Cormorant Research Group Bulletin

Number 8, May 2015

Wetlands International
Cormorant Research Group

The Wetlands International Cormorant Research Group was officially founded at the Third European Cormorant Conference in April 1993 in Gdansk, Poland. Its main aim is to facilitate the exchange of information on both ecology and biology of the different species of cormorants worldwide and on possible conflicts between cormorants and human fisheries' interests. To achieve this goal, regular meetings and workshops are organised and, at least once a year, the Cormorant Research Group Bulletin will be published. Contributions of ornithologists as well as of fishery biologists and nature management officials to our activities are welcomed.

Research group coordinator: Mennobart R. van Eerden, Rijkswaterstaat Dept. Water, Traffic and Environment, P.O. Box 17, NL-8200 AA Lelystad, The Netherlands

Assistant coordinator: Rosemarie Parz-Gollner, Stef van Rijn

Coordination European colour-ring projects: Stef van Rijn, Stefano Volponi

Editors Bulletin: Stef van Rijn, Dave N. Carss & Mennobart R. van Eerden

Webmaster: Stefano Volponi http://cormorants.freehostia.com/index.htm

Artwork: Jens Gregersen

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EDITORIAL AND CRG NEWS

It is a pleasure for us to present hereby the eighth volume of the IUCN-Wetlands International Cormorant Research Group Bulletin. From the editorial board we hope you will like this digital format of the Bulletin as well! This volume has been entirely devoted to the abstracts of the Group's meeting in Osijek, Croatia, April last year. The main activities of the Group are mentioned below in brief:

1. The group participates in the EU projects of CorMan and CormoDist. Our contribution to CorMan intends to focus on the population size and distribution of breeding and wintering Cormorants in Europe and in CormoDist we facilitate the study of the European migration patterns in the Great Cormorant. The projects are EU-funded and deal especially with the continental sub-species *Ph. c. sinensis*. The work is led by the Aarhus University (DK) but other institutions, researchers and key cormorant ringers are involved to varying extents. For details, see the newsletters of the CRG.

2. All the INTERCAFE reports are out and printed by the end of last year. Findings from this major Europe-wide study into cormorant-fishery conflicts involving Great Cormorants (*Phalacrocorax carbo*) have been published, providing one of the most detailed ecological and socio-economic investigations of these fish-eating birds, their impact on fish populations and implications for possible management measures. The reports are available in PDF at http://cormorants.freehostia.com/index.htm. For information contact David Carss at dnc@ceh.ac.uk.

3. We still have not succeeded in finding regional coordinators from other parts of the world, outside Europe. Are you actively involved in cormorant issues, either problem-related or scientifically or managerial working in the areas outside Europe, please contact Mennobart at: freebirders@kpnmail.nl : YOU COULD BE OUR REGIONAL COORDINATOR!!!

4. For information please refer to the Cormorant Research Group's website which is coordinated by Stefano Volponi from Italy. On this site you can find any updated information about the group's activities, plans and ringing programmes (http://cormorants.freehostia.com/index.htm)

5. We continue to publish the WI Cormorant Research Group Bulletin. Depending on activities and contributions, an issue is prepared. Volume 8 is also the first digital issue. It will be published also on the website.

6. We continue to manage the database which records the developments of the European breeding numbers of the Great Cormorant. The Pan European colony count in the breeding season of 2012 was successful. The report can be downloaded in full at: http://tinyurl.com/qjkd45b

7. In January 2013 Cormorant roost counts were organised all over Europe and parts of North Africa. The results of this count are prepared for publication in the next bulletin, to be published later this year (see elsewhere in this volume).

8. This volume of the bulletin includes abstracts and extended abstracts from all oral and poster presentations of the 6th IUCN-Wetlands International Cormorant Research Group meeting in Osijek, Croatia, held in April 2014. The meeting was organized together with the Croatian Society for Bird and Nature Protection.

We hope that this issue will be at least as readable, entertaining and worthwhile as its seven predecessors and that its content will stimulate ever more cormorant workers to make their work, or summaries of it, available to their colleagues by means of this bulletin in the following issues! Please send in any news, small articles or requests to be published in the bulletin to: StefvanRijn@live.nl

Mennobart R. van Eerden, Stef van Rijn & David N. Carss

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Successful census of wintering Cormorants *Phalacrocorax carbo* in Europe in January 2013

Rosemarie Parz-Gollner, Loïc Marion, Jean-Yves Paquet, Stefano Volponi, Thomas Bregnballe & Stefan Pihl

Wetlands International - Cormorant Research Group

A total of 45 countries were contacted to participate in the pan-European roost count census action, organized within the EU Commission funded initiative 'CorMan' in cooperation with the IUCN/Wetlands International Cormorant Research Group.

Due to the huge effort and support given by all the National Coordinators who were in charge and responsible for organizing the wintering counts on a national level and with the help of thousands of fieldworkers all over Europe, this winter census - conducted in January 2013 - turned out to be a great success!

The vast majority of the participating countries have forwarded final results to the project's Area Coordinators who are presently working on the data compilation. At the moment only for a few places are data evaluation and finalization still ongoing and the work is not yet completely finished. Unfortunately it was difficult to ensure full coverage in some of the most northern and far eastern countries of the study area (see Fig. 1).

Besides an overview of total numbers given per country, the Counts Steering Group is busy with building up a 50x50 km grid cell map to present the wintering distribution of the Great Cormorant in January 2013 on an European scale. The final results including the grid cell map will be published in the forthcoming issue of the CRG Bulletin scheduled for October 2015.

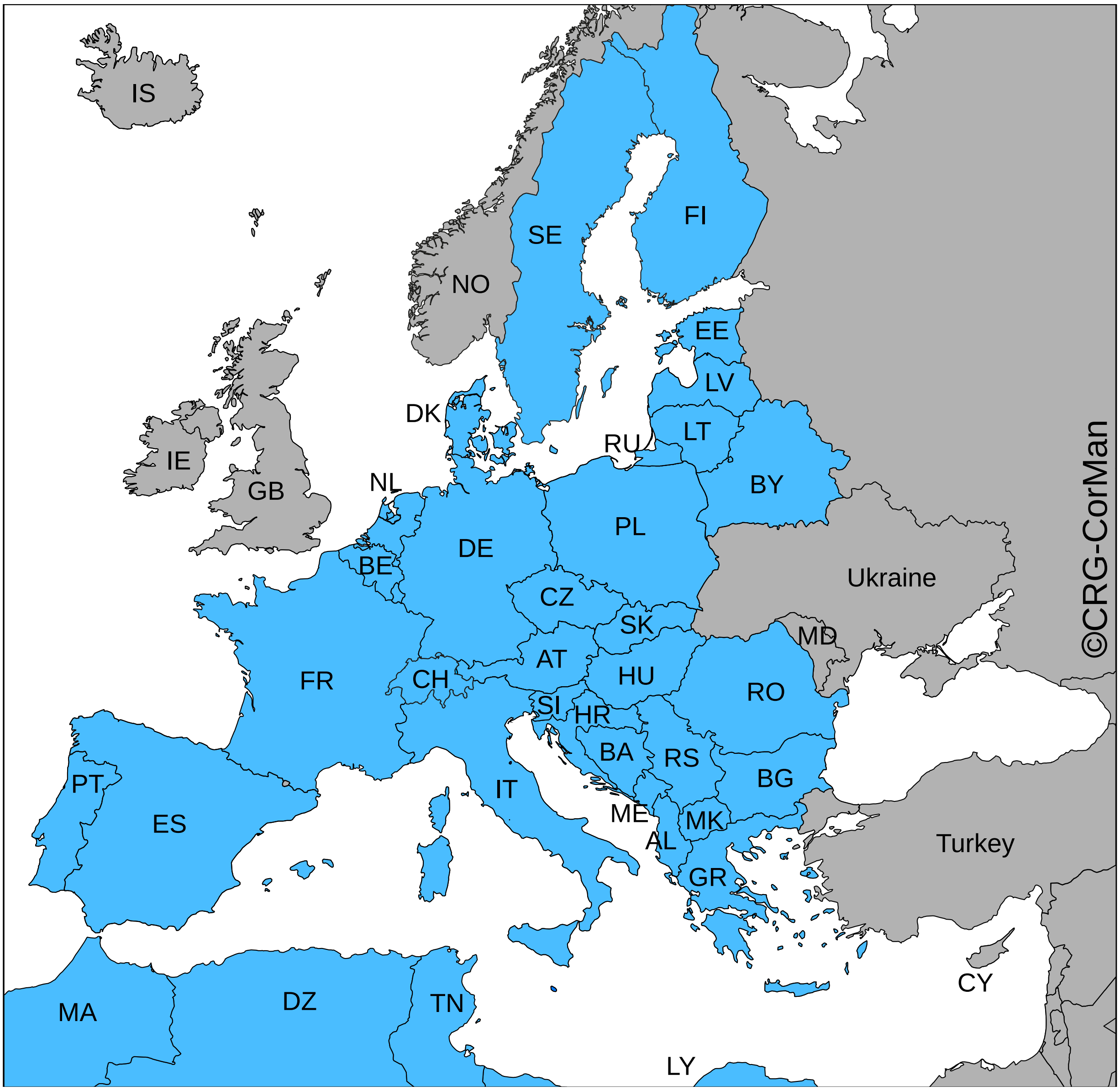

Figure 1. The map is showing the area of successful coverage during the winter census in January 2013: for the blue shaded countries a final record of wintering cormorants could be achieved.

In the NW part of Europe no roost counts were carried out in Norway, United Kingdom, Ireland and Iceland, but available data material from water bird counts during daytime or calculations based on more recent published literature for these countries can be used to be added for an overall data compilation on a European level. For the countries Moldova, Turkey and Ukraine and recent information about wintering numbers is limited (see grey shaded countries).

Cormorant population development, habitat use and demography

The breeding population of Great Cormorant *Phalacrocorax carbo* in the Western Palearctic: A review of status and trends

Thomas Bregnballe, Jennifer Lynch, Rosemarie Parz-Gollner, Loïc Marion, Stefano Volponi, Jean-Yves Paquet, David N. Carss & Mennobart R. van Eerden
Department of Bioscience, Aarhus University, Kalø, Grenåvej 14, DK-8410 Rønde, Denmark.
tb@dmu.dk

We use results from monitoring the breeding population of Great Cormorants *Phalacrocorax carbo* in the Western Palearctic in 2006 and 2012 in order to present an overview of numbers and distribution in 2012 and to describe the major changes since 2006.
In 2012 the continental sub-species *P. c. sinensis* was breeding in almost all countries in Europe and total numbers in the Western Palearctic amounted to more than 370,000 pairs. The 28 EU Member States had 214,500 of the breeding pairs. Most birds were breeding in very large colonies with more than 1,000 nests. The most important breeding area was found along the shallow coastal areas of the Baltic Sea. In this region numbers had increased by 1% from 2006 to 2012, reaching 167,700 pairs in 2012. Between these two years, numbers had decreased in the western part but increased in the eastern part of the Baltic Sea. The Netherlands was another important breeding area with around 23,500 pairs in both years. In some parts of Central Europe and the central and eastern Mediterranean an expansion in breeding range was recorded between 2006 and 2012. However, the overall increase in this region amounted to fewer than 5,000 breeding pairs. Further east, the countries around the western and northern part of the Black Sea had, together with the Sea of Azov, 82,000 pairs in 2012. This was a decline of 27% compared with 2006.
The breeding population of the Atlantic sub-species *P. c. carbo* was estimated at 42,500 pairs in 2012. Norway was the most important breeding area for this sub-species despite a decline there from 30,000 pairs in 2006 to 19,000 pairs in 2012. There were also indications of a decline in the coastal areas of the United Kingdom. Stable or increasing trends were recorded in the other breeding areas: France, Ireland, Iceland and the Barents Sea coast of the Kola Peninsula in Russia.

Assessing egg loss and chick mortality in tree-nesting Great Cormorants in Kąty Rybackie colony (N Poland)

Anna Buczma, Michał Goc, Wojciech Kosmalski and Łukasz Szewczyk
Department of Vertebrate Ecology & Zoology, University of Gdańsk, PL- 80-308 Gdańsk, ul. Wita Stwosza 59. buczma.anna@gmail.com

The breeding success is one of the basic demographic parameters of the population. Studying the clutch size and number of nestlings seems to be relatively easy in cormorant ground colonies compared to those situated in the forest canopy, where collecting representative data can be difficult.
In 2006-2009 we studied egg loss and chick mortality in a large arboreal colony of the Great Cormorant in Katy Rybackie in 3-4 study plots comprising 11-15% of total colony nests. Study plots were controlled every week from the birds' arrival until the end of their breeding

season. Eggs and shells found on the ground were counted and removed. They were categorised as hatched or failed to hatch according to appearance. The number of post-hatching eggshells found during successive controls allowed reconstruction of the breeding phenology. Nestlings fallen out from nests (dead or alive) were individually marked, aged according to measurements and plumage development and left *in situ*.
On average 15% of eggs did not hatch, 18% of hatched chicks fell out of the nest and were found on the ground; more than a half of them (66%) were 3 weeks old or younger. Scavengers are common in the colony and they reduce the number of carcasses found. We estimated the total number of fallen chicks according to a "carcasses disappearing rate". Nevertheless the number of eggs and chicks taken by predators from nests remains unknown in this estimation. We also discuss other factors that may affect the results.

Distribution, population trend, threads and conservation measures for the Pygmy Cormorant *Microcarbo pygmeus* in Italy

Stefano Volponi[1] & Massimiliano Costa[2]
[1]Istitute for Environmental Protection and Research (ISPRA), Via Ca' Fornacetta 9, 40064 Ozzano Emilia (BO), Italy. stefano.volponi@isprambiente.it
[2]Authority for the management of Parks and Biodiversity – Romagna, Via Saffi 2, 48013 Fognano di Brisighella (RA).

The Pygmy Cormorant *Microcarbo pygmeus* has a limited breeding range being restricted to the south-east of the Western-Palearctic Region. The species was, for a long time, considered to be vulnerable because since the 1950s it had suffered a large-scale decline due to drainage and the degradation of wetlands, persecution by fishermen, and the destruction of breeding colonies. In 1994-96 an international plan for the conservation of this cormorant was promoted by the European Community, with the twin aims of stopping further population decrease and improving the conservation status of the Pygmy Cormorant in the medium-long term. In the last two decades the species progressively increased in number and also colonized new regions outside its traditional core area. As a result, the bird is now on the list of species of "least concern" with a secure conservation status. The international plan did not include Italy in its geographical scope because at that time Pygmy Cormorants had just started to breed in the country. In 2012-2013, under the project BeNatur (www.be-natur.it), funded under the South-East Europe Transnational Cooperation Program, the Provincia di Ravenna and the Institute for Environmental Protection and Research (ISPRA) had the opportunity to (a) draft a joint international action plan involving project partners from Romania, Hungary, Bulgaria, Serbia, Greece and Italy, as well as (b) work on the preparation of an Italian action plan. Data gathered since the early stage of colonization in 1994 show the dramatic exponential growth of the Italian population in both the breeding season (2,125 nests in 18 colonies in 2013) and the winter (over 12,500 birds counted at roosts in January 2013). However, bird distribution is still limited to a few sites mainly located along the North Adriatic coast where habitat degradation, pressure from waterfowl hunting and conflict with fish-farmers may become a threat for the species. Italy may play a relevant, and still unacknowledged, role for the conservation of this rare cormorant species in Europe, but active conservation measures should be undertaken to promote the colonization of new areas and to reduce potential conflict with stakeholders in the actual core area.

Increased nest density in ground-breeding Great Cormorants *Phalacrocorax carbo* as a means to avoid predation by mammalian predators, especially Fox *Vulpes vulpes*

Mennobart van Eerden
Rijkswaterstaat, Dept. Water, Traffic and Environment, P.O.Box 17 Lelystad, The Netherlands NL 8200 AA Lelystad. Mennobart.van.Eerden@rws.nl

Nest density in ground breeding Cormorants was assessed in several colonies along Lake IJsselmeer, The Netherlands. At Kreupel island, a man-made bird sanctuary, no mammalian predators occurred during the 10 years period of study (2005-2014). Nest density varied according to local environmental factors but showed no overall trend. Contrasting to this the onshore colony of De Ven where Cormorants used to breed in a dry reed bed had a significantly higher nest density, most probably associated with the presence of mammalian predators (Brown rat *Rattus norvegicus*, Domestic cat *Felis domesticus*, Polecat *Mustela putorius* and Ermine *Mustela erminea*). During the period of study Fox *Vulpes vulpes* entered the scene associated with an even more increased density of nests compared to the period before this predator's arrival. Probably as a result of the latter predator adult birds faced increasingly difficulties in feeding their young as the extremely densely packed nests were only accessible from the air. Breeding numbers as well as breeding success dropped and the colony vanished completely in 2014, except for some 30 pairs breeding in small willow trees, safe for ground dwelling predators.

Key wintering sites for Great Cormorant *Phalacrocorax carbo* and Pygmy Cormorants *Microcarbo pygmeus* in Croatia from 1992-2013

Tibor Mikuska[1], Adrian Tomik[1] & Alma Mikuska[2]
[1] Croatian Society for Bird and Nature Protection, Gundulićeva 19a, HR-31000 Osijek, Croatia; tibor.kopacki.rit@gmail.com
[2] Department of Biology, University JJ Strossmayer of Osijek, dresa, HR-31000 Osijek, Croatia.

Since 1992 wintering cormorants have been regularly reported in the frame of International mid-winter waterfowl counts (IWC). During the wintering period up to 1,337 Pygmy and 19,243 individual Great Cormorants were recorded per winter in Croatia. The winter census results were highly influenced by the research effort and numbers of participants, thus the given results are underestimates of the total national wintering populations. The key areas for wintering Great Cormorants are situated in the Pannonian plain along the large rivers (Danube, Drava, Sava) and their adjacent floodplains, as well as large reservoirs and fishponds. Relatively small numbers of Great Cormorants have been recorded along the Adriatic Sea and the few remaining wetlands. Contrary to that, the key areas for wintering Pygmy Cormorants are situated in the few remaining wetlands in the Mediterranean region – particularly Delta of Neretva River, Krka National Park and Vransko lake Nature Park. In the Pannonian plain the key wintering sites are situated on the Middle Drava at Dubrava and Cakovec Reservoirs, Lower Sava and Jelas fishponds near Slavonski Brod, as well as along the Danube River.

Effect of site variables on site trends in numbers of wintering Cormorants and Goosanders in Central Europe (Czechia and Slovakia: 1991-2013)

Petr Musil[1], Jozef Ridzoň[2], Zuzana Musilová[1] & Katarina Slabeyová[3]
[1]Department of Ecology, Faculty of Environmental Science, Czech University of Life Sciences, Kamýcká 129, 165 21 Praha 6, Czech Republic; *p.musil@post.cz*
[2] Department of Zoology, Faculty of Science, Charles University, Viničná 7, 128 44 Praha 2, Czech Republic
[3]Department of Ecology, Faculty of Science, Charles University, Viničná 7, 128 44 Praha 2, Czech Republic

The wintering population of both fish-eating waterbird species, Common Goosander *Mergus merganser* and Great Cormorant *Phalacrocorax carbo* have increased in Czechia and in Slovakia between 1991 and 2013. The effect of site variables on site trends in wintering numbers was investigated on 230 wetland sites for Great Cormorant and on 162 wetland sites for Goosander. Site numbers of Cormorant increased on 57.9 % sites and site numbers of Goosander was recorded on 40 % of sites in 1991-2013. On the contrary, local decreases in numbers were recorded in 15 % in Cormorant and on 22.3 % sites in Goosander. Site trends of Cormorants were significantly affected by climatic conditions, proportion of wetland habitats and habitat diversity. Higher increase in numbers was recorded in colder sites, isolated wetlands and those in more diverse landscapes. Local trends of Goosanders were affected only by geographical position, when higher increase was recorded in the eastern part of the study area. Surprisingly, negative trends of Goosanders were recorded in larger rivers in Central Bohemia (Labe and Vltava), especially since the regular wintering of larger numbers of Cormorants in the area. We assume the existence of competition between these two fish-eating species, especially in large rivers.

Why the wintering population of Cormorants *Phalacrocorax carbo* strongly increased in France since 2009

Loïc Marion
UMR CNRS ECOBIO-University of Rennes1, Campus Beaulieu, 35042 Rennes Cedex, France. Loic.Marion@univ-rennes1.fr

The 12th National Census of wintering Cormorants in France occurred during winter 2011-2012 for all night roosts (about 1,200). For the first time the size of population reached 105,400 cormorants in January 2012, against 95,400 in 2011 and 86,500 in 2009, which represented a crash (-13%) compared to the winter of 2007 (about 99,700). This regular increase since 2009, when the population was considered to be levelling-off at under 100,000 birds due to carrying capacity since 2005, could indicate *a posteriori* an abnormal mortality during the cold 2009 winter, following by a recovery of population during the subsequent 3 years. Is this recovery due to an increase of the breeding populations in France and from northern countries from which wintering cormorant came, a higher carrying capacity in France due to mild winters, or a lower shooting of cormorants in France?

Cause and consequence of increased number of wintering Cormorants *Phalacrocorax carbo* at Lake IJsselmeer, The Netherlands

Mennobart van Eerden & Stef van Rijn
Rijkswaterstaat, Dept. Water, Traffic and Environment, P.O.Box 17 Lelystad, The Netherlands NL 8200 AA Lelystad. Mennobart.van.Eerden@rws.nl

Great Cormorants were counted by means of an extended aerial survey at Lake IJsselmeer. From these monthly counts that comprise both the foraging waters as well as the roosts it is clear that the use of the lake by wintering Cormorants has greatly increased. The origin of the wintering birds is from the local breeding population that tends to stay over winter locally more often than before. However, the majority of the birds is from areas further north-east. The reasons behind the numerical increase are examined in relation to local factors (availability of fish, milder winters), the increased population in the areas NE of The Netherlands (increased pressure at flyway level) and the possible effect of avoiding mortality by shortening the migration journey (ecological effects, shooting). The overall effect of increased winter numbers at the system is discussed in relation to the effect on the breeding population.

Habitat use, diet and time budgets of a coastal colony of Great Cormorants studied with GPS loggers

Ruben C. Fijn[1], Martin J.M. Poot[1], Stef H.M. van Rijn[2], Mennobart R. van Eerden[3] & Theo J. Boudewijn[1]
[1]Bureau Waardenburg, P.O. Box 365, 4100 AJ Culemborg, the Netherlands; r.c.fijn@buwa.nl
[2]Delta Project Management, P.O. Box 315, 4100 AH Culemborg, the Netherlands.
[3]Rijkswaterstaat WVL, P.O. Box 17, 8200 AA Lelystad, the Netherlands

Rotterdam Harbour is expanding into the offshore Natura 2000-SPA 'Voordelta', the area off the Rhine-Meuse-Scheldt estuary in the south-western part of The Netherlands. A set of measures has been designed to compensate the loss of foraging habitat for breeding seabirds in this area. To assess the effects of these measures, we used GPS-loggers and pellet analysis to study habitat use and foraging ecology of one of these breeding seabird species, the Great Cormorant.

A total of 11 nesting Great Cormorants were caught on the nest in May 2012. All birds were ringed with a metal ring and a field-readable plastic colour-ring. Additionally all birds were equipped with a GPS-logger to study habitat use and time budgets. These loggers took a GPS position every 2 or 4 minutes for several weeks. Data could be downloaded via a remote bluetooth connection. Loggers were attached with a specifically designed backpack loop harness made out of teflon. Attachment techniques and logger effects were tested and evaluated on captive Great Cormorants before deployments in the field (Fijn *et al.* 2012). From these tests we concluded that long-term deployments require a teflon harness to keep the loggers in place for the entire study period. Underneath the nests of tagged Great Cormorants pellets were collected for detailed diet analysis based on otoliths and fish bones.
Diverse foraging strategies were recorded ranging from exclusively freshwater feeding (Fijn *et al.* 2014 in press) to offshore foraging, with the furthest recorded distance from the colony being 27.6 km at sea. Average trip duration, average trip length, average maximum foraging range and frequency distributions of these parameters were determined and will be discussed

in future publications. Most trips took between 2 to 6 hours and were between 20 to 40 km long. Time budgets were investigated from the GPS positions and the largest part of a foraging trip was spent resting ashore (~60%), followed by foraging (~30%), and time spent in flight (~10%). Evidence of sex-specific differences in foraging behaviour, and changes in foraging parameters with increasing chick age were also found. A variety of fish species was found in the pellets, with highest densities of flatfish otoliths in the diets of these cormorants. This study was part of the monitoring program (PMR-NCV), that was initiated by the Dutch Ministry of Infrastructure and the Environment, and was commissioned by Deltares and Rijkswaterstaat WVL Fieldwork was carried out in a nature reserve of Natuurmonumenten and W. van Steenis and H. Meerman are thanked for their cooperation and hospitality.

Cormorant feeding ecology and diet

The diet of Great Cormorants *Phalacrocorax carbo* in the upper section of the Soča River (Slovenia)

A. Pajtnar[1], G. Torkar[2] and M. Govedič[3]
[1] Dolje 11, SI-5220 Tolmin, Slovenija
[2] Laboratory for Environmental research, University of Nova Gorica, Nova Gorica, Slovenia
[3] Centre for Cartography of fauna and flora, Klunova 3, Ljubljana, Slovenia;
marijan.govedic@ckff.si

The Soča (Isonso) River is one of the most pristine rivers in the Adriatic Sea drainage basin. It is widely known for marble trout *Salmo marmoratus* and angling tourism. Due to the long-term introgression by brown trout *Salmo trutta* strains, a marble trout population reintroduction project commenced two decades ago. The number of great cormorants in Europe is increasing and they are now present in the Soča River basin. Diet of cormorants had already been analyzed in the lower section of the Soča River, but not in the upper section where an ongoing reintroduction project is taking place and fishing tourism is an important industry.
From 2004 killing some cormorants was permitted during actions to drive them away. Stomachs of most of the killed specimens were removed and preserved. The cormorants' diet was studied using stomach content of 75 shot specimens (2004-2011) from the upper section of the Soča River and Idrijca River, the largest tributary in the upper Soča River basin. Stomach contents were carefully analysed, including otoliths.

In stomachs remains of 8 fish species was found: Marble trout, Rainbow trout *Oncorhynchus mykiss*, Grayling *Thymallus thymallus*, Nase *Chondrostoma nasus*, Vairone *Telestes souffia*, Italian chub *Squallius squalus*, Chub *Squallius cephalus* and Bullhead *Cottus gobio*. Remains almost certainly represent Italian barbel *Barbus plebejus* and Danube barbel *Barbus balcanicus*. Seven stomachs were empty (9.3 %). Length and weight were determined for 259 specimens, their total estimated weight was 28.3 kg. The most frequent prey by number were *Cyprinidae* (65.7%) and by weight *Salmonidae* (71.6 %). Fish total length varied from 27 mm to 487 mm, weight from <1 g to 1,302 g. The number of fish per stomach varied from 1 to 33 (average 4.2, median 2), mostly from 1 to 10 (88.2%). In 43.3 % stomachs only 1 fish was found. Mean stomach content total weight was 449.2 g (Q1-Q3: 252-561 g).
Identified fish sizes are comparable to those found in other studies of cormorant diet on similar rivers. Despite the fact that Salmonidae were present in almost all analyzed stomachs, their total share by mass and numbers was smaller than could be expected for this area. A higher abundance of chubs is probably a result of the cormorants feeding in lakes. Most of the cormorants tried to catch big fish in order to meet their daily intake. Average total mass of fish in the stomachs is higher than in other studies on nutrition in cormorants that examine pellets or stomachs, being more comparable with studies on daily energy expenditure (DEE).

What fish do Cormorants eat in Alpine foreland freshwaters?

Johannes Oehm[1], Bettina Thalinger[1], Lena Manzl[1], Claudia Breitschopf[1], Sophie Steinmetz[1], Andreas Zitek[2], Michael Traugott[1]
[1]Institute of Ecology, University of Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria; Johannes.Oehm@uibk.ac.at
[2] University of Natural Resources and Life Sciences, Division of Analytical Chemistry, VIRIS Laboratory for Analytical Ecogeochemistry, Konrad-Lorenz-Straße 24, 3430 Tulln, Austria

The Alpine foreland has a variety of water bodies of different structure, temperature and nutrient conditions. Therefore, it bears a highly diverse spectrum of fish species: salmonids, such as trouts and whitefish, are adapted to cold, nutrient-poor and fast flowing alpine rivers as well as cold oligo- to mesotrophic lakes. Cyprinids inhabit rather warm, nutrient rich streams and eutrophic lakes together with predatory fish such as pike, perch and pikeperch. Hence, cormorants *Phalacrocorax carbo sinensis* find a very diverse spectrum of feeding grounds and prey. The birds initially only overwintered in the Alps and its foreland, nowadays they have also established breeding colonies there. As a result, freshwater fish must have faced increased perennial predation by the birds, but it is poorly known how cormorant prey choice changes throughout the year. This study is the first one investigating the prey choice of cormorants at the mesotrophic lake Chiemsee (Bavaria, Germany) during the breeding season as well as during winter roosting. The breeding colony was established in the early 1990's and consisted of 111 breeding pairs in spring 2012, whilst the overall number of cormorants roosting at the lake remained unknown.

Pellets were collected fortnightly for two years at the breeding colony and the winter roosts and prey choice was examined using morphological hard part analysis. During 42 sampling trips, approximately 5000 cormorant pellets were collected and investigated. During the breeding seasons from March to the end of July, 100 to 150 pellets could be found per sampling date, but in winter not every sampling date yielded such high pellet numbers due to the absence of birds, unknown roosting places or snow cover.

The diet of the cormorants in the sampling period was dominated by schooling fish such as perch, cyprinids and whitefish. The fish species consumed most frequently in terms of individual numbers was perch, but the large number of individuals was restricted to only one third of the collected pellets. In contrast, almost half of the analysed pellets contained cyprinid remains, but the number of consumed cyprinid individuals represented only around 30 % of the total individuals detected. Moreover, in the breeding season there were seasonal changes in the diet of the birds: for example, perch and cyprinid consumption correlated negatively and their proportions changed between the sampling dates. Riverine fish, which are expected to be an important prey during winter when lakes are frozen, were also taken but only in a small proportion. This coincides with the warm weather conditions during the two examined winter roosting seasons.

Furthermore, the foraging grounds of cormorants breeding and roosting at lake Chiemsee are determined by investigating whether the birds exclusively feed on fish from the lake or if they also hunt within the surrounding water bodies. Therefore, water samples out of lake Chiemsee and waters in close proximity were taken. These are supposed to differ in their chemical compositions due to their different geological backgrounds and catchment areas. Such differences should be reflected in the bones and otoliths of the inhabiting fish. Measuring the isotope ratios of strontium, calcium and magnesium in water samples of the eight biggest lakes and rivers in the study area showed, that all of them could be discerned from each other. Hence, fish out of these water bodies were caught and the bones will be analysed to investigate, if these signals are reflected in them. If this is true, these data can be used to classify the otoliths from cormorant pellets according to their origin, and, consequently, for determining the foraging range of cormorants in the Alpine foreland.

Examining Cormorant feeding behavior by molecular means

Bettina Thalinger, Johannes Oehm, Hannes Mayr, Christiane Zeisler, Michael Traugott,
Institute of Ecology, University of Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria
Bettina.Thalinger@uibk.ac.at

The feeding ecology of Great Cormorants has been examined previously in the Central European Alpine Foreland using morphological analysis of fish remains in regurgitated pellets. Important aspects such as a general identification of fish prey on a species-specific level and temporal variations in the cormorants' feeding behavior, however, were addressed incompletely. This lack of information provides a hurdle to the understanding of cormorant feeding ecology which is essential to manage these birds in the Alpine foreland and elsewhere. Here, a molecular system enabling fish identification on a species-specific level and its application to a two year field study conducted at Lake Chiemsee (Germany) are presented. Throughout the breeding and overwintering periods regurgitated pellets were collected every second week and analyzed using a series of multiplex PCR assays:

In a first step, short mitochondrial DNA fragments of fish were detected and identified on a family-specific level. For this, each fish species occurring in Central Europe was assigned to one of nine target groups depending on its taxonomic position. Since a species-specific identification was not possible for species rich taxa in this first step, follow up reactions were developed for Salmoniformes, Cyprinidae and Perciformes. If a cormorant pellet for example tested positive for Salmoniformes in the first multiplex PCR, the respective salmonid species was determined in the follow up reaction. The high number of cyprinid species in Central Europe made it necessary to develop three follow up reactions for this taxon, which were run in parallel after cyprinid DNA was detected in the first, family-specific reaction.

The molecular approach, combined with the narrow sampling interval, makes it possible to detect changes in cormorant feeding behavior at unprecedented detail. Furthermore, these data enable the examination of relationships between species-specific fish phenology and cormorant feeding behavior. A first preliminary analysis revealed that certain families and species are consumed at times when they are predicted to be easily accessible to cormorants. Previous studies which were based on the morphological identification of indigestible fish remains in the cormorant pellets showed, that the cormorants in the Alpine Foreland around Lake Chiemsee mainly feed on schooling fish such as perch, roach and whitefish. It is our goal to determine whether the application of the multiplex PCR system to cormorant pellets leads to higher detection frequencies compared to morphological pellet analysis. The new molecular system should also enable the species-specific identification of Cypriniformes and small fish species which is difficult via morphological analysis.

The effect of water transparency on the fish size in a diet of Great Cormorant *Phalacrocorax carbo sinensis* in a deep reservoir

Robert Gwiazda, Institute of Nature Conservation, Polish Academy of Sciences, Mickiewicza 33, 31-120 Kraków, Poland. gwiazda@iop.krakow.pl

Introduction

Physical parameters of water such as temperature and transparency are important factors affecting the diet of fish-eating birds (Gwiazda 2006). Grémillet and Wilson (1999) suggested that water temperature is an important factor for swimming costs of the Great Cormorant *Phalacrocorax carbo sinensis*. Because plunge-diving birds need to detect their prey visually, water transparency also seems to be a very important factor. Eriksson (1985) showed that lower density of fish in oligotrophic lakes in Sweden can be compensated for by higher water transparency in pursuit divers. Great Crested Grebe *Podiceps cristatus* avoided areas with water transparency < 0.4 m Secchi depth in IJsselmeer Lake (The Netherlands) (Van Eerden et al. 1993). High water transparency (mean 3.5 m) probably compensated for low fish density in an inundated opencast sulphur mine (Piaseczno Reservoir, Poland), where the density of the breeding Great Crested Grebe was relatively high (Gwiazda 2009). The effect of water transparency on fish size in the diet of the Great Cormorant has not been sufficiently studied (Van Eerden and Voslamber 1995, Enstipp et al. 2007).

Greater size of fish in higher water transparency was expected. On the other hand, fish availability can be lower in higher transparency waters because some fish species avoid areas where water transparency is high (Mous et al. 2003).

The aim of this study was to determine an impact of higher and lower water transparency on the fish size in the diet of Great Cormorant in a deep water body.

Study area

The study was carried out in the Dobczyce Reservoir (49°52' N, 20°02' E) about 30 km south from Cracow in southern Poland. It is a submontane, eutrophic reservoir with an area of 985 ha, mean depth of 11.0 m (max. c. 27 m) and shoreline of c. 42 km. The main function of the Dobczyce Reservoir is the storage of water for municipal purposes. There are no large water bodies within 50 km of the reservoir. In general, the littoral zone is narrow because of the relatively steep slopes of the inundated river valley. The beds of aquatic macrophytes are restricted to the shallow bay, and few other small areas.

The dominant species in the fish community are: roach *Rutilus rutilus*, bream *Abramis brama*, bleak *Alburnus alburnus*, perch *Perca fluviatilis*, and pikeperch *Stizostedion lucioperca*. The avifauna is dominated by Great Crested Grebe, Mallard *Anas platyrhynchos*, and Black-headed Gull *Chroicocephalus ridibundus*. Numbers of Great Cormorant increased from the late 1990s. The peak number of Great Cormorant was recorded in autumn (max. abundance >600 individuals). There is a Cormorant roost (no breeding colony) on the shore of the reservoir. Roach was the main prey in the Cormorant's diet (Gwiazda 2006, Gwiazda and Amirowicz 2010).

Material and Methods

Diet of Great Cormorant was studied by examination of pellets. About 10 fresh pellets were collected at a roost on the Dobczyce Reservoir monthly from May to November in 2002 and 2004. Remains (pharyngeal bones) of roach were identified. The number of individuals represented in a pellet was approximated by the highest total of the identifiable parts present, taking right and left parts separately. They were measured to calculate the prey length using published regression formulae (Horoszewicz 1960). Water transparency (Secchi depth) was

studied monthly in the main part of the Dobczyce Reservoir from June to November 2002 and 2004.
Spearman correlation was used to study relationships between median of total length of roach and water transparency. Differences of total length of roach in a diet of Great Cormorant and water transparency in particular months of 2002 and 2004 were tested by Mann-Whitney U test.

Results and Discussion

The maximum Secchi depth (4.0 m) in June 2002 and 2004 was found in the Dobczyce Reservoir. The minimum value (1.4 m) in October 2004 was measured. The differences of Secchi depth between studied years were 0.4 m in July, 0.5 m in August, 0.3 m in September and 0.6 m in October. Secchi depth in June and November was not different in 2002 and 2004.

No relationship between water transparency and median of fish total length in the Cormorant's diet in both studied years was found (Rs=0.49, P=0.33; Rs=-0.54, P=0.27, respectively). Cormorants consumed roach of greater size in a higher water transparency in August (Z=5.06, N=51, P=0.0001) but of lower size in a higher water transparency in July and October (Z=2.76, N=42, P=0.006; Z=2.33, N=14, P=0.02, respectively). Differences in the size of roach in the diet between higher and lower water transparency in September were not found (Z=1.53, N=22, P=0.13). Results of the effect of water transparency on the fish size in a diet of Cormorant in a deep reservoir were unclear in 1.4-4.0 m water transparency. The effect of water transparency is probably more pronounced for surface-feeding avian piscivores than for diving piscivorous birds (Mous et al. 2003). The Great Cormorant is able to feed efficiently in turbid water or in low light conditions. Van Eerden and Voslamber (1995) showed changes in the Cormorant's behavior as a result of the reducing water clarity in the habitat of IJsselmeer Lake (The Netherlands). Big fishing flocks of Cormorant in low water transparency were observed. Great Cormorants wintering in Greenland foraged during the polar night in the dark (Grémillet et al. 2005). Study of two lake systems (Macedonia) with different turbidity and fish density showed that Great Cormorants remain highly efficient fish predators even in the most turbid water (Grémillet et al. 2012). Prey size and light conditions did not have a significant effect on cormorant prey–capture performance (Enstipp et al. 2007). However, social fishing by Cormorants in IJsselmeer Lake (The Netherlands) is directed towards the catch of relatively small fish (Van Eerden and Voslamber 1995). The switch in Cormorant diet towards small fish in the Dobczyce Reservoir (Poland) was related to fish density (Gwiazda and Amirowicz 2010). The densities of different fish cohorts appears to be the most important factor affecting foraging of Great Cormorant in a deep reservoir.

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Long term changes in composition of the freshwater fish community in Lake IJsselmeer, a large shallow lake in The Netherlands affect fish availability for Great Cormorants *Phalacrocorax carbo* and other fish-eating birds

Mennobart van Eerden, Charlotte Deerenberg, Stef van Rijn & Ruurd Noordhuis
Rijkswaterstaat, Dept. Water, Traffic and Environment, P.O.Box 17 Lelystad, The Netherlands NL 8200 AA Lelystad. Mennobart.van.Eerden@rws.nl

Long-term trends in fish stocks in Lake IJsselmeer, an 1800km^2 large and shallow lake show that species composition and overall fish stock conditions have significantly changed since the 1980s. Of the planktivorous species Smelt *Osmerus eperlanus* showed a strong overall decline in numbers and biomass and over the years the disappearance of the 1+ cohort. The benthivorous species Eel *Anguilla anguilla*, Bream *Abramis brama* and Roach *Rutilus rutilus* have declined remarkably, by contrast Ruffe *Gymnocephalus cernuus* has increased. Of the predatory species Perch *Perca fluviatilis* and Pikeperch *Stizostedion lucioperca* tend to decline, whereas Pike *Esox lucius* locally increases. New and/or formerly rare species have entered the lakes following re-introduction programmes upstream and improvement to the possibilities of passage through the barrages and weirs in rivers like Houting *Coregonus lavaretus complex* and Sea trout *Salmo trutta trutta*. Alien fishes like three species of Danube and Black Sea gobies as well as Asp *Aspius aspius* have also entered the lakes. We argue the link with the continuous decline of the nutrient load causing longer periods of clear water favouring aquatic macrophytes combined with the extensive pressure by the commercial fisheries. As a result, fish availability for fish-eating birds has greatly changed and the consequences for cormorants are discussed.

Cormorants and fishes in one of Europe's core areas: understanding the long-term changes of prey choice and carrying capacity

Stef van Rijn & Mennobart van Eerden
Rijkswaterstaat, Dept. Water, Traffic and Environment, P.O. Box 17 Lelystad, The Netherlands NL 8200 AA Lelystad. StefvanRijn@live.nl

In The Netherlands Lake IJsselmeer, Lake Markermeer and the Border Lakes comprise some 2000 km^2 of shallow freshwater habitat. Great Cormorants *Phalacrocorax carbo* use these waters year round as feeding habitat.
Total number of breeding pairs has declined after peak levels in the early 1990s. Concurrently the number of colonies has increased and, in recent years, Cormorants breed in ten colonies along the Lake IJsselmeer complex. Cormorants have for decades adopted a social hunting technique which enables the birds to perform long foraging trips. We describe the major patterns in food choice, both in summer and in winter. Whereas diet composition in recent years is to a large extent comparable to the days when numbers peaked during the 1980s and 1990s subtle changes occur. The long-term patterns in prey choice are to a large extent a reflection of fish availability within the foraging range. Diets from different colonies along the same lake show different patterns in prey composition and size distribution. The recent finding of marine fishes corresponds with long foraging trips outside Lake IJsselmeer into the Wadden Sea. Moreover, the presence of the newly arrived fish species as prey fish in the diet corroborates the conclusion that, within the size range of available fish, cormorant diet to a large extent reflects the composition of the fish community in the lakes.

Cormorant distribution, dispersion and migration patterns in relation to environmental factors

Migration patterns and distribution outside the breeding season of Great Cormorants from the Danish breeding population

Thomas Bregnballe[1], Jacob Sterup[2] and Morten Frederiksen[3]
[1]Department of Bioscience, Aarhus University, Kalø, Grenåvej 14, 8410 Rønde, Denmark; tb@dmu.dk
[2]Svanningevej 40, 5600 Faaborg, Denmark
[3]Department of Bioscience, Aarhus University, Frederiksborgvej 399, 4000 Roskilde, Denmark.

Knowledge about the migration patterns and distribution of Great Cormorants *Phalacrocorax carbo* in Europe is relevant for reaching a better understanding of why cormorant numbers change over the years in staging and wintering areas. The Great Cormorant is also an interesting species because of the huge variation among individuals in the direction and distance they migrate before they settle for the winter. Furthermore, it is interesting to study how dynamic populations of cormorants are with respect to short and long-term changes in migration patterns and choice of wintering area.

In order to conduct a few preliminary explorations of these issues we used data on recoveries of Great Cormorants ringed in Denmark during 1972-2012. The 65,888 chicks ringed over these years resulted in approximately 5,400 dead recoveries up until the spring of 2013.

We explored whether the distribution outside the breeding season was linked to the geographical location of the colony in Denmark. We found that the direction of post-breeding dispersal was somewhat affected by the location of the individual colonies and that this – in some cases – had large influences on the directions taken during autumn migration leading to differences in where the birds from the different colonies were found wintering. An example of differences in autumn and winter distribution of cormorants from different sectors of the breeding range within Denmark is shown in Fig. 1.

We used the ring recoveries of cormorants to look for age-related differences in the distance between the colony of ringing and the area where it was reported to be found dead in winter (including birds reported drowned or shot). Contrary to what we expected and contrary to earlier findings (van Eerden & Munstermann 1986, Bregnballe, Frederiksen & Gregersen 1997), first-year birds were not found further from the colonies than older birds (Fig. 2).

Winter counts of cormorants in Europe suggest that cormorants may be ‘pushed’ further south in severe winters. We explored whether the apparent effects of winter severity on choice of wintering area could be detected in the winter distribution of ringed birds reported dead (including those drowned or shot). We found no tendency for birds to be recovered further away from the breeding areas in severe winters than in mild ones. This might be because birds wintering in the northern and eastern parts of Europe are more likely to die and be recovered in cold winters than in mild winters whereas this is not likely to be case in more southern wintering areas where temperatures become less critical in cold winters. However, we found indications of a relationship suggesting that birds faced with cold weather in their first winter selected wintering areas further south in Europe than did birds which were not exposed to cold weather in their first year of life (Fig. 3).

We tried to look for indications of changes in the long-term distribution outside the breeding season. One of the apparent changes is that Danish birds have decreased their use of areas in the central Mediterranean (e.g. the Adriatic Sea, Italy, Sardinia and Tunisia) but have increased their use of wintering areas closer to the Atlantic Ocean, e.g. France and Spain. An example of a change in the distribution of winter recoveries is given in Fig. 4. Caution is needed when interpreting such apparent changes. Thus changes in the distribution of recoveries may – to a smaller or larger extent - reflect changes in where cormorants are recovered dead and reported rather than a change in the actual distribution of birds. For example, we expected an increase in the proportion of birds being recovered in France as the number of cormorants shot in France increased.

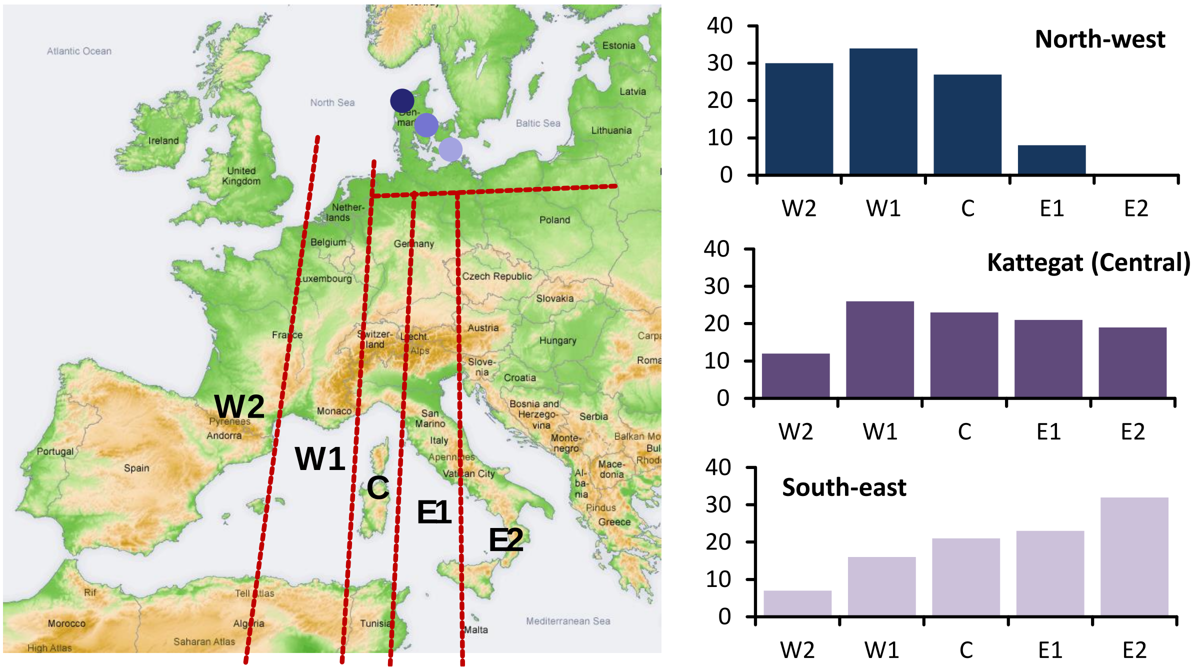

Figure 1. Relative distribution (%) of Great Cormorants ringed in three different parts of Denmark and recovered dead between August and February 1983-1998 in five east-west zones in Europe. Recoveries from the post-breeding areas north of the horizontal read line were not included. The number of recoveries were 54 from the north-west, 599 from Kattegat, 101 from the south-east.

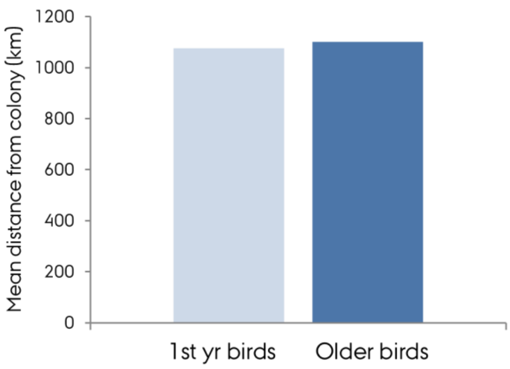

Figure 2. Mean distance between the colony where the Great Cormorant was ringed as a chick in Denmark and the site where it was reported dead, given for birds recovered dead in their first year of life and for older birds. The mean is based on recoveries from the winters 1975/76 and 2012/13.

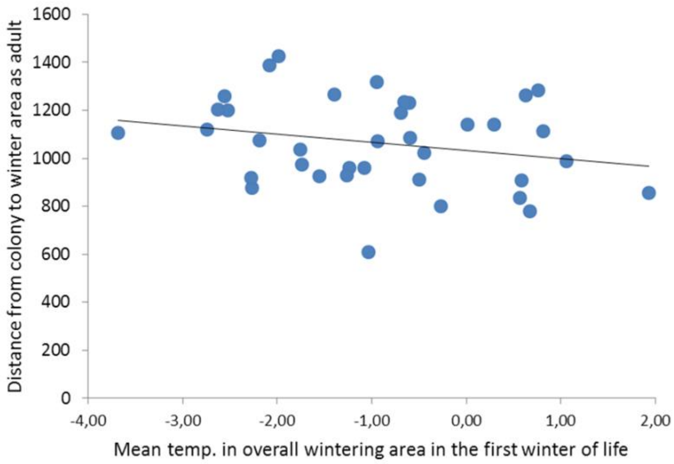

Figure 3. The mean distance between the colony of origin in Denmark and the site where Great Cormorants older than 1½ years were recovered dead in winter in relation to the mean temperature in the birds' first winter. Each mean is based on the recovery of at least 15 individuals.

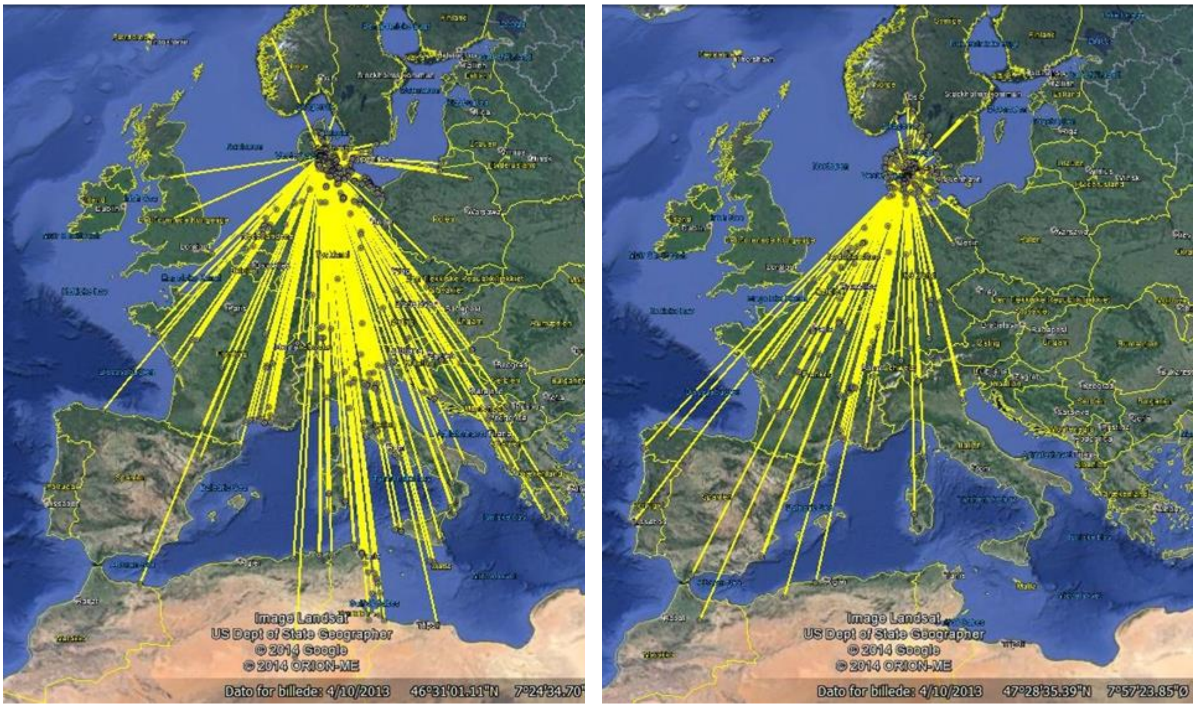

Figure 4. The winter distribution of ring recoveries of Great Cormorants ringed in the Vorsø colony during 1945-78 (left) and 1996-2004 (right).

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Changes in migration pattern and wintering phenology of East-German Cormorants *Phalacrocorax carbo sinensis* from the 1930s until today according to ringing recoveries

Christof Herrmann, Juliane Wendt & Ulrich Köppen

Ringing of Cormorants in Germany was begun in the 1930s by Richard Stadie. From 1932 to 1938, Stadie ringed quite a high number of Cormorants in the colony of Pulitz (Isle of Rügen), but also some birds in other Pomeranian colonies (Lake Jassener See, river Brahe near Prechlau, both locations are nowadays situated in Poland). The recoveries of these banding activities were published in 1934 and 1939. Ringing was continued from 1957-1979 in Niederhof at the coast of Greifswald lagoon, during the first years with Helgoland rings, and since 1965 with rings of the bird ringing centre of Hiddensee. With the expansion of Cormorants over almost all Germany, ringing was also started in the other Federal States of the working area of the ringing centre Hiddensee (Mecklenburg-Western Pomerania, Brandenburg, Saxony-Anhalt, Saxony and Thuringia). In 2010, the bird ringing centre Hiddensee started a programme of colour ringing which resulted in an increased number of reports of living birds. The total number of birds ringed in the working area of the ringing centre Hiddensee during the period 1932-2013 is >10,500, the number of recoveries (dead birds and sightings) approaches almost 2,000. Though Cormorants have been ringed in other Baltic countries even in higher numbers, there are no other data from this region covering the period since the 1930s. Only The Netherlands can offer comparable data series.
The autumn migration of Cormorants towards their wintering areas proceeds mainly during the months September-November, the return to their breeding colonies between February and April. A clear temporal separation between migration and wintering does not exist. For analysis of the wintering phenology, ringing recoveries from the period 16 November to 15 February have been considered (n=278).

The geographical distribution of ringing recoveries allows three different migration routes to be distinguished. First, the south-eastern migration route follows the Adriatic Sea, where the birds may reach Greece or even Turkey. Second, the southern migration route leads the Cormorants via Italy or Corsica/Sardinia to North Africa, especially Tunisia and Algeria. Third, the western migration route leads the birds to Western Europe (The Netherlands, France, Spain, Portugal). A certain proportion of birds is wintering near to the breeding areas. Birds which are recorded at a distance of less than 500 km from the ringing site are not assigned to any migration route, they are considered to be short-distance migrants.

During the 1930s, 35 % of the winter recoveries were obtained from the south-eastern migration route. This proportion declined to about 10 % during the period 1990/91-2009/10; at the same time the migration distance on this route was significantly reduced. Finally, this migration route was completely abandoned - there is not one single recovery from the period after 2010!

The proportion of birds using the southern migration route does not show a clear trend. It was 38 % in the 1930s, slightly above 50 % from 1990/91 to 1999/00, and 28 % after 2009/10. However, the migration distance on this route was significantly reduced: The mean migration distance was 1,549 km in the 1930s, but only 806 km during the period 2000/01-2009/10 and 954 km during the years after 2009/10. Reports from North Africa have been numerous in the 1930s and even until the 1990s, but then became scarce.

The proportion of birds using the western migration route was almost the same between the 1930s until 2009/10 (21-27 % in most periods, only 1957/58-1979/80 it was lower), but increased recently (39 % after 2009/10). There is a slight, but significant, increasing trend in the migration distance. Reports of birds from distances of more than 2,000 km (Portugal, southern Spain, northern Morocco) are still numerous.

The short-distance migration is a quite new phenomenon: Before the 1990s, recoveries from distances of <500 km were rather exceptional (only two cases, 1963 and 1987). During the 1990s, the proportion of near-distance migrants was already 12 % and increased afterwards to about 30%.

Another interesting finding is the change in the use of coastal/inland wintering areas: Winter recoveries in the 1930s were almost exclusively obtained from coastal areas (92 %). The proportion of birds wintering on inland sites increased to 83 % for the period 2000/01-2009/10. During recent years, there is again a certain trend towards coastal wintering areas (51 % inland, 49 % coast for the period 2010/11-2013/14).

Movements, distribution and ecology of cormorants outside the breeding season: Gaps in current knowledge

Morten Frederiksen[1] and Thomas Bregnballe[2]
[1]Department of Bioscience, Aarhus University, Frederiksborgvej 399, 4000 Roskilde, Denmark; mfr@bios.au.dk
[2]Department of Bioscience, Aarhus University, Kalø, Grenåvej 14, 8410 Rønde, Denmark.

Great Cormorants *Phalacrocorax carbo* are widely distributed in Europe both in the breeding and non-breeding season, and they are widely involved in conflicts with human interests. These conflicts are particularly widespread and pronounced in the wintering areas, but nevertheless our current knowledge of the movements, behaviour and ecology of cormorants outside the breeding season is limited and fragmentary.
This lack of knowledge is to a large extent related to the difficulty of collecting data on individuals during the non-breeding season, when birds are highly mobile. However, analysis of existing data combined with targeted use of technological advances in bird-borne instruments should allow considerable progress in answering many of the outstanding questions.

On the large scale, our understanding of how breeding cormorants from different parts of Europe distribute themselves outside the breeding season is still limited, in particular regarding potential changes over time as a response to increasing density in wintering areas, climatic changes or management actions. Large amounts of data have been gathered through recoveries and resightings of ringed birds (e.g. Bregnballe, Frederiksen & Gregersen 1997), and these data contain information that will allow many of these questions to be answered. As an example, as part of the EU-funded project CormoDist, ring recovery data from all European schemes will be analyzed in order to estimate migratory connectivity, i.e. the composition of wintering populations in different areas in terms of their breeding origin (Fig. 1). Through such analyses, we can answer some of the questions about e.g. how management may or may not affect populations in different parts of Europe.

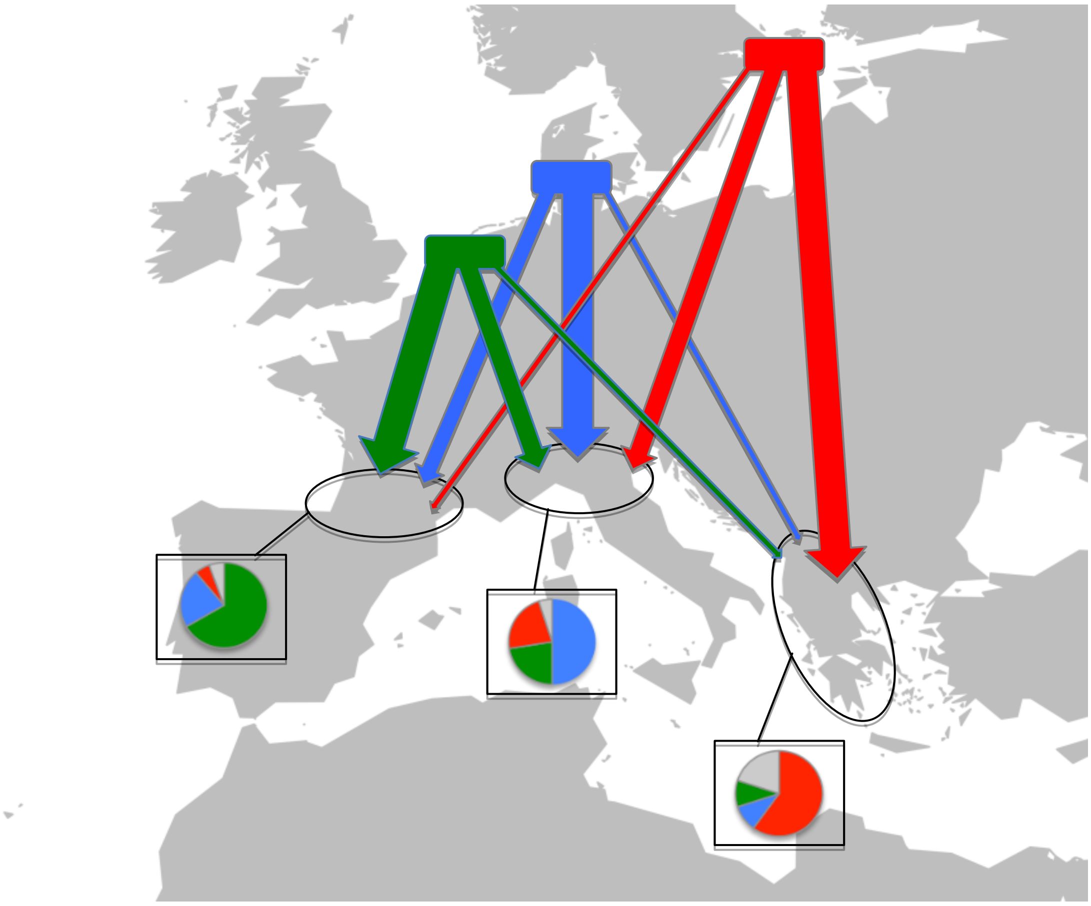

Figure 1. Schematic illustration of migratory connectivity. Birds from three breeding populations (of different size) migrate to various wintering areas, leading to a different composition of the wintering population in each area.

On the medium scale, there is still much to learn about which types of landscapes are attractive to cormorants outside the breeding season. For instance, are cormorants attracted to landscapes where fish farms or other anthropogenic food sources are common? Furthermore, we know next to nothing about how changes in density affect these preferences; are the best landscapes occupied first, and do birds then gradually appear in less favoured landscapes as the population builds up? Coordinated winter roost counts offer a way of addressing some of these questions, and the first steps in this direction have been taken (van Eerden et al. 2012). However, for many questions more detailed information on individual behaviour is needed. For example, very little is known about how individual cormorants exploit their wintering landscape: are birds faithful to their roosting sites within and between winters (but see Frederiksen et al. 2002), do they use one or several foraging sites on a daily basis, how do they react to changes in their environment, including both natural (weather) and human (management) factors? Energy balance is a particularly critical question, because cormorants carry little fat and are dependent on regular access to high prey densities (Grémillet, Wanless & Linton 2003). Only by answering such questions will it be possible to evaluate and predict the effects of site-specific management on cormorant numbers and site usage. Recently developed technology, e.g. GPS data loggers, time-depth recorders and accelerometers allow the collection of such detailed data and have already been used with success on many aquatic birds. Although deployment of electronic devices is more difficult for cormorants than for many other species, this is certainly an area where much progress can be expected.

Finally, various types of simulation models, including energy-balance, individual-based and population models, are needed to integrate the information from different sources and allow the exploration of scenarios of e.g. different management actions.

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The power of many: how a large observer network can help to describe patterns of movements and habitat selection of Great Cormorant *Phalacrocorax carbo* in a changing world

Jean-Yves Paquet, Département Études Aves-Natagora, Rue Nanon 98, 5000 Namur Belgium
jean-yves.paquet@aves.be

Following a very large increase of its breeding population, the Great Cormorant is now one of the most widespread waterbirds in Europe. Thanks to standardized coordinated counts of night roosts and colonies, population development is described with a relatively high accuracy in most European countries. Detailed studies on habitat use (i.e. fine-grain pattern of foraging habitat selection) are generally conducted during focused scientific studies, which are mostly limited to small geographical scale and short-term period. In Europe, millions of observational bird data are recorded every year through a very large network of amateur birdwatchers using web-based data portals (building so-called “opportunistic datasets”). Here, we explore the possibilities and the limits of using one of these very large datasets to describe changes in Great Cormorant habitat use in Wallonia (Southern Belgium).

In Wallonia, during the period 2008-2012, 23,000 records of Great Cormorant have been entered in a naturalist online portal “observations.be”. All these observations are “opportunistic”, not effort-controlled, with strong geographical bias, strongly dependent on birdwatchers’ habits. To partly circumvent these limitations, we used spatial distribution modelling (MaxEnt presence-only method), which combines georeferenced positive records of a given species with environment variables a probability of occurrence of Great Cormorant in 1 km² spatial units. The resulting probability map shows a model of the distribution of Great Cormorant during the month of January (Fig. 1). As the records at the basis of this model are day record and not roosts counts, this gives a complementary indicative view of the area used by cormorant during foraging time. The probabilities of presence fit well with the distribution of rivers, and even smaller tributaries are also used by a few Cormorants, as are ponds. On a particular river called the Lesse, shooting of cormorants under derogation has occurred in the recent years. The local roost was recently abandoned, which may suggest that the heavy shooting deterred the birds. However, observational data confirm that foraging birds are still present on this river during the day. Raw observational data can also be used to assess the effect of exceptional event, like a short cold spell during the winter (Fig. 2). The effects of these temporary events are usually not well described by fixed-date standardized roost counts.

In conclusion, opportunistic observations recorded by online portals provide a useful complementary source of information on Cormorant local distribution, although they will never replace standardized counts when the question is to assess numbers.

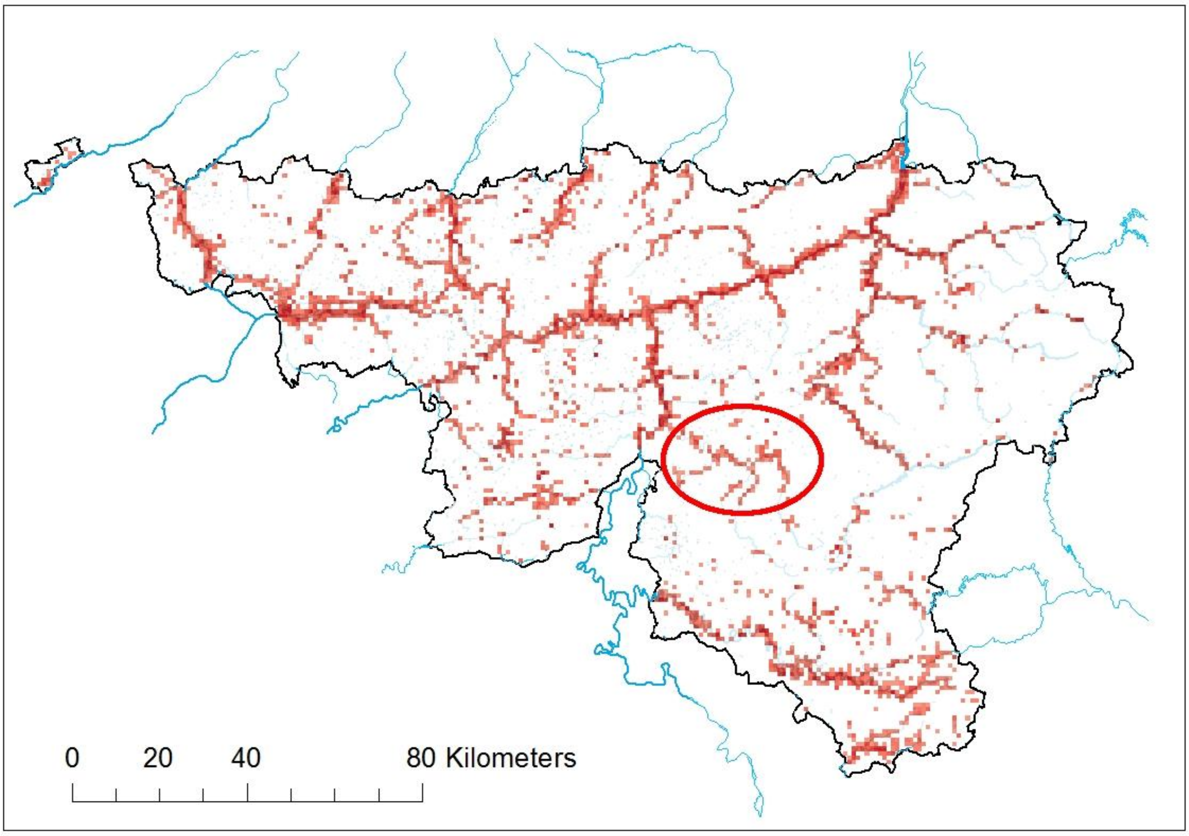


Figure 1. Distribution of Great Cormorant in January in Wallonia, as modelled using observational data from 2008-2012. Intensity of red indicates increasing probability of presence. Most of the river system is heavily used by the cormorants. The red ellipse indicates the river Lesse, with evidence that cormorants are still using this river valley while their night roost there has now disappeared.

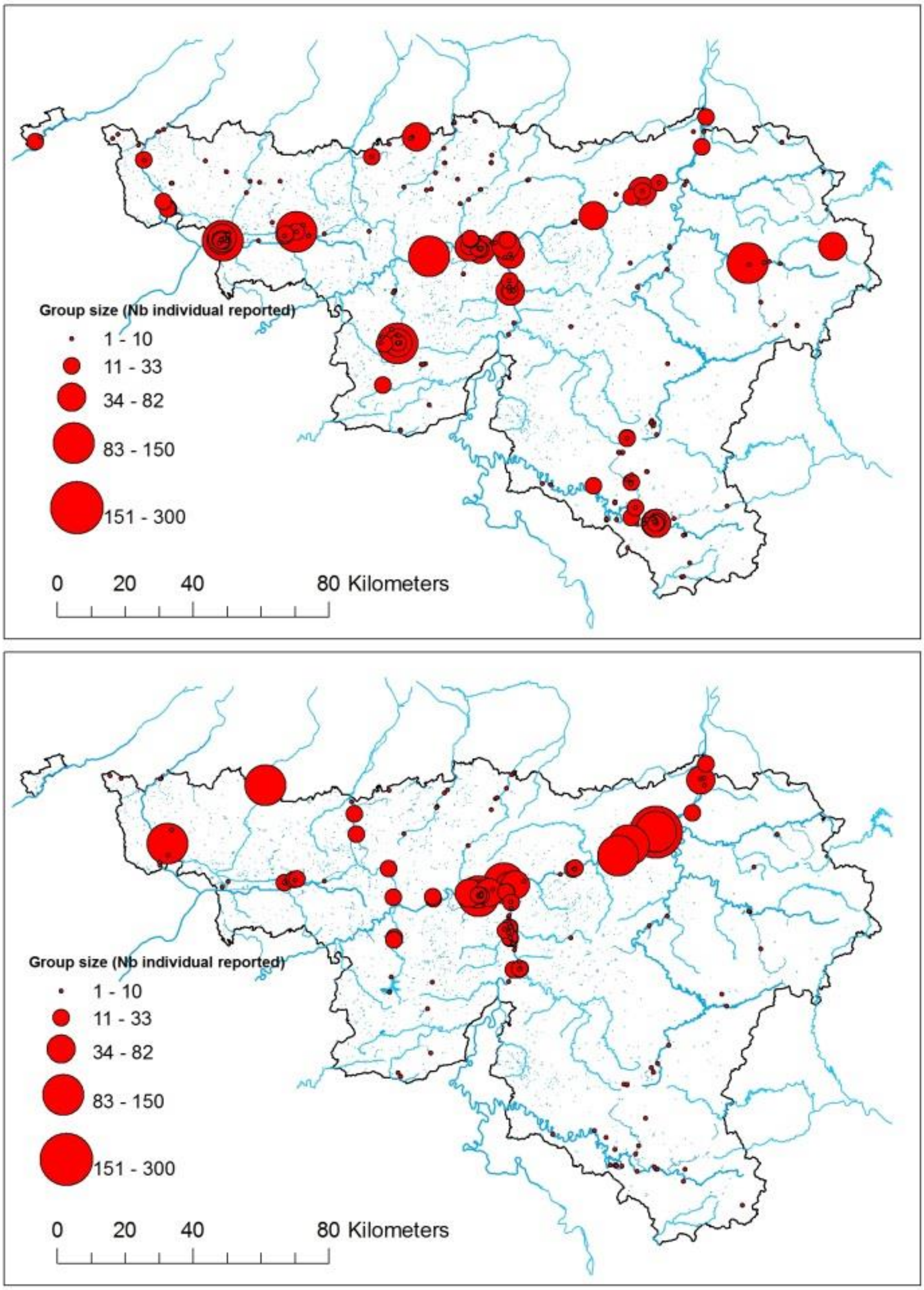


Figure 2. Reported groups of Great Cormorant in Wallonia, during winter 2012. On the left, in January (before a cold spell); on the right, during a very intense but short cold spell in January-February; Prior to the cold spell, Cormorants are also dispersed in the south of Wallonia, including smaller rivers, while the cold spell forced the birds to northern parts characterized by lower altitude, milder temperature and the presence of unfrozen rivers.

Cormorant-fishery interaction and management

Cormorants and shags worldwide: what other species can tell us

Mennobart van Eerden
Rijkswaterstaat, Dept. Water, Traffic and Environment, P.O.Box 17 Lelystad, The Netherlands NL 8200 AA Lelystad. Mennobart.van.Eerden@rws.nl

In the western world Great Cormorant *Phalacrocorax carbo* and Double-crested Cormorant *Phalacrocorax auritus* have got a lot of attention because of the ever-lasting issue of possible damage in relation to fish stocks with an interest to humans. Worldwide there are, according to the different taxonomic views, about 40 species of Phalacrocoracidae. From the sub-arctic to the tropics and over all continents, cormorants and shags thrive in the full range of freshwater and marine habitats. Some species have a limited distribution and a small population size. Others range over vast territories and their numbers comprise millions of birds. By comparison of two contrastingly different species, the King Shag *Leucocarbo carunculatus* of New Zealand and the Socotra Cormorant *Phalacrocorax nigrogularis* of the Persian Gulf, behavioural and ecological traits which have evolved from adaptation to different, and sometimes extreme, environmental conditions show patterns that may help in identifying and interpreting the behaviour and ecology of species in a more temperate environment.

Color ringed Great Cormorants in Latvia

Karlis Millers

Despite of the fact that Great Cormorant research had been undertaken for more than five years, only in 2013 was the first ever in Latvia colour-ringing action undertaken. During the last season at the regularly investigated colonies, a total of 99 Great Cormorants were ringed with colour-rings (97 fledglings and 2 adult birds). Blue colour-rings with white inscription were used on the left leg and a metal ring on the right leg. The direction of the colour-ring read from up to bottom, i.e. for A88 the “A” was near the body and the “8” near the foot. During long-term research more than eight colonies were surveyed every year. Because of Latvia`s geographical location and other specific issues, only a few of the colonies are suitable for ringing. Most of the nests at colonies are tree located, on average >15 m high. There is only one ground breeding colony on a half floating island at Engure lake and one in the rocks of Kolka lighthouse, an artificial islet 5 km off in Baltic Sea on the border with the Gulf of Riga. It is problematic to visit either of these colonies. The Engure lake colony has a ‘weight limit’ for researchers because of soft foundation. Furthermore, Kolka, because of its location, has extremely changing weather conditions which often make it problematic or even impossible to disembark on the islet, as there is no pier or dock there. The main ringing place was at the biggest colony (~1500 bp) in Latvia in recent years. It is located in Kemeri National Park, a restricted area on an islet at Kanieris lake. Some nests at the edge of colony were located in bushes within the reach (2 – 3 m). As the result, 80 fledglings and 2 adult Cormorants were ringed here. Two-thirds of Akmenssala (Stone islet) at Lubans lake, where second biggest colony (~600 bp) is located, are covered with an impassable jungle of bushes. As well as access, reaching the islet can be different every year depending on sluice usage

around the lake during/after the spring floods. In mid-June 2013 at the first attempt the islet was reached by boat where access used to be by walking. The second attempt was more successful and 14 fledglings were ringed. The last three fledglings were ringed at Engure lake when it was possible to reach the nests and fledglings.
Gathering all available information about ring readings, there were at least 14 reports from five countries, including Latvia. Thus, the first report was from rocky shoreline of Riga Gulf at Pekrags, Mersrags, 22 days after the ringing. This bird was ringed at the Kanieris lake colony 46 km away - the closest report from the ringing place. Two more reports followed from the same place in next few days. Both birds were ringed at Kanieris lake.
Two recoveries were reported from Poland. One was ringed at the Kanieris colony and found dead. The other was reported as alive - the ring being read after 110 days, ~632 km away from the Lubans lake colony, the only recovery from this colony. One wintering individual was reported five times from around Kiel, Schleswig-Holstein Germany about 880 km from the ringing place. The bird was present from 21.11.2013 until at least 25.01.2014 having been ringed at Kanieris lake.
One individual was reported alive, 69 days after ringing, from the Czech Republic ~1,060 km away from the Kanieris lake colony. The furthest report came from Gonars, Udine, Italy (near Adriatico). It was a bird from Kanieris lake and was reported after 167 days, ~1,420 km away from ringing place. In 2014 color ringing in Latvia will continue.

Past and future studies in cormorants: from the Great Cormorant towards great cormorants

Mennobart van Eerden
Rijkswaterstaat, Dept. Water, Traffic and Environment, P.O.Box 17 Lelystad, The Netherlands NL 8200 AA Lelystad. Mennobart.van.Eerden@rws.nl

The Great Cormorant is one of the few species of fish-eating birds in Europe that has been monitored and studied thoroughly and over a long time. From the early ecological studies in the first half of the 1900s by van Dobben, and the ethological work of Kortlandt, the species has been subject to numerous descriptive, and a few experimental, studies. Its fish-eating habit has induced this long-lasting interest and the damage-protection dilemma was the most important motor behind a lot of political issues, especially since the population expansion took place in the 1980s. This paper gives a brief overview of the state-of-the-art of major themes of research and addresses the gaps concerning population development, food and feeding ecology in relation to predation of fish, dispersion patterns and migration, behaviour and moult, the subspecies/guild dilemma and miscellaneous studies. Although a lot has been described and unravelled, few attempts have been made to summarise and integrate findings at a larger geographical scale and/or synthesise findings from different thematic fields. Examples are given where this approach has been successful and a plea is made to call for more integrated future studies. The indicator function that cormorants and shags have with respect to the state-of-the-art of the water system deserves more attention.

Posters

Seasonal pattern and population trend of the Great Cormorant in the Grado lagoon, upper Adriatic Sea

Mauro Cosolo[1] & Stefano Sponza[2]
[1]Via Roma 65, 34075 Pieris (GO), Italy
[2]University of Trieste, Department of Mathematics and Geoscience, Via Weiss 2, 34127 Trieste, Italy

Introduction and methods

The Great Cormorant *Phalacrocorax carbo sinensis* is mainly a migrant and wintering species in Friuli Venezia Giulia, upper Adriatic Sea (NE Italy). In the period 1991-2001 the wintering population increased from 637 to 2,366 birds; at present, about 2,600 birds overwinter in the area (International Waterbird Census data). The first breeding was only recently recorded (May 2008). The species is perceived as highly problematic for fishing and fish farming activities, especially in the coastal area where the traditional aquaculture activities (i.e. extensive fish ponds) operate.

As a contribution to the balancing of conservation issues with the protection of aquaculture activities, we have investigated the occurrence of the species, throughout the year, in the Grado lagoon. Just in this area we have most (1,400 ha) of the fish ponds (1,700 ha) located in the coastal region. The Grado lagoon includes a shallow (about 1 m deep) tidal wetland of about 8,000 ha, with natural and artificial channels (up to 5 m deep). The area is of national importance for wintering Great Cormorants, hosting about the 4% of the Italian population (Baccetti et al. 2002).

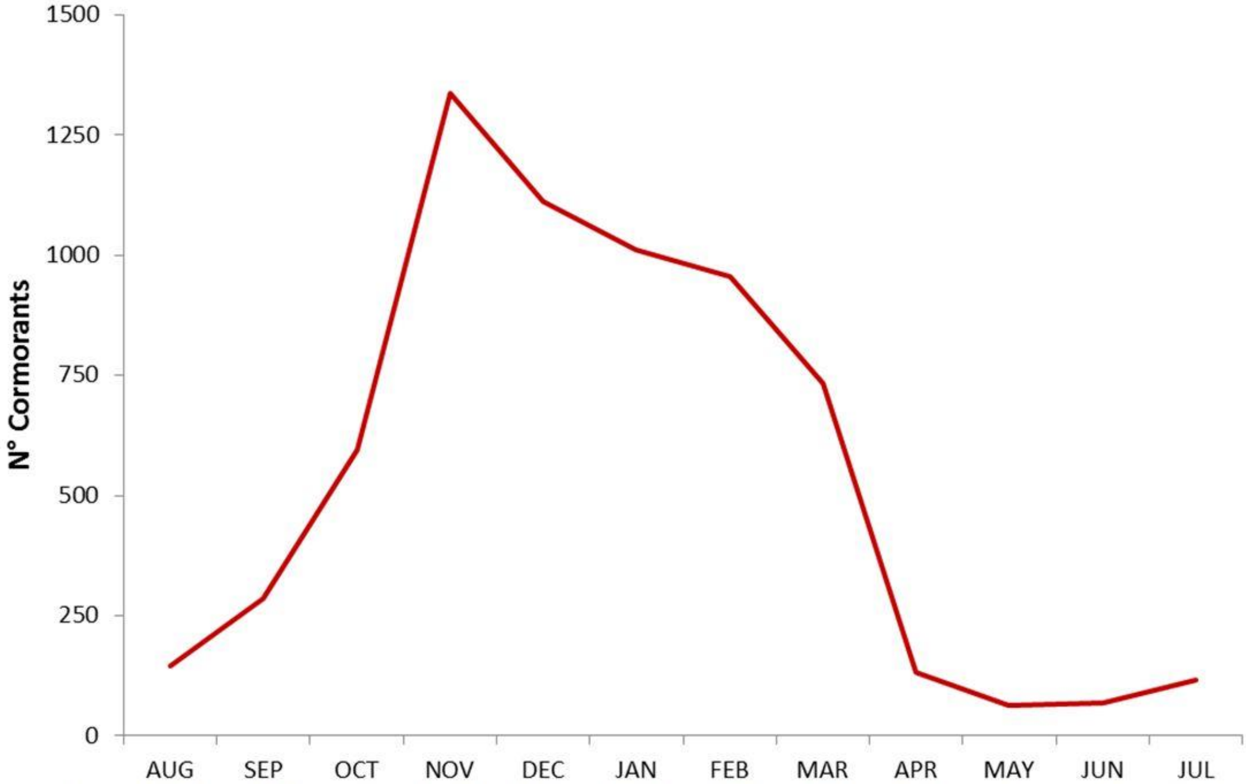
From August 2002 to March 2014, we monitored monthly the six roosts used by the species in the area. Roosting sites consist mainly of small coastal woods; navigation poles, beached trunks, lighters and floating platforms for Mussel farming are also used. Censuses were carried out at dusk on a single day or on consecutive days, in order to avoid the overestimation of the population.

Results and discussion

Overall, we recorded the highest numbers from October (mean = 594.2 ± 266, years 2002-2014) to March (mean = 732.7 ± 274.7, years 2002-2014), with a peak in November, due to a remarkable post-breeding migration in the period 2008-2011 (2,281 birds in 2009 and 2,162 birds in 2010) (Figs. 1 and 2). During summer, the numbers are low (Fig. 1) as a result of a small breeding population (20-30 pairs/year, period 2008-2013; 52-55 pairs, year 2014).

In 2004, the presence of the species during winter reached the lowest level (Fig. 2). At that time, 696 cormorants were shot according to the Regional law n. 10/2003, which was successively repealed due to an EU infraction procedure. Now, the control is in coherence with the Italian Law n. 157/1992 and the Birds Directive 2009/147/CE. Over the following ten years, we recorded a significant and consistent increase during winter (December – February), starting from about 800 birds in 2004/2005 to the current 1,300 cormorants (Spearman's rho correlation, $N = 30$, $r_s = 0.825$, $P < 0.0001$) (Fig. 2).

In such a context of increasing numbers, we highlight that our cormorants forage largely on non-reared species. Commercially important aquacultured species (*Sparus aurata* and *Dicentrarchus labrax*) indeed represent together just the 2.2% and the 13.8% by frequency and biomass of the whole diet (Cosolo et al. 2011). Moreover, the ecology and behaviour of target prey species (*Platichthys flesus* and *Mugil* spp.) affect the foraging performance of cormorants, resulting in higher access to prey and elevated prey-capture rates for benthic with respect to pelagic fishes (Cosolo et al. 2010). Finally, the wetlands managed for extensive aquaculture seem not to be profitable feeding grounds for the most part of the year (Cosolo et al. 2010). These results lead to the same conclusion that Great Cormorants in the Grado lagoon do not represent a limiting factor for the aquaculture activities.



	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
Mean	145.0	286.7	594.2	1,337.5	1,110.5	1,010.2	955.8	732.7	131.4	63.2	69.1	115.3
SD	83.0	149.8	266.0	528.6	237.6	250.7	236.4	274.7	64.3	45.4	50.4	63.9

Figure 1. Seasonal trend of the Great Cormorant population in the study area, on the basis of 12 years of monitoring data. In the table, we report Mean values and the related Standard Deviations (SD).

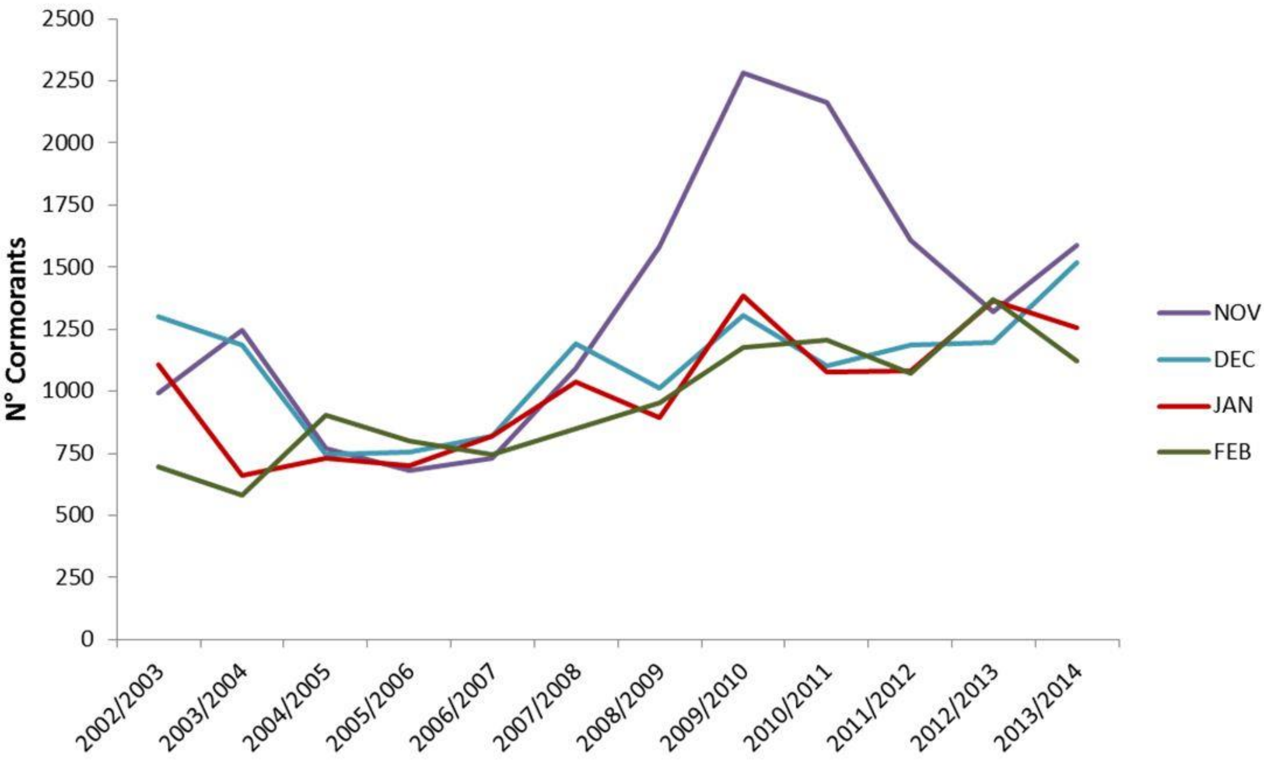


Figure 2. Trend of the Great Cormorant population in the last 12 years during winter (December-February) and during the post-breeding migration (November).

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Unwanted guest in heronries: the influences of Great Cormorant *Phalacrocorax carbo* on nest site selection of Grey Heron *Ardea cinerea* in northwestern Italy.

Alessandra Gagliardi[1], Daniela Casola[1], Damiano Preatoni[1], Lucas Wauters[1], Stefano Volponi[2], Adriano Martinoli[1] and Mauro Fasola[3]
[1]Dipartimento di Scienze Teoriche e Applicate, Università degli Studi dell'Insubria, via Dunant 3 - 21100 Varese ; alessandra.gagliardi@uninsubria.it
[2]Istituto Superiore per la Ricerca e la Protezione Ambientale, via Cà Fornacetta 9 - 40064 Ozzano dell'Emilia (Bologna)
[3]Dipartimento Scienze Terra Ambiente - Università degli Studi di Pavia, via Ferrata 1 – 27100 Pavia

Introduction and aims of the work

The Italian breeding population of Great Cormorant *Phalacrocorax carbo* is presently estimated at about 4,000 pairs in 48 colonies, recently established in Northern Italy and mainly within protected areas. Almost all colonies are located in protected sites where long-established colonies of Grey Heron *Ardea cinerea* and other colonial Ardeidae exist (Volponi & CorMoNet.it, 2013).We observed that syntopic breeding seems to generate competitive interactions between Great Cormorants and Grey Herons, that tend to use the same forest strata for breeding. We predict that the limited availability of protected breeding sites, safe from direct and indirect human disturbance, could result in interactions between these species. In this study we investigate whether the recent establishment of Great Cormorant in northwestern Italy shows any pattern of interference with Grey Heron, in particular in terms of (a) spatial overlap of the nest distribution among species, and (b) vertical distribution of the nests.

Methods

During the 2013 breeding season, we explored the potential effects of Great Cormorant establishment on spatial distribution of the two species inside a sample of six colonies, located in NW Italy (Fig. 1), that differed in the year of settlement by Cormorants (from recent establishment to long-time presence of the species). (a) Spatial overlap among species. All the trees with nests were identified and mapped using GPS. Each occupied nest was assigned to the Cormorant, the Grey Heron or to other Ardeidae. The overlap between species in each colony was estimated by producing a 5 m buffer around each occupied tree, and by calculating the surface area of the intersections between these buffers for each species, weighted by the total surface area of the colony. (b) Vertical distribution of the nests. The vertical distribution of the nests of the two species was investigated, using a random sample of at least 30 trees in each of 6 colonies. Nest height and tree height were measured using a hypsometer. The data were analyzed by ANOVA, testing the effects of species, site and the species by site interaction.

Results

(a) Spatial overlap among species. We found high overlap between the two species in the colonies of recent Cormorant settlement, while lower overlap was registered in the colonies where Cormorants had been present for a long time (Fig. 2).The relationship between overlap proportion and time since first Cormorant arrival can be modeled by a hyperbolic regression (Overlap = S/Year, $t(5) = 4.12$; $p = 0.0092$), with the S parameter (representing the rate of overlap) estimated as $S = 0.878 \pm 0.548$.
(b) Vertical distribution of the nests. Great Cormorant nests were placed significantly higher (average 13.21 ± 5.60 m, N = 439) than those of the Grey Heron (average 10.78 ± 6.76 m, N =

346; F(4,864) = 121.3, $p < 0.0001$) (Fig. 3). The "site" variable has an effect: nests of the two species were placed at different heights on a per-site basis (F(6,864) = 460.4, $p < 0.0001$). The time since Cormorant arrival seems again to affect the vertical distribution of the two species (species by site interaction F(13,864) = 15.5, $p < 0.0001$), as in the case of the spatial overlap. In colonies with recent Cormorant settlement, the Great Cormorant nests were higher than those of the Grey Heron, and the differences in nest height between the two species seem to decrease in the colonies where the two species have coexisted for a longer period. We found also the vertical alignment of Great Cormorant and Ardeidae species through vegetation is in direct relation to their body size, as suggested for colonial Ardeidae by Fasola and Alieri (1992).

Figure 1. Study area. Little dots represent the distribution of heronries in northwestern Italy, larger dots indicate the sites of coexistence with cormorants and triangles represent the sample of six studied colonies.

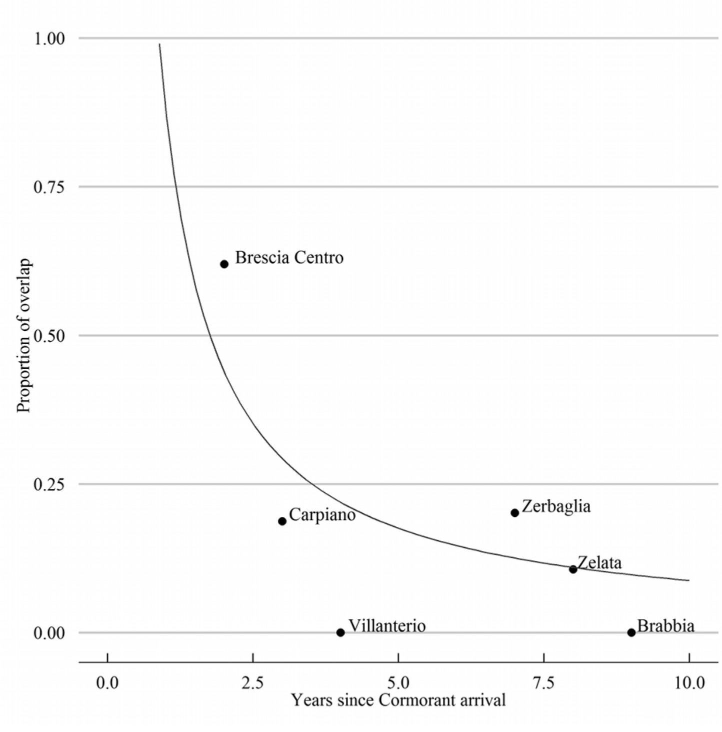

Figure 2. Relationship between overlap proportion among species and time since first Cormorant arrival. High overlap is registered in the colonies of recent Cormorant settlement, while lower overlap is registered in the colonies where the two species have coexisted for more time.

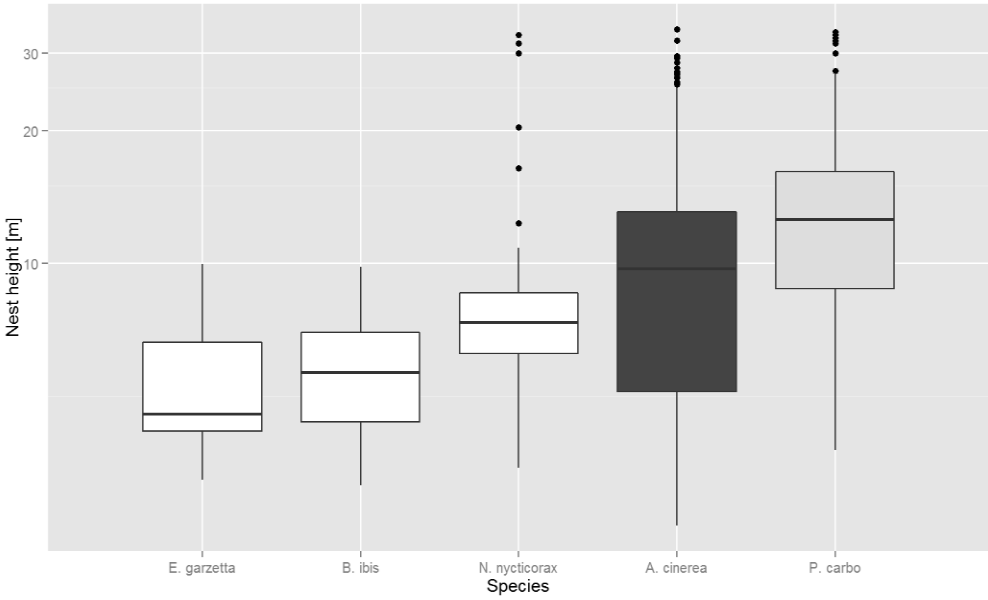

Figure 3. Vertical distribution of nests of different colonial species. Great Cormorant nests were placed higher than those of the Grey Heron.

Conclusions

In conclusion, the arrival of the Great Cormorant seems to affect the Grey Herons with a gradual spatial and vertical segregation between the two species in the colonies. The Italian breeding population of the Great Cormorant is actually only a small fraction of the European one (<1%), and the establishment in NW Italy is rapidly increasing over the last few years. If the population should continue to increase, we can expect stronger effects on breeding Grey Herons.

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Wintering population and diet of Great Cormorant *Phalacrocorax carbo sinensis* at the Eastern Macedonia and Thrace National Park, Greece

Savas Kazantzidis[1], Maria Panagiotopoulou[2], Aris Christidis[2], Efterpi Patetsini[2] and Stefan Donth[2]

[1]Forest Research Institute, GR 57006 Vassilika, Greece; savkaz@fri.gr
[2]Management authority of the Eastern Macedonia and Thrace National Park, GR 67063, Porto Lagos, Xanthi, Greece

Introduction

The National Park of Eastern Macedonia and Thrace is one of the most important wetlands in Greece regarding the wintering of Great Cormorants *Phalacrocorax carbo sinensis*. The National Park has also a great importance for fisheries that are developed in a traditional way at the coastal lagoons. Fishermen, in order to minimize the impact of Great Cormorants to their fishery, placed nets above the fish-wintering channels. Deterrent devices such as gas cannons and occasionally shooting (although illegal) are supplementary applied. In order to assess the impact of Great Cormorants to the fishery, research was carried out for first time in Greece regarding this issue.
The aim of the first phase of the research, presented in this article, was to record the number of the Great Cormorants wintering in the National Park, their distribution in the feeding areas and their diet.

The study area

The National Park (92,000 ha) consists of 5 rivers, 17 lagoons and freshwater lakes, is a Special Protection Area (partially), site of Community importance (SCI) and is included in the list of the protected under Ramsar Convention wetlands. The fishery here is one of the most important human activities within the National Park and there are eight Fishing Associations that employ more than 100 people.

Methods

The research was carried out from October 2013 to March 2014. The number of Great Cormorants was counted at their night roosting sites in the early morning (before the departure of birds to their feeding grounds) or in the afternoon (when birds return from the feeding grounds to roost overnight). Counts at the roosting sites were carried out simultaneously, once to three times per month.
The main feeding areas of Great Cormorants were recorded through surveys carried out once or twice a month at the lakes and lagoons of the National Park. Main feeding areas were thus considered to be those that Great Cormorants exploited for feeding immediately after their departure from the night roosting sites.
The diet was studied by analyzing pellets collected once a month from the day roosting sites.

Results

Great Cormorants numbers ranged from 1,550 to 12,078 individuals (Fig. 1). The highest numbers were recorded in early November 2013 but high numbers (more than 10,000) were present in the area up to December. These were the highest numbers of Great Cormorants ever recorded wintering in a Greek wetland. Great Cormorants wintering in the National Park used four night roosting sites. One of them was active during the whole wintering period (Agios Christoforos, a rocky islet at the coastal zone of the National Park). The rest were non-permanent. Two of them were in riverine forests (at Kompsatos River estuary and at Nestos

River) and the third was at the Porto Lagos lagoon, very close to the artificial fish-wintering channels. The majority (99.5%) of Great Cormorants used the largest lake of the National Park (Vistonis Lake) and the lagoons of Porto Lagos surrounded the fish wintering channels as their main foraging sites.

In 72 pellets collected from two different sites, 547 remains of fish (mostly otoliths) were recorded belonging to at least 303 fish of at least 13 species (Table 1). The mean number of fish in each pellet was 4.0±5.0 (ranging from 1 to 36) while the mean number of fish species was 2.3±1.3. The most abundant species was Boyer's Sand Smelt followed by Golden Grey Mullet and unidentified species of Mugilidae family (Table 1). Golden Grey Mullet dominated in pellets by frequency of occurrence followed by Thin-lipped Grey Mullet (Table 1). Great Cormorants consumed low percentage (8.6%) of high commercial value fish (European Seabass, Flathead Grey Mullet and Sharpsnout Seabream) while they consumed high percentage (54.5%) of medium commercial value fish (Mugilidae and Lisa sp).

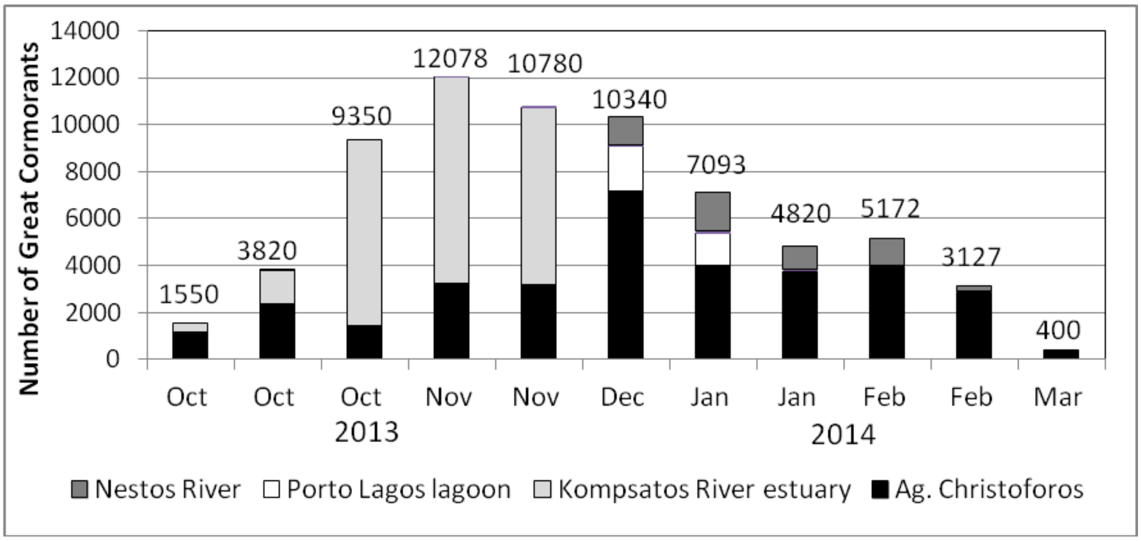

Figure 1. Numerical changes in Great Cormorants at the National Park of the Eastern Macedonia and Thrace during the winter 2013-2014 according to simultaneous counts at each one of the night roosting sites.

Discussion and conclusions

The number of wintering Great Cormorants in the National Park increased considerably during the last decade, since, during the 1990s and 2000s it ranged from 1,000 to 5,000 individuals (Panayotopoulou et al. 2011). The diet composition of Great Cormorants reflected, to a great extent, the fish community at the lagoons of the study area (Koutrakis et al. 2005). The low occurrence of commercially important species that are produced in local fisheries indicates that the measurements taken by fishermen in order to protect their fishery (excluding shooting) seems to be adequate. However, the impact may be locally and/or temporarily serious, since one of the roosting sites and a foraging area is next to the fish wintering channels.

Table 1. Diet composition of Great Cormorants wintering at Eastern Macedonia and Thrace National Park during the winter 2013-2014 according to pellet analysis and expressed by fish numbers (in %) and frequency of occurrence. In bold are mentioned fish species of high commercial value.

	Fish species recorded in pellets	Fish recorded in pellets % (number of fish in pellets)	Frequency of occurrence (%) (number of pellets)
1	Boyer's Sand Smelt *Atherina boyeri*	22.1 (67)	20.8 (15)
2	Golden Grey Mullet *Liza aurata*	19.8 (60)	44.4 (32)
3	Mugilidae sp.	15.2 (46)	33.3 (24)
4	Thin-lipped Grey Mullet *Liza ramada*	11.9 (36)	40.3 (29)
5	Leaping mullet *Liza saliens*	7.6 (23)	29.2 (21)
6	Black goby *Gobius niger*	5.9 (18)	9.7 (7)
7	Thicklip Grey Mullet *Chelon labrosus*	5.6 (17)	16.7 (12)
8	**Flathead Grey Mullet *Mugil cephalus***	**4.6 (14)**	**13.9 (10)**
9	**Sharpsnout Seabream *Diplodus puntazzo***	**2.3 (7)**	**6.9 (5)**
10	Gobiidae sp	2.3 (7)	2.8 (2)
11	**European Seabass *Dicentrarchus labrax***	**1.7 (5)**	**6.9 (5)**
12	European anchovy *Engraulis encrasicolus*	1.0 (3)	1.4 (1)
13	Syngnathus sp.	0.7 (2)	2.8 (2)
	TOTAL	(303)	(72)

Acknowledgements
The research was carried out in the framework of the project "Assessing the impact of cormorants' (*Phalacrocorax carbo*) population growth in the fish of the National Park" implemented by the Management Body "Nestos Delta-Vistonida–Ismarida" through incorporated act in the Operational Program "Environment and Sustainable Development - EPPERRA" entitled "Protection and Biodiversity Conservation of EPAMATH".

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A historical review of Great Cormorant breeding population in Croatia from 1960 to 2013

Alma Mikuška[1] and Tibor Mikuška[2]
[1]Department of Biology, Josip Juraj Strossmayer University of Osijek, Ulica cara Hadrijana 8/A, HR-31000 Osijek, Croatia; amikuska@biologija.unios.hr
[2]Croatian Society for Bird and Nature Protection, Gundulićeva 19a, HR-31000 Osijek, Croatia.

Introduction

The breeding of Great Cormorant in Croatia has been known since the 19th century when colonies at Palača-Korodj and Kopacki rit wetlands were described (Gjurasin 1901, Mojsisovics 1883, Schenk 1918, 1929). Due to persecution, reclamation and drainage of wetlands, pollution of rivers and streams, their breeding population reached minimum levels during the 1960s and mid-1970s when they were driven to the brink of extinction. Unfortunately, this decline was not properly documented in the national ornithological literature. After 1960 our knowledge of the Cormorant population started to increase, particularly thanks to late professor József Mikuska who started with the long-term monitoring program in the Kopacki rit wetlands. The Cormorant population started to increase since late 1970s for two main reasons: construction of fishponds that served as new supplemental feeding sites and a ban of persecution through legal protection. This increase lasted until the beginning of 21st century, since when the breeding population has stabilized. The purpose of this paper is to provide the literature review of the Cormorant breeding population recovery during period from 1960 to 2013.

Results and discussion

During period from 1963 to 2013, the breeding of Cormorants was recorded in 18 colonies along the Danube, Drava, Sava and Vuka rivers (Table 1).

Danube River - the key breeding area for the Cormorants in Croatia is the Danube river floodplain area from Mohacs downstream of Drava River mouth, including Kopacki rit wetlands. By 1960 three known colonies along the Danube (Monostorski rit, Vagon and Srebrenica) had been abandoned or destroyed (Szlivka 1959 in Puzović et al. 1999). Regular annual censuses started during 1963 and irregular breeding of 23-133 pairs per year occurred until the mid-1970s (Mikuska & Lakatos 1977). The population started to expand exponentially from 1977, reaching a peak in 1988 (Mikuska & Mikuska 1994). A decline in the number of breeding pairs occurred in 1990 when adults and chicks in the colony were intentionally killed by fishermen. In the 21st century numbers have fluctuated (between ca. 1,000 and 2,000 pairs), but over the last six years a constant decline in the breeding numbers has been observed, presumably due to deterioration of the nesting habitats and dry seasons. Since 2012 two breeding colonies exist in Kopacki rit wetlands which still represents the major breeding site in Croatia.

Drava River – Drava River is a second major tributary to the Danube River in Croatia. Irregular breeding of Cormorants on the Donji Miholjac fishponds started in 1969 and lasted until 1972 (Mikuska & Lakatos 1977). Due to persecution by fisherman since 1973 Cormorants changed their nesting location along Drava with frequent changes of nesting location in the consecutive years (Mikuska & Lakatos 1977; Perić 1997). Finally, since 2003 they breed on Hungarian territory where 190-359 pairs were recorded (Mikuska pers.obs.; Szinai 2014). From 1982 to 1984 a small colony of 50 pairs was established on the Grudnjak fishponds, located 20 km south-east from Donji Miholjac. By 1985 this colony was extirpated by fisherman (Grgić 1998).

Sava River – the Sava river, as the second largest Danube tributary, contains large alluvial wetlands downstream of Sisak. Breeding of Cormorants along Sava River has been officially documented since 1976 when a small colony was established and quickly destroyed on the Bardaca fishponds in Bosnia and Herzegovina (Kotrošan et al. 2012; Sjeničić, J. & Kotrošan, D. 2014). In 1981 a small colony of 14 pairs was established on the Jasinje fishponds, 28 km downstream of Bardaca (Šetina, pers.obs). Cormorants bred there until 1984 when persecution by fishermen caused the translocation of the colony to Mrsunjski lug forest (Šetina, pers.obs). As fishermens' persecution continued at Mrsunjski lug colony, part of the breeding birds moved to Radinje forest, situated 15 km upstream from Jasinje and 13 km downstream from Bardaca fishponds, respectively (Šetina, pers.obs). This colony contained 818 pairs in 1991, while Cormorants ceased to breed in Mrsunjski lug colony by 1994. In 1985 two new colonies were discovered in the Lonjsko and Mokro polje area (Schneider 1989), 100 km upstream from Jasinje fishponds. The first colony at Mokro polje held 124 and 181 nests during 1986 and 1987, respectively, while the second at Lonjsko polje had 182 nests during 1987 (Schneider 1989). By 1988 only the Lonjsko polje colony was active with 209 pairs (Schneider-Jacoby, 1993). Since 2007 breeding was confirmed along Sava River near Puska village, situated 21 km downstream from Lonjsko polje and 15 km upstream from Mokro polje former colonies. The breeding numbers in this colony fluctuated from 350 to 700 pairs until nowdays. During 2014 after a large flood a new colony of 70 pairs was established at Cigoc polje, 18 km upstream of Puska colony.

Vuka River – this small tributary of the Danube River had extensive marshlands in the 19th century with large heron and cormorant colonies (Gjurasin 1901). However, river regulation and land reclamation has drained the marshes and caused disappearance of Palaca-Korodj colony by the late 1920s (Schenk 1929).

Conclusion

After the historical decline in the 1960s, the Great Cormorant breeding population in Croatia started to recover during late 1970s. By the mid-1980s new colonies were established on major fishponds and in large alluvial floodplains along the Sava and Drava rivers. Since colonies on fishponds were quickly destroyed, the breeding population was forced to move into the alluvial wetlands that were inaccessible to fisherman. The population increased exponentially and reached its peak in the late 1980s with over 3,000 breeding pairs. Since then it has fluctuated between 1,500 and 2,500 pairs. Large floodplains along Danube and Sava rivers which still remain are key sites for the Croatian breeding population.

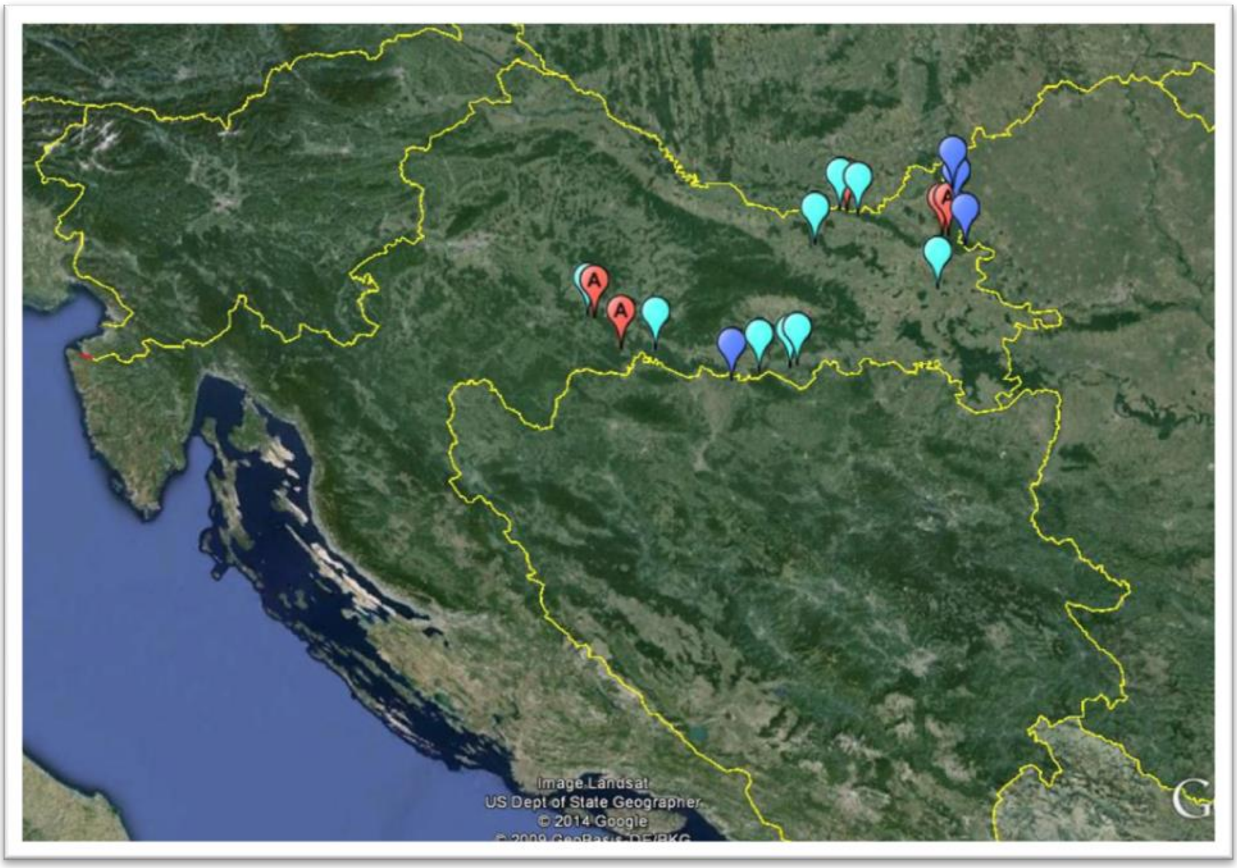

Figure 1. Distribution of Great Cormorant colonies in Croatia. Red - active, blue - former colonies, dark blue - colonies in Bosnia and Herzegovina and Serbia

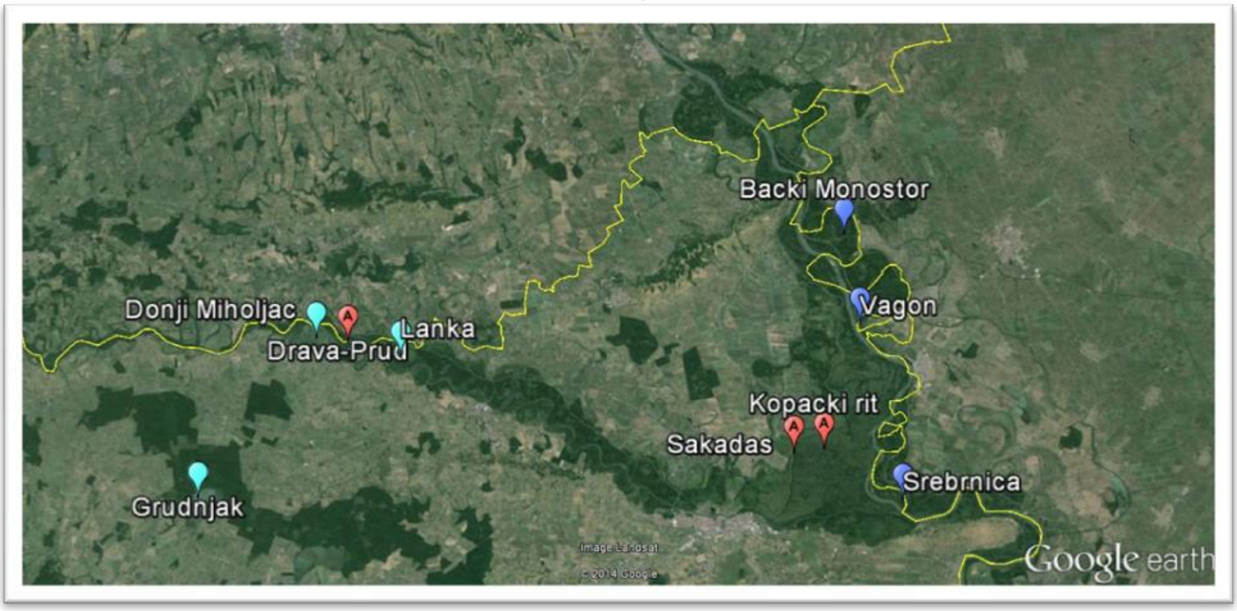

Figure 2. Distribution of Great Cormorant colonies along the Danube and Drava rivers. Red - active, blue - former colonies, dark blue - colonies in Serbia

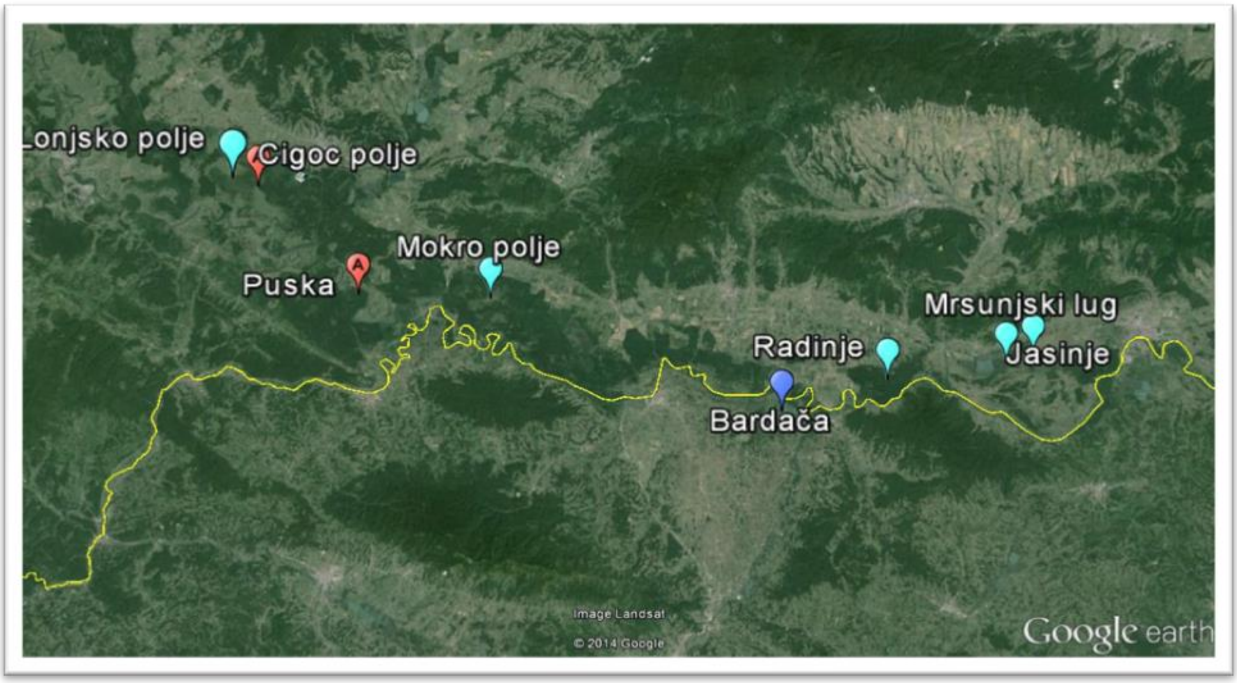

Figure 3. Distribution of Great Cormorant colonies along Sava River. Red - active, blue - former colonies, dark blue - colony in Bosnia and Herzegovina

Table 1. Historical review of the Great Cormorant colonies in Croatia.

	Danube River					Drava River				Sava River								Vuka River
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Site	Kopački rit	Sakadas lake	Monostorski rit (SR)	Srebrenica (SR)	Vagon (SR)	Donji Miholjac fishponds	Drava Prud (HU)	Lanka	Grudnjak fishponds	Jasinje fishponds	Mrsunjski lug	Radinje	Bardača (BIH)	Lonjsko polje	Cigoc polje	Mokro polje	Sava Puska	Palaca-Korodj
1963	1	0	already destroyed (before 1958)															drained
1964	?	0	0	0	0													0
1965	1	0	0	0	0													0
1966	50	0	0	0	0													0
1967	1	0	0	0	0													0
1968	0	0	0	0	0													0
1969	0	0	0	0	0	10												0
1970	133	0	0	0	0	0												0
1971	0	0	0	0	0	0												0
1972	78	0	0	0	0	6												0
1973	27	0	0	0	0	0		10-12										0
1974	100	0	0	0	0	0		10-12										0
1975	100	0	0	0	0													0
1976	50	0	0	0	0								9					0

1977	142	0	0	0	0								0					0
1978	366	0	0	0	0													0
1979	334	0	0	0	0													0
1980	534	0	0	0	0													0
1981	781	0	0	0	0					14								0
1982	858	0	0	0	0				(50)	?								0
1983	1014	0	0	0	0				(50)	?								0
1984	878	0	0	0	0				(50)	136	0							0
1985	900	0	0	0	0				0	0	B			20	0	100		0
1986	1200	0	0	0	0				0	0	B			B?	0	124		0
1987	1500	0	0	0	0				0	0	B			182	0	181		0
1988	2855	0	0	0	0				0	0	B			209	0	0		0
1989	2667	0	0	0	0				0	0	B			0	0	0		0
1990	1367	0	0	0	0				0	0	B			0	0	0		0
1991	?	?	0	0	0				0	0	B	811		?		?		0
1992	?	?	0	0	0				0	0	B	?		?		?	?	0
1993	?	?	0	0	0				0	0	B	?		?		?	?	0
1994	?	?	0	0	0				0	0	B	?		?		?	?	0
1995	?	?	0	0	0				0	0	0	?		?		?	?	0
1996	?	?	0	0	0				0	0	0	?		?		?	?	0
1997	?	B	0	0	0			B (Borik i Lanka)	0	0	0	?		?		?	?	0
1998	1614	B	0	0	0	0			0	0	0			0		0		0
1999	1586	0	0	0	0	0			0	0	0							0
2000	2500	0	0	0	0	0			0	0	0							0
2001	2500	0	0	0	0	0			0	0	0							0
2002	1000	0	0	0	0	0			0	0	0							0
2003	1226	0	0	0	0	0	B		0	0	0							0
2004	1627	0	0	0	0	0	359		0	0	0							0
2005	1173	0	0	0	0	0	259		0	0	0							0
2006	1816	0	0	0	0	0	209		0	0	0						B	0
2007	2090	0	0	0	0	0	?		0	0	0						B	0
2008	1435	0	0	0	0	0	?		0	0	0						721	0
2009	1200	0	0	0	0	0	?		0	0	0						?	0
2010	1050	0	0	0	0	0	334		0	0	0						500-600	0
2011	B	6	0	0	0	0	195		0	0	0						?	0
2012	808-813	0	0	0	0	0	190		0	0	0		0				518-580	0
2013	B	12-15	0	0	0	0	?		0	0	0						B	0
2014	B	408	0	0	0	0	?		0	0	0				70		B	0

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Current status of breeding population of Great Cormorant in the Czech Republic

Petr Musil and Zuzana Musilova
Department of Ecology, Faculty of Environmental Science, Czech University of Life Sciences, Kamýcká 129, 165 21 Praha 6, Czech Republic; p.musil@post.cz

After an absence since 1962, Great Cormorants Phalacrocorax carbo sinensis re-colonized the Czech Republic in 1982 when a colony was discovered in South Moravia. In the following years the Czech Great Cormorant population expanded rapidly, with a mean annual increase of 45 % between 1982 and 1991. By 1991 it appeared that an upper limit had been reached of 682 pairs. By 1997 the breeding population had decreased to 153 pairs as a result of dead trees falling and regulatory measurements (esp. shooting in the pre- and post-breeding seasons). A gradual increase in the number of breeding pairs was recorded again after 1997 reaching 291 pairs in 2005. Afterwards, total number of breeding pairs fluctuated between 266-350 pairs. Nevertheless, the number of breeding pairs in 2013 was the lowest since 2005. The recent decrease in numbers of breeding pairs, as well as nestlings per nest, is likely affected by drying and dying of breeding trees affected by Cormorant excrement. In total, 22 different breeding colonies were recorded in the Czech Republic between 1982 and 2013.
In 2013 there were 266 breeding pairs of Great Cormorants in a total of six colonies in the Czech Republic. Complete coverage of all known colonies was obtained in the 2013 count and in all previous counts since the re-establishment of the breeding population in 1982. In 2013, Great Cormorants bred in four regions across the Czech Republic with the majority of breeders located in the south of the country. Almost half of the breeding population was found in one colony located in the Trebon Basin in the region of Southern Bohemia (48 %, 129 nests). A further 37 % of the breeders (98 nests) were located in three colonies in the region of Southern Moravia. Great Cormorants also bred in small numbers in one colony in the floodplain area of the River Odra in Northern Moravia (11 %, 29 nests) and in one colony in the Chomutov District in Northern Bohemia (4 %, 10 nests).

Recent status of the cormorant species in Hungary; Cormorant feeding ecology and diet

Peter Szinai
Balaton Uplands National Park Directorate Csopak, Kossuth u. 16. Hungary H-8229
szinai@bfnp.hu

After the extinction of the Great Cormorant *Phalacrocorax carbo sinensis* as a breeder in Hungary in the beginning of the 20th century, the species recolonized the country (Kis-Balaton) in 1947 (10 pairs).
The Kis-Balaton colony was the only known breeding site in the country until the 1970s. Since then, the population has increased and spread to the initial suitable habitats. In the 1990s the population reached 1,700-1,800 pairs and between 1999 and 2001 the number of breeders remained stable at ca. 3,200 pairs (3,192 pairs in 1999 3,185 pairs in 2000 and 3,285 pairs in 2001) (Oláh et. al. 2003). Since the Millennium the breeding population has been declining slightly.

In 2013 it was estimated that there were 2,500 breeding pairs of Great Cormorants in a total of 20 colonies in Hungary. A slight decline has been detected since 2012 when there were ca. 2,661 breeding pairs in 22 colonies in Hungary. Over 94 % of the Great Cormorants in

Hungary nest in trees, mainly in floodplain forests and on forested islands of rivers and lakes. The largest colony held 470 nests.
The pan-European winter count (mid-January 2013) produced slightly over 10,000 individuals in 43 roosting sites. According to ringing recoveries, the wintering birds mainly originated from the Baltic populations. The wintering population has also declined in the recent years (Faragó & Gosztonyi, 2013).

After the extinction of the Pygmy Cormorant *Phalacrocorax pygmeus* as a breeder in Hungary in the beginning of the 20th century, the species recolonized (Lake Tisza) in 1988 (one pair).

Since the 1990s, the population has increased and spread to initial suitable habitats. The breeding population in the last ten years: 2003: 210-300 pairs, 2004: 270-340 pairs, 2005: 330-450 pairs, 2006: 450-640 pairs, 2007: 410-540 pairs, 2008: 490-620 pairs, 2009: 660-750 pairs, 2010: 810-1,060 pairs, 2011: 1,100-1,350 pairs, 2012: 690-940 pairs. In 2013 there were 985-1,110 pairs in a total of 22 colonies in Hungary. The Pygmy Cormorants in Hungary mainly nest in reed beds on large fish pond systems and lakes, partly in floodplain forests and on willow bushes by rivers and lakes. The largest colony (Hortobágy) held 250-280 nests.
The wintering population increasing (total 4,000-5,000 birds) the main wintering sites are Szeged, Hortobágy and Kis-Balaton.

Fish consumption of the Great Cormorant in the area of Hortobágy Fish Farm, Hungary

Norbert Tóth, Péter Gyüre and Lajos Juhasz
University of Debrecen, Centre for Agricultural and Applied Economic Science
Department of Nature Conservation Zoology and Game Management Debrecen, Hungary
toth@agr.unideb.hu

The Great Cormorant *Phalacororax carbo* is a bird species that nests sporadically but also in colonies, besides larger fishponds and rivers in Hungary. The number of individuals has been increasing during the last two decades. The species eats solely fish, therefore it can cause serious depredation to the fish stocks of fishponds in intensive systems and after the freezing of the ponds, in larger rivers, which are not yet frozen. The aim of our research is to reveal the damage the birds can cause in the study areas and the extent of the losses the Hortobágy Fish Farm Co. has to realize.

Our studies were carried out between April 2012 and November 2013. During dissection, the investigation of the crop contents of the birds and their biometric studies were conducted. The results revealed the diverse prey base of the species. In the samples, we have determined 300 identified fish individuals; in 289 cases, the exact fish species were also determined. Although statistical differences were found between the particular pond units and the consumption of corresponding fish species, this cannot be considered as absolutely certain.

Our investigation is of considerable significance in terms of nature preservation and, not least, it has substantial financial concerns too. Under ever harder fish production conditions, the presence and thus the permanent presence and predation of the bird affects the fishermen. In favour of maintaining of the natural ecological balance and the income of the fishers, the elaboration of adequate protective and efficient preventive processes will be necessary in the near future.

Spending the time, ranging the space - preliminary results for Great Cormorant males: GPS telemetry during breeding season

Michał Goc, Mateusz Kobierzyński and Agnieszka Wardak
Department of Vertebrate Ecology & Zoology, University of Gdańsk, PL- 80-308 Gdańsk, ul. Wita Stwosza 59; biogoc@ug.gda.pl

In 2013, three breeding male Great Cormorants were captured in the early breeding stage in the Katy Rybackie colony (N Poland) and equipped with GPS – GSM loggers. Two of these loggers recorded bird position every half an hour and they worked for 23 and 57 days, respectively. The third logger collected data 4 times a day and worked for 194 days, but only results relating to the period of the breeding season were analysed. The telemetric data were supplemented by observations of bird behaviour during nest building. We showed daily activity pattern, number, timing and range of foraging flights and their seasonal variation.

Instructions to authors

The Cormorant Research Group Bulletin accepts all manuscripts dealing with cormorant ecology, cormorant research and cormorant protection in the broadest sense as well as Cormorant Research Group items.

All manuscripts should be submitted in English language and in electronic form. Text files should be submitted in *.doc-format; Font in Times New Roman 12 point and tables and graphs in *.xls-format and pictures in good quality and *.jpg-format.

Follow an appropriate authority for common names (e.g. Checklist of Birds of the Western Palearctic). Give the scientific name in full, in *italics*, at first mention in the main text, not separated by brackets. Numbers - less than ten use words e.g. (one, two three etc) greater than 10, use numbers with comma for numbers over 1,000. In case of doubt please look at the last issue of the Cormorant Research Group Bulletin.