small area available
DK	Denmark	12000	cs	2	extensive ice cover, partial count +estimate
NL	The Netherlands	16400	cs	3	partial count in 2003 + estimate
BE	Belgium	9005	cs	4	night roost count
LU	Luxembourg	237	cs	4	night roost count
FR	France	89261	cs cc	4	night roost count
CH	Switzerland	4200	cs	4	night roost count
IT	Italy	55000	cs	3	day count + night roost count
ES	Spain	75000	cs cc	4	about 90% of the night roosts counted
PT	Portugal	12000	cs cc	2	incomplete count, estimate partly from 1995
MA	Morocco	700	cs	2	estimate from 1996-2000 IWC counts in feeding areas
DZ	Algeria	5000	cs	0	no data since 1990, roughly estimated
TN	Tunisia	12500	cs	2	rough estimate from incomplete counts
LY	Lybia	1200	cs	3	estimate day counts in feeding areas
NW Europe & North Africa		**396 423**			
code	country	number	subspecies	accuracy	remarks
EW	Estonia	30	cs	2	coastline counted, severe winter
LV	Latvia	0	cs	2	best estimate by nat. coord., severe winter
LT	Lithuania	10	cs	2	best estimate by nat. coord., severe winter
RU	Russia /Kaliningrad	200	cs	2	coastline counted, severe winter conditions
PL	Poland	15000	cs	4	coast completely counted, ice inland
CZ	Czech Republic	7600	cs	3	counted + eastern part estimate
SK	Slovakia	6000	cs	2	partly counted + estimate
DE	Germany	38000	cs	4	night roost count
AT	Austria	3500	cs	4	night roost count
FL	Liechtenstein	33	cs	4	night roost count (one roost site only)
H	Hungary	2500	cs	4	night roost count
SL	Slovenia	4000	cs	4	night roost count
BH	Bosnia Herzegovina	5000	cs	2	best estimate by national coordinator
CR	Croatia	11000	cs	2	best estimate by national coordinator
SB	Serbia	9300	cs	2	best estimate by national coordinator
MT	Montenegro	3500	cs	2	best estimate by national coordinator
AL	Albania	4000	cs	0	no data, roughly estimated
RO	Romania	5000	cs	3	partly counted + best estimate (iced Delta!)
BG	Bulgaria	14000	cs	3	partly counted + best estimate
GR	Greece	23500	cs	3	partly counted + best estimate
Central / Eastern Europe		**152 173**			
Total Europe & North Africa		**548 596**			

Distribution pattern across Europe

From Fig. 2 it is clear that on a European level the majority of Cormorants are present in winter in the more southern regions, that is France, Spain, Italy and Greece, but with only moderate numbers in northern Africa. This is quite contrasting to the distribution during the breeding season when the largest numbers are found in the countries bordering the North Sea, Baltic Sea as well as the NW Black Sea (Bregnballe *et al*. 2011, this volume).

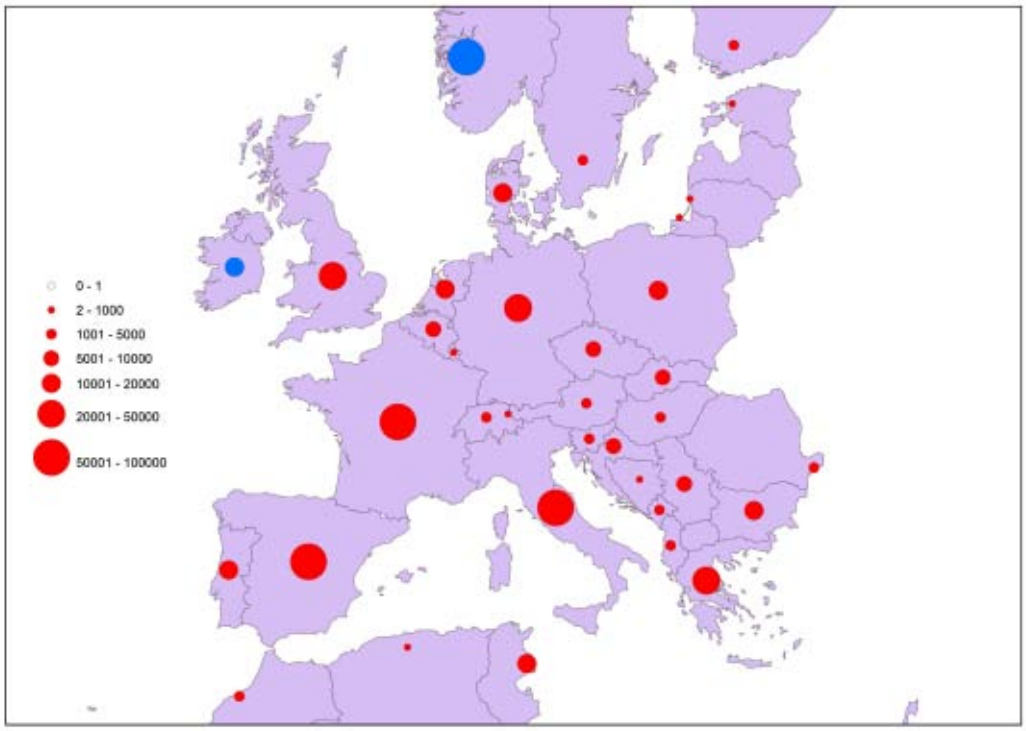

Fig. 2 *Distribution of total number of wintering cormorants per country, according to the data of January 2003 Pan-European count. In blue, countries where only P. c. carbo occurs. For numbers refer to Table 2 and see discussion for extended view on subspecies.*

Figure 3 shows the distribution of the Great Cormorant as a density chart, that is total number per 50x50km square. The pattern is clearer than the country map, as large and small countries do no longer show up in this map, which is not sensitive to any borders. Again the pattern emerges that large parts of France, Spain, Italy but also the Low Countries and central and southern Germany have high densities. The large rivers can easily be detected e.g. Marne, Seine, Loire, Rhône, Rhine, Garonne and Meuse in France/Germany, Ebro, Tagus and Guadiana in Spain/Portugal and the Danube in Eastern Europe. Clearly visible is the gradient in density in Cormorant numbers that runs through Germany, the northern interior parts having far less birds than the southern parts. Larger numbers occur in this region only at the coast in northern Germany, along the East coast of Denmark as well as in some spots in Poland along the Baltic Sea. Noticeable is that the interior parts of Great Britain, especially England has densities similar to the adjacent parts in continental Europe.

Effects of temperature

The effect of low temperatures is a prime factor in determining the Cormorant's winter distribution. Fig. 3 shows the best fit with the long-term average isotherm of January of -5.5^{o}C. Almost 98% of all Cormorants counted during the January 2003 census fell to the warmer side of this limit. At this temperature the on average still or slow running surface waters are largely frozen over. This boundary has been investigated in greater detail and will be explained together with other environmental factors elsewhere (Van Eerden *et al* 2012 in press). See for instance the details of the temperature border and some coastal areas near the Baltic Sea in the region of Gdansk, the Czech Republic, lower Austria and Slovenia. These appear as Cormorant staging sites on the warmer side of this boundary, surrounded by colder and empty areas. Exception is the lower Alpine range of southern Germany, Austria, Slovenia, Italy, Switzerland and France. Also this "mountain effect" is visible in the lower part of Pyrenees and in the Tatra Mountain ranges of Slovakia and southern Poland. Altogether this occurs in about 45 grid cells.

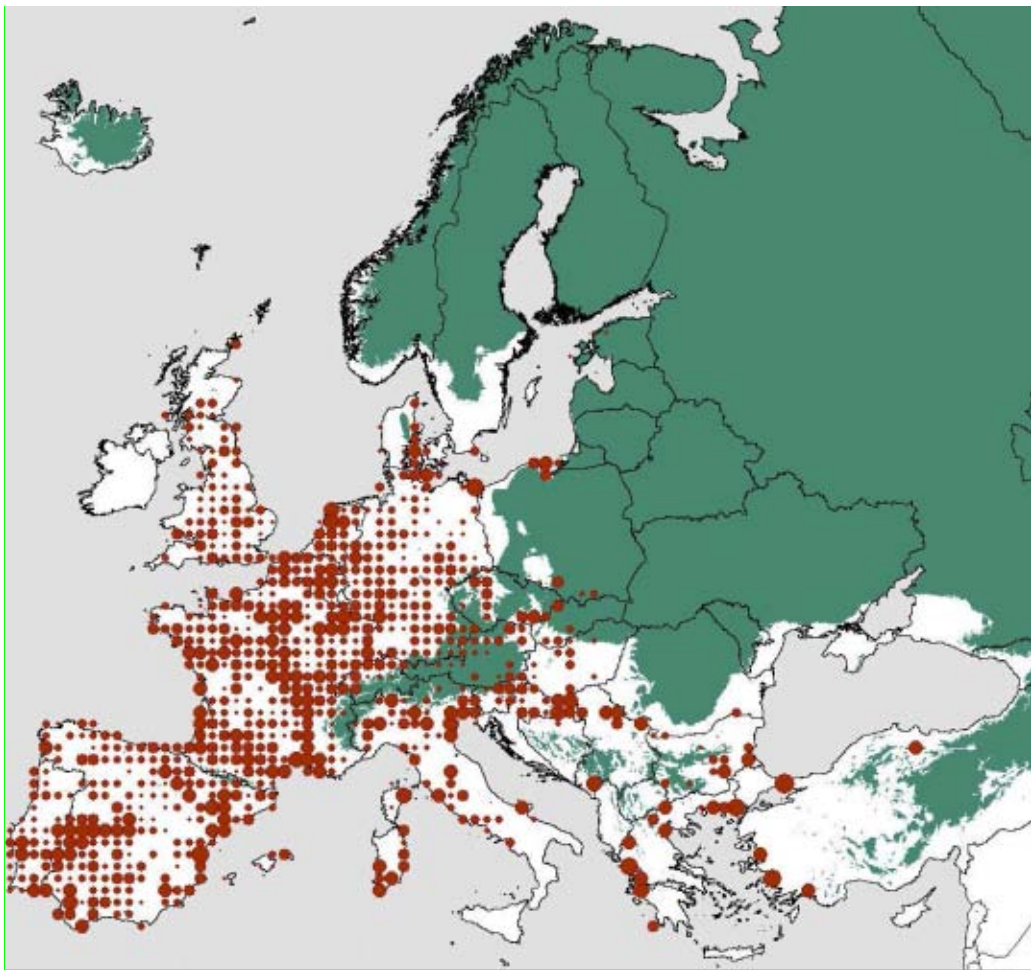

Fig. 3 *Distribution of Cormorants in Europe in January 2003. Only geo-referenced data are shown, thus excluding most carbo birds in Norway, Iceland and Ireland, as well as birds in Ukraine, Russia and parts of Turkey. The green area depicts the average long-term winter temperature of -5.5°C that largely coincides with areas not used by wintering Cormorants.*

Discussion

Accuracy of the count

Because counting of night roosts of Cormorants requires a good organisation and sufficient skilled people it is difficult to achieve when such an investigation is not a tradition. In many countries and when local conditions are severe (climate, marine rocky coasts in *Ph. c. carbo* area), applying this accurate method was a great challenge for all participating countries. However, only a minority of countries could entirely follow these rather strict counting regimes during this first pan European census action. Taking into account additional available data sources (IWC day counts in feeding areas or best estimates by national coordinators), a maximum estimate of about 548,600 Cormorants could be proposed in this part of Europe for January 2003.

If we take into account the increase of breeding population since 1995, particularly in countries where the population recently has extended (Sweden, Germany, southern inland Norway, eastern England, Belgium, France, Italy), while the number of breeders in the core area of pioneering countries was levelling-off (The Netherlands, Denmark), the estimate of about 440,000 wintering Cormorants in 1995 for North-West and Central Europe and North Africa (corrected from Marion 1997 for Norway, overestimated at this time) seems largely more accurate than the theoretical simulation of 700,000 Cormorants (350,000 counted birds x 2) proposed at the same time by Veldkamp (1996), that supported the opinion of Staub (1996) that half of the real population were lacking in the winter counts.. Similarly the calculations of Trolliet (1999) of 805,000-1,150,000 wintering Cormorants in 1995 for the whole of Europe (including Iceland and former USSR), North Africa and Middle East, seems an overestimation by multiplying the number of breeders by 3.5 to 5. If we consider the breeding population of the area studied here, and if we exclude the breeding population of Romania that migrates as the Ukrainian and Russian populations out

of the Black Sea, the breeding population in 1995 was about 160 000 pairs (Marion 1997). By considering a fledging rate of about 1.2 young per nest, a survival rate of 0.65 in the first year, 0.75 in the second year and 0.86 afterwards, the resulting wintering population in January 1995 (after most of the annual mortality had occurred) fits well with the estimated population from winter counts in Europe and North Africa at this time (440,000).

We can make a similar simulation for estimating the accuracy of the total number of wintering Cormorants that we obtained during the 2003 Pan-European Census. If we generalise to the whole studied area the mean increasing rate of breeders observed in the more important European breeding area (DK, NL, G, S, N), the number of breeders of 1995 could have increased by 3.2% per year between 1995 and 2000 and probably 2% up to 2002 (see Bregnballe *et al*. 2003), that give about 195,000 pairs in spring 2002. Because density-dependent regulation has obligatory depleted the recruitment and survival rates, we only need to have 1 fledged young per pair and an annual survival rate of 0.6 in the first year, 0.7 in the second year and 0.8 thereafter to obtain 560,000 wintering Cormorants in January 2003. The difference with the estimated wintering population from the 2003 census results (548,600) is very minor (2 %), and nil if we consider that a small part of the population of Central Europe migrates out of the Black Sea (e.g. into Turkey and further South). The rest of wintering populations in the Middle East (for instance 23,000 Cormorants in Israel in 2003, or 52,000 in Egypt as mentioned by Veldkamp 1996) concern most likely birds from Ukraine, Belarus and the Russian Federation. These Cormorants are supposed to mainly migrate out of the Black Sea (e.g. from Ukraine, Nemtzov 2008). In conclusion we state that the numbers presented here are reliable not only in relative terms (distribution patterns) but also in absolute terms (with respect to an estimate of population size).

Effects of harsh weather conditions

The adverse cold wave conditions that caused freezing of most of the inland water bodies (and part of the Baltic sea) just before the count in mid January 2003 undoubtedly diminished the wintering population of Cormorants in northern Europe. For instance, Denmark lost about two third of its usual wintering population (T. Bregnballe and J. Sterup pers. com), and The Netherlands probably one third (van Rijn & Nienhuis 2004). Part of these lost birds probably died but another part migrated southward, for instance into Belgium (where the population doubled, as during the previous cold wave of 1997 when it increased by two third, Paquet 2007) and also in northern France (Marion 2003a). However such a move of Cormorants did not reach the southern parts of France and probably neither Spain nor North Africa. Similarly many Cormorants will have left those parts of E Europe to the East and North of the -5.5°C isotherm resulting in a concentration in the countries sharing the catchment area of the Danube.

Flyways, counts and subspecies

Before 1981, the distribution of *P. c. carbo* (only on coasts in Norway, British Isles and Northern France) and *P. c. sinensis* (rest of continental Europe) was relatively well known. The extension of the distribution of *P. c. sinensis* in UK and France induced an increasing mixing of these traditional subspecies previously totally separated (Marion 1983, 1995, Goostrey *et al*. 1998, Winney *et al*. 1998, 2001). So the partitioning of the two subspecies in the wintering population of these countries given in table 2 for 2003 is roughly estimated according to the proportion of breeders. In this table we did not take into account the new discovery of a third subspecies, *P.c. norvegicus*, made by Marion & Le Gentil (2006), because we have no means to estimate its proportion in the wintering population. The figure 4 shows an estimate of distribution of the three subspecies during breeding in Europe according to Marion & Le Gentil (2006): -*P. c. carbo* in the N-W part of the dot line, -*P. c. sinensis* in the S-E part of the dot line (continental species, but also present on the coasts in North France, NL, DK); -*P. c. norvegicus* along the coast from North Norway to Britanny, with a decreasing proportion in the populations of local breeders (carbo and/or sinensis) from about 90% in Lofoten islands to 4% in Britanny. Since 1981, the "marine subspecies" *P. c. carbo* invaded the new breeding areas of *sinensis* in west France and East England, beginning also a "continental" subspecies. In west France *P. c. norvegicus* followed the same behaviour (and may be in East England, but there is not an appropriate genetic study in this area for the moment).

These data are important for managing shooting in France because only *P. c. sinensis* can be legally shot, *P.c. carbo* being stable in Europe. So shooting of Cormorants has been prohibited in Britanny recently due to the presence of *P. c. carbo* also in continental roosts. Of course the EC Bird directive of 1979 did not take into account the new subspecies *P. c. norvegicus*.

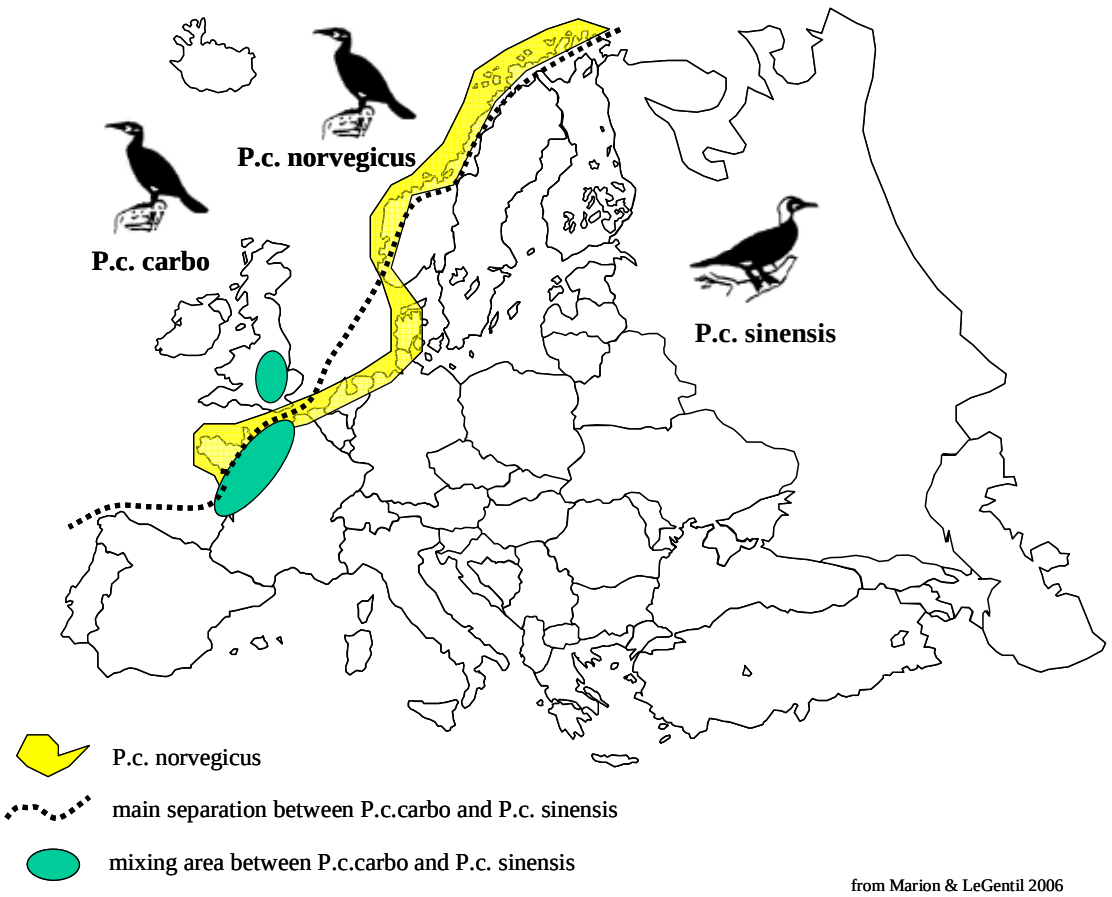

Fig. 4 *Subspecific division of Great Cormorants in Europe, according to data from birds in breeding colonies. In winter the degree of mixing is largely unknown but possibly more extended than in summer, (from Marion & Le Gentil 2006 and this volume)*

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