7th International Conference on Cormorants
4th Meeting of Wetlands International Cormorant Research Group

23 - 26 November 2005
Villeneuve (VD), Switzerland

Programme and Abstracts

Coordinators

International Cormorant Research Group: Mennobart van Eerden
Schweizerische Vogelwarte Sempach/Swiss Ornithological Institute: Verena Keller

Supported by
Fondation des Grangettes
Pro Natura Vaud

PROGRAMME

Talks allow for 20 min, including questions and discussion

23 November 2005

1600-2000 h Registration

2000 h Informal get together
Information about colour ringing programmes
Video

24 November morning

0915 h Opening address and welcome
Mennobart van Eerden, Cormorant Research Group
Verena Keller, Swiss Ornithological Institute
Pierre Goeldlin, Fondation des Grangettes/Pro Natura Vaud

Session 1: Numbers and status (7)

0940 h Van Eerden, Mennobart R. and Stef van Rijn
Cormorants in the Netherlands: forty years of countrywide protection 1965-2005

1000 h Marion, Loïc
Trends of breeding population of Cormorants in France

1020-1050 h Coffee break

1050 h Veldkamp, Ronald
Does a yearly count of a Cormorant colony under-estimate the real number of breeding pairs?

1110 h Hatzofe, O., Yifat Davidson, Y. Harari and S. Nemtzov
The wintering Great Cormorant, *Phalacrocorax carbo sinensis*, in Israel - abundance and distribution

1130 h Thapa, Tej B.
Status review, habitat use and conservation threats of Great Cormorant (*Phalacrocorax carbo*) in lowland Terai of Nepal

1150 h Pandiyan, Jahanathan, Krishnamoorthy Thiyagesan and R. Nagarajan
Abundance and distribution pattern of Indian Little Cormorant *Phalacrocorax niger* in seasonally dynamic lakes of Cauvery Deltaic Region of Southern India

1210 h Le Gentil, Jérôme and Loïc Marion
Population structuring of the cormorant in Europe: two or three subspecies?

1230-1400 h Lunch break

24 November afternoon

Session 1 cont: Numbers and status (3)

1400 h Schifferli, Luc, Marcel Burkhardt and Matthias Kestenholz
Population of the Great Cormorant *Phalacrocorax carbo* wintering in Switzerland, 1967-2003 and numbers during the breeding season

1420 h Marion, Loïc
Trends of wintering population of Cormorants in France

1440 h Van Rijn, Stef, Jeroen Nienhuis and Mennobart R. Van Eerden
Cormorants in the Netherlands in winter: the increasing importance of breeding habitat being used by wintering birds

Session 2: Food and feeding ecology (3)

1500 h Carpentier, Alexandre, Loïc Marion and Jean-Marc Paillisson
Response of a breeding colony of Great Cormorants to changing prey stocks in an inland French natural lake

1520-1550 h Tea break

1550 h Liordos, Vasilios, S. Zogaris and D. Papandropoulos
Great Cormorant food and human perceptions at the Amvrakikos Gulf, westernGreece

1610 h Musil, Petr , Zuzana Musilová and Hana Cimburková
Increasing numbers wintering of Great Cormorants *(Phalacrocorax carbo sinensis*) and its possible effect on other fish-eating species

1630 h CRG Meeting

Session 3: Poster presentations

1800 h **Reception at Village Hall**
2000 h **Dinner at Restaurant Oasis (Hotel du Port)**

25 November morning

Session 2 continued: Food and feeding ecology (2)

0840 h Thiyagesan, Krishnamoorthy, K. Balamurugan, and R. Nagarajan
Population dynamics, roosting behaviour, time activity pattern, and food and feeding habits of Little Cormorants *Phalacrocorax niger* (Vieillot) in Neyveli, Tamilnadu, southern India

0900 h Van Eerden, Mennobart R., Stef Van Rijn and Mervyn Roos
Food and feeding behaviour of Cormorants at Lake IJsselmeer: the birds at the interface of man's use of the environment

Session 4: Migration, roosting behaviour (5)

0920 h Paquet, Jean-Yves
Great Cormorant *Phalacrocorax carbo* night-roost occupancy in relation to habitat variables: are there indications of varying roost quality in a given wintering area?

0940 h Newson, Stuart E. and John H. Marchant
Colonisation and range expansion of inland breeding Cormorants in England

1000 h Bzoma, Szymon , Tomasz Mokwa and Maciej Gromadzki
Recoveries of Great Cormorants (*Phalacrocorax carbo*) in Poland

1020-1050 h Coffee break

1050 h Van Rijn, Stef and Mennobart R. Van Eerden
Almost 25 years of Cormorant colour ringing in the Netherlands

1110 h Hénaux, Viviane, Thomas Bregnballe and Jean-Dominique Lebreton
The potential of capture-recapture analyses for the understanding of population dynamics

Session 5: Impact assessment, interaction with fisheries and management (9)

1130 h Coleman, Jeremy T.H., Milo E. Richmond, Lars G. Rudstam, James R. Jackson, Anthony J. Vandevalk, Richard B. Chipman, and Brian J. Iirwin
The response of sport fish populations to Double-crested Cormorant management: an assessment of eight years of cormorant hazing on an inland lake in New York

1150 h Somers, Christopher M. and Victoria A. Kjoss
Double-crested Cormorants and fisheries: potential interactions in Saskatchewan, Canada

1210-1400 Lunch break

25 November afternoon

Session 5 continued

1400 h Hanisch, Shauna L., Peter H. Butchko and Brian S. Dorr
A new policy for management of Double-crested Cormorants in the United States and an example of its implementation

1420 h Barras, Scott C., Bronson K. Strickland, Brian S. Dorr, Richard B. Chipman and John E. Mcconnell
Adaptive management of Double-crested Cormorant impacts to habitat, fisheries and rare species in the northeastern United States

1440 h Bregnballe, Thomas
Shooting of Great Cormorants as a management tool in two Danish fjords

1500 h Sterup, Jacob, Thomas Bregnballe and J. Eskildsen
Oiling of Great Cormorant eggs in Denmark and behavioural responses to oiling

1520-1550 Tea break

1550 h Gerdeaux, Daniël
Overview on the national management plans on Cormorants in European countries

1610 h Staub, Erich
Assessment of the Swiss Cormorant Management Plan 1995 and new Management Plan 2005

1630 h Behrens, Vivien, F. Rauschmayer and H. Wittmer
Managing the Cormorant – A case study of failure of a European action plan to minimise the conflicts between great Cormorant and fisheries

1650 h Discussion on management issues and future developments

1710 h Closing of conference

2000 h Jean-Marc Fivat
Les Cormorans et les oiseaux du lac
Public slide show (in French, with translation into English)

26 November morning

Excursion to the Ramsar site Les Grangettes

0830 h Departure from meeting point at Restaurant Oasis
Return c. 1200

Abstracts of 1) oral presentations, 2) extra papers of authors not able to be present at the meeting and 3) posters

Oral presentations

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Cormorants in the Netherlands: forty years of countrywide protection 1965-2005

Cormorants have been protected in the Netherlands since 1965. This country with a significant breeding population was the first in Western Europe to ban interference in colonies. The logistic growth of the population showed a strong increase of the Dutch population in the 1970s and 1980s, stabilising in the 1990s.
Since 1995 10-12,000 pairs of Cormorants have bred in the freshwater environment of Lake IJsselmeer (55-67% of the total Dutch population). This is less than at the beginning of the 1990s when the number increased to more than 15,000 under temporary favourable circumstances. Recently, a natural stabilization of the numbers took place after a dramatic decrease in 1994. The population development in the major IJsselmeer colonies is described and the sudden set-backs in number of breeding pairs, the “crashes”, related to environmental (local) developments. The relative importance of the IJsselmeer decreases over time and within the area a shift occurs towards the northern part of the lake. In the early 1990s a new, relatively small colony settled in the central part of the lake IJsselmeer, just north of the city of Enkhuizen. In this colony, since 2000 a spectacular increase with more than 4,000 breeding pairs was recorded. At the same time the colonies of Lepelaarplassen and Oostvaardersplassen faced some strong declines in breeding numbers in 1999 and 2004 respectively. Consequently the total population remained stable. As the stabilization suggests, the maximum level of exploitation of the area has been reached.
Production of young in the old colonies is at a low level nowadays, often less than one young fledged per nest. Breeding success is particularly dependent on wind conditions. The fact that breeding success in the old colonies is strongly correlated, with no relationship with colonies outside the area, indicates that the local food availability at the lake is responsible for variations in breeding success. Density dependent recruitment and population development towards equilibrium supports the view that natural conditions have limited further growth.

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Trends of breeding population of Cormorants in France

The first common National Census of breeding Cormorants in both inland and coastal France occurred in 2003. The population reached 4855 breeding pairs distributed in about 71 colonies, including 2107 pairs in 38-39 coastal colonies (presumed *Phalacrocorax c. carbo*) and 2748 pairs in 33 inland colonies (presumed mainly *Ph. c. sinensis*). The coastal population was practically levelling off since 1998 in the Channel, but it recently expanded to the Atlantic coast with a pioneering colony in the Gulf of Morbihan, which induced the most part of the global increase of population size. The inland population, that appeared in France in 1981 with the pioneering colony of Grand-Lieu, largely contrasts with the coastal one, both in its larger distribution (19 departments instead of 6) and in its rate of increase (13.8% per year between 1998 and 2003). However, the 5 larger pioneering colonies that appeared 15 or 10 years ago are all stabilized since several years, and the remainder of the population is scattered over 28 small colonies, which became established with difficulties, with a cumulated number of abandoned colonies practically twice more important in 13 years. Most of these inland colonies are distributed in the third northern part of France. There is a strong contrast between this distribution of the breeding French population and the wintering population. Densities of breeders stay very low for a bird: 1.6 breeding pairs of Cormorant per kilometre of sea-coast for the marine population, and 0.015 breeding pairs per km^2 for inland Cormorants in the northern third part of France.

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Does a yearly count of a Cormorant colony underestimate the real number of breeding pairs?

The author counted the number of breeding pairs in the oldest colony in The Netherlands, the Wanneperveen-colony, annually since 1983. These counts were carried out once a year. Due to the fact that in this colony the laying of eggs by some birds can start in January while other birds will start months later, a single count of the number of nests counted in April or May probably underestimates the real number of breeding pairs in the colony. During the breeding season 2005 weekly counts were carried out in a part of the colony and 20 nesting trees were photographed once a week to make an estimate of the exact number of breeding pairs. At one of the nests observed, young were reared twice during the 2005-breeding season.

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The wintering Great Cormorant, *Phalacrocorax carbo sinensis*, in Israel - abundance and distribution

During the last quarter of the 20th century, the wintering population of the Great Cormorant in Israel had increased dramatically (up to 3-4 fold). While in 1975 only 59 Great Cormorants were counted in Israel, the wintering population today is estimated at 20,000-30,000 individuals.
Traditionally, this population wintered in a few large water bodies in northern Israel. The population has expanded its distribution to new water bodies in all parts of the country (up to 400 km apart), even in water-bodies in the extreme desert (<50 mm annual precipitation). The water bodies occupied in recent years are diverse both in size and function, and include rivers, reservoirs, fishponds, a city park's lake, and the Mediterranean and Red Sea shores. The day-roosting sites are also quite diverse, and there are Great Cormorants that roost even in urban areas.
We are engaged in monitoring, management and research, to estimate Great Cormorant damage to freshwater fisheries, and to study their behaviour at wintering sites. In addition we are experimenting with practical methods to regulate their distribution within the country in order to reduce conflict with the fisheries.
The Israeli Greater Cormorant population nests, most probably, in the Ukraine, as all rings recoveries (n=45) were from there. Naturally, this has management implications that call for collaboration between the two countries.

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Status review, habitat use and conservation threats of Great Cormorant (*Phalacrocorax carbo*) in lowland Terai of Nepal

This study aimed at reviewing the status, distribution and threats of greater cormorant (*Phalacrocorax carbo*) in the lowland Terai region of Nepal, and assessing the habitat use of the species in and around the Royal Chitwan National Park (RCNP). The greater cormorant is widely distributed in wetlands throughout the Terai. Although well preserved inside the protected areas, the greater cormorants are facing many threats including habitat loss and degradation due to over use or unsustainable use of water resources for irrigation and man-made modifications, reduced productivity and food availability due to increasing runoff and sedimentation caused by agricultural practices and deforestation in and around the wetlands, water pollution, over harvesting of wetland resources including fish, Infestation of Invasive Alien Species, etc. The ecology of cormorant particularly temporal and spatial distribution and choice of roosting and foraging sites are an important preliminary for management of these species. Identified sites of distribution in the entire Terai region, and foraging and roosting sites in and around the RCNP have been mapped using geographic Information system. A comprehensive population-monitoring programme is essential to monitor the distribution and status, and collect other ecological information of the Cormorants in the Terai of Nepal. This paper also discusses causes of wetland degradation and its implication on the cormorant conservation in the country.

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Abundance and distribution pattern of Indian Little Cormorant *Phalacrocorax niger* in seasonally dynamic lakes of Cauvery Deltaic Region of Southern India

The water quality parameters and soil nutrients are vital for the survival of diving birds. Many studies have been carried out on the diving pattern of diving birds but very few studies closely investigate the environmental factors of specific wetlands and related organisms. This study was conducted with emphasis on availability of wetland habitats, especially lakes, prey availability survey, evaluation of water quality parameters, soil nutrients and conflicts between the cormorants and human activities in the Cauvery Deltaic region of Tamilnadu, southern India, 2003-2005. The appropriate statistical tools have been applied and obtained positive results between the bird characteristics features such as cormorant density, diversity, richness and wetlands types. Correlations (r) and step-wise multiple regression analyses showed a causal relationship between the water quality variables and cormorant population characteristics. Potential prey items such as polychaete worms and molluscs differed significantly between the areas used by cormorants within the range of wetland habitats. The present study revealed that water quality parameters, soil nutrients and prey availability strongly influence the diving pattern of diving bird communities, especially cormorant community structure.

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Population structuring of the Cormorant in Europe: two or three subspecies?

The Great Cormorant *Phalacrocorax carbo* is known to have two subspecies in Europe, the marine *P. c. carbo* on the coasts of Norway, Iceland, British isles and France, and the continental *P. c. sinensis*. After a dramatic decline until the 1960s, this last subspecies largely expanded and introgression in the *P. c. carbo* area was observed in western France and eastern England, with increasing number of inland colonies which can be attractive for the marine population itself. In the aim to determine the new distribution of populations in such situation, the population structure was studied at the scale of Europe according to 35 sampled populations, by using sequences of domain I of the d-loop mtDNA and six loci of microsatellites. We found 59 haplotypes based on 30 polymorphic sites, levels of allelic diversity and heterozygosis were high (uncorrected mean alleles/locus and He were respectively 4.3-11.1 and 0.64-0.91). Significant genetic structuring with isolation by distance was detected through the European scale, despite a low differentiation. Instead of two expected clades corresponding to the traditionally described subspecies, genetic results revealed three major clades through the European range: "S" mainly in mainland, "C" mainly in the western part of the range (UK, coastal France), and "N" mainly present in the Nordic range (Norway, but also on the coasts from Sweden to Brittany). Scottish and northern Norwegian colonies seemed to be genetically isolated, whereas the new inland French colonies are essentially composed of the two clades S and C.

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Population of the Great Cormorant *Phalacrocorax carbo* wintering in Switzerland, 1967-2003 and numbers during the breeding season

Based on roost counts and national waterbird counts in mid-January, 1967-2003, we document the numbers wintering in Switzerland and adjacent waters. Numbers increased exponentially, from 331 in 1967 to the maximum of 8'415 in January 1992, and in parallel to the growth of the breeding population in The Netherlands, Denmark and Germany, the major sources of the Swiss wintering population. 1993-2003, numbers fluctuated around 5,619±459, in spite of a continued growth of the breeding population. On 15 large lakes (surface>10 km^2), holding three quarters of the national total, fluctuations following the peak run in parallel to the yield of the professional fishery, which was taken as an index of food supply (perch *Perca fluviatilis* and roach *Rutilus rutilus*). This confirms predictions of Suter (1995), suggesting that food limited the population in the Swiss winter quarters earlier than on the breeding grounds.
Until 1976, Cormorants were restricted to the Lakes of Constance, Geneva, Zurich and Neuchâtel. Subsequently, other lakes were colonised. Their total peaked in 1989. The final stage of growth, however, was mainly the result of an expansion to rivers (free running and dammed parts), holding a third in January 1991. Coinciding with measures taken to disturb Cormorants on rivers holding important populations of threatened fish species (e.g. Grayling *Thymallus thymallus*), the riverine proportion of Cormorants declined and stabilised (January mean, 1997-2003: 19±2 %).
Since the mid-1980s, summer visitors increased to some 200. First breeding occurred in 2001. The number of pairs has been increasing and in 2004 100 young fledged from 53 broods.

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Trends of wintering population of Cormorants in France

The 8th National Census of wintering Cormorants in France was conducted during winter 2004-2005 for all night roosts. The size of population reached 96 578 cormorants in January 2005, in 819 roosts dispersed over 91 departments. The annual increase rate represented 4.05% between 2003 and 2005, against 2.40% between 2001 and 2003 and 1.01% between 1999 and 2001, showing a small increase after a strong previous decrease of growth (7% between 1997 and 1999 and 15% between 1970 and 1992). The annual increase rate of the number of roosts (3%) confirmed a decrease after the previous large increase (5% between 2001 and 2003, 9.8% between 1999 and 2001, 11% between 1997 and 1999). The distribution of roosts did not really change since 2001, the main axis concerning the valleys of large rivers (Rhône, Loire, Rhine, secondary Garonne and Seine) and the coasts, all of them showing a levelling-off or a decreasing size of population. There was no relation between intensity of shooting and change in distribution of populations between departments, as for the preceding censuses. The distribution appeared to be largely related to resources, even if locally disturbance may influence the size of some roosts and may change the number of cormorants, the general pattern thus being little related to the intensity of shooting during the same winter. The increasing levelling-off of the national French wintering population largely corresponds to those of the breeding populations in the northwestern Europe from which wintering birds originate, and shows a classic density-dependent regulation curve.

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Cormorants in the Netherlands in winter: the increasing importance of breeding habitat being used by wintering birds

Two countrywide surveys have been carried out in the Netherlands during recent years (January 2003, 2004 and partly 2005). The results show a strong increase in number of wintering birds, compared to estimates in the 1980s and 1990s. Besides the area of the large rivers, the IJsselmeer area has become a major wintering site. The results indicate a shift in temporal use of habitat and discussed are the effects of wintering birds on their breeding conspecifics.
The reason behind this is discussed in relation to the increased wintering population in Western Europe. The role of management measures in wintering areas for Dutch birds may have contributed to this shift (shooting, roost disturbance). Also, the increased water quality of inland waters and the mild climate are supposed to play a role in relation to the observed patterns. The results from the winter counts are compared by data from the colour-ring project.

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Response of a breeding colony of Great Cormorants to changing prey stocks in an inland French natural lake

In the present study we examine the response of a population of breeding top predators, the Great Cormorant *Phalacrocorax carbo*, to changing prey availability of fish stocks, in an inland eutrophic lake in France, Lake Grand-Lieu. Facing an increasing dominance of cyprinid stocks (250 to 383 kg/ha corresponding to 79 and 90 % of the stock, respectively) through a 4-years period, with regards to the lake waters quality trend, this generalist predator showed 1) a strong plasticity (adaptability) in its diet, and 2) a rather limited exploitation of prey stocks (about 3 to 9 % of the fish stock according to different estimations). We also found that fishing strategy of Cormorants, i.e. foraging tactics (social *vs* solitary fishing) and feeding locations (littoral, vegetated and open water areas), were more conditioned by food accessibility rather than overall abundance of prey stocks. Cormorants mainly exploited open waters of the lake (about 85 % of fishing birds) using social fishing where fish stocks were the lowest (*e.g.* in 2000-2001: 200 to 300 kg/ha compared to 510 to 760 kg/ha in floating macrophytes area and 1200 to 1800 kg/ha in the littoral zone) and quasi-exclusively composed of shoaling species. In conclusion, the regulation of this population, the largest in France and approaching stabilisation, seems to be more linked to resource accessibility than abundance, which is amazing knowing the low rate of predation pressure on fish stock.

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Great Cormorant food and human perceptions at the Amvrakikos gulf, western Greece

The diet of the Great Cormorant (*Phalacrocorax carbo*) along with the perceptions of local fishermen was examined at the Amvrakikos Gulf, western Greece. Twenty-two birds were taken and their stomach contents analysed to assess diet. The opinions of 51 fishermen on Great Cormorant behaviour and diet were also monitored. The most abundant prey types found in the stomachs analysed were Boyer's Sand Smelt (*Atherina boyeri*) and *Gobius* spp. by numbers, and members of the mullet (Mugilidae) family by biomass. Fish species of high commercial value contributed 3.8% by numbers and 18.2% by biomass to the birds' diet. Fishermen consider Great Cormorants as the main threat to both their income (44%) and fish populations (84%). They also believe that Great Cormorants consume either fish of high commercial value (31%), or juvenile individuals of valuable species (53%). Most of the fishermen thought that the birds consume all available species (74%), while some mainly Mugilidae (24%). Diet analysis revealed that Great Cormorants feed on a variety of prey types, though few were found in considerable proportions. In addition, fish species of low and medium commercial value dominated their diet, contrary to the fishermen's beliefs.

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Increasing numbers wintering of Great Cormorants *(Phalacrocorax carbo sinensis*) and its possible effect on other fish-eating species

Regular wintering of Great Cormorant *(Phalacrocorax carbo sinensis*) in the Czech Republic was recorded from the mid 1980s. Wintering population size was estimated at 500 -1500 individuals in 1982-1985, resp. 4000 – 6000 individuals in 1999 and more recently at 9500- 10000 individuals in winter 2004/05. The last estimate is based on data from International Waterbird Census, which achieves almost complete coverage (478 sites in 2004 and 567 sites in 2005) on the territory of Czech Republic. The regional shift in distribution of wintering Cormorants was recorded during last decades. In 1980s and early 1990s the majority of wintering Cormorants was recorded in South Moravia. Nevertheless, North and Central Bohemia seems to be the most important region for wintering Cormorants since the mid 1990s. Climatic conditions affected wintering Cormorants numbers and distribution in the Czech Republic. Numbers of wintering Cormorants increased especially in mild winters, when Cormorants invaded also standing waters. On the other hand, wintering Cormorants are strongly related to running water in colder winters. The changes in distribution of wintering Cormorants were recorded after large flooding in late summer 2002. In following years, numbers of Cormorants decreased in upper part of Vltava river and increased downstream on Labe river.
Interesting changes in pattern of distribution of Goosander *(Mergus merganse*r) were recorded since late 1990s. Although total numbers of wintering Goosanders are affected by weather conditions during particular winters, Goosanders move from the largest Czech river Labe to smaller rivers after Cormorant expansion. The possibility of inter-specific competition between fish-eating birds will be discussed in presentation.

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Population dynamics, roosting behaviour, time activity pattern, and food and feeding habits of Little Cormorants *Phalacrocorax niger* (Vieillot) in Neyveli, Tamilnadu, southern India

Population dynamics, roosting behaviour, time activity pattern, and food and feeding habits of Little Cormorants *Phalacrocorax niger* (Vieillot) were studied in a roost at the Ash Pond in the Neyveli Lignite Corporation area (NLC), Cuddalore District, Tamilnadu, southern India. The population was almost stable (28-29) during July to August 2004. There was a sudden increase in the population during September 2004 to attain a peak of 50. Thereafter it dropped to 20 and then to 12 at the end of the study period. The roosting time and awakening time of the Little Cormorants varied during different months of the study period. There was a tendency to awaken later in the morning and returning to the roost earlier in the evening as the season changes from Pre-monsoon (July – September) to Monsoon (October-November). The activity pattern of little cormorants, as inferred from the percent of birds that left the roost in different hours of day, was bimodal in most of the months of the study period, one in the morning hours and the other in the evening hours. Totally 33 pellets were collected from the roosting sites. They were 1.788 ± 0.413 cm in length, 1.056 ± 0.429 cm in width and 1.378 ± 0.808g in weight. The fish *Punctius filamentosus* was the most predominant item in the prey remains collected from the roost/nest site. The number of fish remains per pellet was 2-6. Otoliths of five species of fishes occurring in the Ash Pond viz., *Cirrhina mrigala, Ctenophalyngodon idella, Oreochromis mossambicus, Chela bacaila* and *Puntius filamentosus* were recovered from the pellets of Little Cormorants. *Oreochromis mossambiucus* was the most preferred prey item. The little cormorant seemed to prefer fishes (*O. mossambicus*) of weight of 90.0 - 110.0 g.

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Food and feeding behaviour of Cormorants at Lake IJsselmeer: the birds at the interface of man's use of the environment

Water transparency is the major factor determining habitat use by Cormorants in the Lake IJsselmeer situation; the years 1988-1990 were good years with respect to fish availability when relatively clear water occurred in the lake Markermeer, which is a favourable fishing ground for the majority of the birds from the old colonies. The water transparency declined during the 1990s in both lakes with lowest values in lake Markermeer. The period of low underwater visibility coincided with the period of redistribution of the breeding birds to the northern part of the area. This period was characterised by years with huge sand extractions from the lakes to more than 10 million cubic meters per annum. In recent years the sand extractions declined to less than 1 million cubic meters. The water transparency is increasing again and Cormorants tend to use lake Markermeer in higher numbers again since 2002.
Fish is caught by huge flocks of birds, diving synchronously. Pellet analysis from birds in winter and breeding condition show the predominance of non-commercially fishes, super abundant prey. The Cormorant is thus considered being a good indicator of the state of the water system. The long-term effects of a strong fishery pressure by man are discussed in relation to recent developments of fish stocks in the lake, and in turn to the effect upon Cormorants' diet.

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Great Cormorant *Phalacrocorax carbo* night-roost occupancy in relation to habitat variables: are there indications of varying roost quality in a given wintering area?

The "buffer effect" is a potential population regulatory mechanism, occurring when an increasing proportion of a growing population is driven to poor-quality sites, where fitness costs are higher. This mechanism, recently demonstrated in shorebird populations, could eventually affect the still-expanding population of Great Cormorant (*Phalacrocorax carbo*) in Europe.
In Wallonia (Southern Belgium), the increasing wintering Cormorant population has been successively establishing night-roosts in all available aquatic habitats: first slow-flowing large rivers, then ponds and lakes and finally fast-flowing smaller rivers. It could be hypothesized that late-established roosts are located in less "Cormorant-suitable" habitats, only occupied when optimal habitats were saturated. Alternatively, the order of roost settlement could be primarily determined by the progressive discovery of equally optimal fishing and resting places by wintering Cormorant, a species known to be of "traditional habits" during wintertime.
To address this question, we compared two sets of variables: first, some night-roost occupancy parameters that could be indicative of the roost "quality", such as the maximum number of roosting birds, the age-ratio, the number of bird-days over the winter, the initial growth rate of the roost, the variability in bird numbers, etc. and secondly, some habitat parameters, like the surrounding water system types, the distance to main feeding area, the potential human-disturbance level, the local characteristic of the roost sites, etc.
Roosts located in direct vicinity of large slow-flowing rivers are larger, less quickly saturated, and less variable in occupancy and contain a lower proportion of immature birds than roosts located in other habitats. This suggests that wintering sites differ in quality and that an increasing part of the wintering population is using sites of lower quality, although it is not known if this lower quality affects fitness costs.

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Colonisation and range expansion of inland breeding Cormorants in England

Before 1981, the Great Cormorant *Phalacrocorax carbo* in England rarely attempted to breed away from coastal cliffs, stacks and offshore islands. Following the establishment and development of a tree-nesting colony at Abberton Reservoir in eastern England in 1981, Cormorants have subsequently bred successfully in one or more years at a further 57 inland sites. In this paper we examine the colonisation and subsequent range expansion of the inland breeding cormorant population in England from 1981-2005. Counts of apparently occupied nests and details of displaying individuals and nest building attempts are obtained through a number of sources: (a) County Bird Reports and correspondence with County Bird Recorders, (b) The British Trust for Ornithology Heronries Census, and (c) personal communication with birdwatchers, bird ringers and reserve or site managers. Through analyses of metal and colour-ringing data we examine the extent to which *P. c. sinensis* from the continent and *P. c. carbo* from British coastal breeding colonies have contributed to the development of the inland breeding cormorant population in England, and discuss these findings in relation to the wider literature.

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Recoveries of Great Cormorants (*Phalacrocorax carbo*) in Poland

The paper describes data on Great Cormorant (*Phalacrocorax carbo*) recoveries obtained up to the end of 2004 (incl. 8 recoveries from 2005) in Poland. There were 5002 birds ringed in Poland and they have given 358 recoveries. Also 235 birds ringed abroad were observed in Poland (Sweden 63, Denmark 39, Estonia 34, Russia 29, Germany 26, Czech Rep. 15, Finland 11 and other countries 18). 81% of known recoveries concern dead birds (44% of them were shot, 36% drowned, 1% other reasons, 19% unknown reason of death), 19% of reported cormorants were alive (92% read, 8% controlled, mostly by fishermen). Recovery data from birds ringed in Poland have shown, that these birds migrate through Western Europe, but winter mostly in Central Europe and on the Mediterranean coast. The mean distance from the colony to recovery place was growing uniformly from August (214 km) to December (1215 km), than stable to March (1308 km) (N=258, imm=189, ad=69). None of the birds ringed in Poland were found in Poland during winter (XII-II). Birds wintering in Poland came mainly from Denmark, Sweden, Baltic States and colony located on the Gulf of Finland. Two wintering birds came from the colony located on Azov Sea. Also 7 birds of race *carbo* were found in Polish Baltic coast, six from White Sea and one from Fundholmen colony (70°44'N, 29°22'E). Eight chicks from Polish colonies were observed as adults during breeding season in Western Baltic coast and two in Southern Czech Republic.

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Almost 25 years of Cormorant colour ringing in the Netherlands

A colour-ringing programme with individually identifiable birds gave the opportunity to study migration, survival and emigration. The study started in the IJsselmeer colony of Oostvaardersplassen in 1983 and since 2001 birds have been colour ringed in the colony of Enkhuizen at the opposite side of the lake. Additionally and for comparison birds have been ringed at the Wadden Sea locations of Vlieland and de Hond at the Ems estuary. The databank consists of about 5,000 colour-ringed birds and over 20,000 recoveries since the start of the project.
In general Cormorants start breeding when they are three years old. Annual survival of young in their first year is 48%, increasing to 64% for their second year and up to 83% in their third year and beyond. Emigration as well as immigration of birds from the Oostvaardersplassen colony has been recorded. Birds, which were born here, were observed breeding in four different countries. However, the majority of the birds was faithful to the mother colony. Production of young, together with estimated survival of the birds, suggests a constant immigration of Cormorants from outside the area. The IJsselmeer area can thus be seen as a 'sink' in such a way that consequently less young are produced here than survive.
The new situation of strong increase in the Enkhuizen colony proved to be a matter of redistribution by breeding birds and young originating from the Oostvaardersplassen colony. Some recent data about winter distribution will be discussed in the perspective of the recently apparent changing conditions for wintering in Europe.

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The potential of capture-recapture analyses for the understanding of population dynamics

Since the landmark Cormack-Jolly-Seber model (1965) made it possible to estimate separately survival and capture probabilities based on capture-recapture data, capture-recapture methodology in the broad sense has evolved considerably. In particular, multistate models, in which individuals move between sites or, more generally states (such as breeder and non-breeder), appear as a powerful tool for answering a variety of biological questions. They provide also a natural way of analysing mixtures of information such as live recaptures and dead recoveries. Altogether, multistate models appear as a powerful framework for modelling the fate of individual characterized by categorical attributes changing over time. In this context, age-dependent multistate models considering reproductive status (breeder vs. non breeder) can help analysing recruitment, modelled as an age-dependent pattern of accession to reproduction. By combining adequately the various possibilities offered by multistate capture-recapture models, we develop here a multi-site recruitment model allowing to model and estimate separately the rate of accession to reproduction, natal dispersal, breeding dispersal, and permanent emigration out of the set of studied sites. We illustrate the potential of the approach with the example of the Danish Cormorant population and discuss foreseeable developments.

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The response of sport fish populations to Double-crested Cormorant management: an assessment of eight years of cormorant hazing on an inland lake in New York

Coincident with an increasing Double-crested Cormorant population on Oneida Lake, New York, were declines in numbers of sport fish in the 1990s, most notable in walleye and yellow perch. Analysis of over 40 years of data shows higher juvenile mortality for both species in the 1990s compared to the previous three decades. We have studied cormorant diet annually since 1988, and found that they select fish in this age range, and that their consumption accounted for the increased mortality of sub-adults. Concern over impacts of a growing cormorant colony on other nesting birds, and political pressure from local angler groups, led to a new cormorant management program in 1998 to reduce reproductive success of the colony and move fall migrants off of the lake. Cormorant response to management was monitored through weekly counts of birds and nests, and radio tracking of local movements. The program resulted in a reduction in predation pressure on the fishery of approximately 45% from the 1997 level. The long-term dataset for the fishery has allowed for an analysis of both cormorant impact on sport fish and of the effects of the cormorant management plan enacted from 1998 to 2003. Population modelling of cormorants and prey species has allowed us to simulate varying levels of predation pressure on the system to better our understanding of prey response. It is likely that increasing numbers of adult walleye observed since 2000 are the result of reduced cormorant impact through management.

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Double-crested Cormorants and fisheries: potential interactions in Saskatchewan, Canada

Dramatic growth of the North American population of Double-crested Cormorants (*Phalacrocorax auritus*) over the past 25 years has caused concern regarding the impact of these birds on fisheries. In Saskatchewan, located in central Canada, numbers of breeding cormorants have been steadily increasing in areas where angling and commercial fishing are important sources of revenue. Consequently, various stakeholders have voiced complaints about cormorants to government authorities. In response, we initiated a research program to provide some basic information on the potential conflict between cormorants and fishermen in Saskatchewan. Specifically, we (a) conducted an angler survey, (b) examined lake use by cormorants at two popular fishing lakes, and (c) characterized cormorant diet at three breeding colonies in different regions using nestling regurgitations. Our survey has so far shown that 52% of anglers perceive cormorants to pose a significant threat to fish stocks, confirming the need to formally address this issue. Observations on two high-use lakes in 2005 showed that cormorants foraged and roosted in areas removed from town sites and angling boats, indicating low overlap in specific habitat use by these birds and humans. The principal prey items in nestling regurgitations from three different colonies were: yellow perch (*Perca flavescens*), stickleback (*Pungitius* and *Culaea* spp) and tiger salamander (*Ambystoma tigrinum*). Cormorants did not regularly consume fish of sport or commercial value at any of the three colonies studied. We are currently expanding this research program to include more intensive diet sampling, and a larger number of lakes and breeding colonies.

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A new policy for management of Double-crested Cormorants in the United States and an example of its implementation

In the fall of 2003, the U.S. Fish and Wildlife Service (USFWS), in cooperation with USDA-Wildlife Services (USDA-WS), completed an Environmental Impact Statement (EIS) for the management of Double-crested Cormorants (DCCOs) in the United States. The USFWS subsequently published new regulations to implement the EIS proposed strategy. One part of the new regulations, a "public resource depredation order" (PRDO), allows state wildlife agencies, tribes, and USDA-WS to control DCCOs on a localized level to protect fish, wildlife, plants, and their habitats in 24 states. We'll discuss this new policy and will highlight the management activities, including monitoring and evaluation efforts, occurring in one of the states working under the PRDO: those of the USDA-WS program in Michigan which, in 2004 and 2005, implemented a plan to reduce DCCO foraging in the Les Cheneaux Islands area of Lake Huron as a means of improving the yellow perch fishery.

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Adaptive management of Double-crested Cormorant impacts to habitat, fisheries and rare species in the northeastern United States

The Wildlife Services Program in the United States Department of Agriculture has the primary Federal responsibility for managing damage to public and private resources caused by wildlife. Wildlife Services biologists and research scientists partnered with state wildlife agencies in the states of New York and Vermont in 2004-2005 to reduce predation on recreational fisheries in New York lakes and destruction of native vegetation on islands in Lake Champlain, Vermont by nesting cormorants. The management approach incorporated input from interest groups and conservation agencies for development of management goals. Actions to reduce damage were selected from the most effective non-lethal and lethal methods available to managers. As part of the management approach, an intensive research and monitoring regime was established to predict, evaluate and direct cormorant management actions. Monitoring efforts included population surveys and the use of radio and satellite telemetry. We will present the preliminary results of our research and management efforts along with lessons learned from this adaptive management approach.

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Shooting of Great Cormorants as a management tool in two Danish fjords

A new cormorant management plan for Denmark was launched in 2002. This included an option for hunters to obtain a license to shoot cormorants in two fjords in West Denmark during September-January 2002/03-2004/05. More than 500 hunters obtained a license, however only 52-88 of the hunters killed at least one cormorant per season. The annual number of cormorants shot in the two fjords ranged from 308 to 459. In one of the years intensive shooting took place during a week near the preferred day- and night-roosting site in one of the fjords. This led to an immediate reduction in the number of cormorants staging in the fjord. Shooting in the other fjord was scattered over a large area and was not permitted within 1000 m of the islet that constituted the main day- and night-roosting site. Most of the cormorants shot were not local birds, but young birds originating from colonies located to the north and east of the fjords. The annual kill was estimated to amount to <8% of the individuals that used the two fjords in autumn. It is concluded that shooting had only minor effects on the number of cormorants that reappeared in subsequent years. Besides the general license to shoot cormorants, permission was given to shoot cormorants at the main river during the migration period of Salmon smolt. This appeared to have an efficient scaring effect and is believed to have lowered the predation of smolt.

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Oiling of Great Cormorant eggs in Denmark and behavioural responses to oiling

Oiling of Great Cormorant eggs has been used as a management tool in Denmark since 1994. The purposes of oiling have been a) to avoid successful establishment of new ground-nesting colonies, b) to reduce the production of young, and c) to reduce the size of some existing colonies. Oiling was intensified after a new cormorant management plan was launched in 2002. Since then oiling has been carried out in up to 12 colonies. The annual number of colonies exposed to oiling has ranged from 7 to 13 during 2002-2005, corresponding to 14-22% of all colonies in Denmark. The annual number of nests exposed to oiling ranged from c. 3,100 to 6,200, corresponding to 8-16% of all occupied nests in Denmark during 2002-2005. Due to the presence of colour-ringed cormorants in one of these colonies, we were able to study how individuals exposed to oiling responded behaviourally within and between seasons.

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Overview of the national management plans on Cormorants in European countries

France and Switzerland were among the first countries to kill Cormorants for the management of the conflict between cormorants and fisheries. The presentation gives details on the history of the cormorant management plan in France and an overview on the development of national management plan in a majority of European countries. More and more countries have now a national management plan and a lot of them included the possibility of killing cormorants (adults, juveniles or eggs). The number of killed cormorants during the last winters is probably around 50 000 birds for entire Europe. This can explain the observed stagnation of the increase of wintering birds in France the last years. It is necessary now to collect good data on killed birds at the European scale to be able to understand the dynamics of the European Cormorant population. This is important for the conservation of the population. This overview is a part of the INTERCAFE Cost action.

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Assessment of the Swiss Cormorant Management Plan 1995 and new Management Plan 2005

The success of the 1995 Swiss Cormorant Management Plan was assessed in terms of its implementation, effects/secondary effects and achievement of its objectives. This was used as the basis for drawing up the 2005 Management Plan, which clarifies in particular the handling of over-summering and breeding cormorants and introduces some minor adjustments for the winter compared with the previous Management Plan. A broad-based working group "Cormorant and Fisheries" set up by SAEFL (the Swiss Agency for the Environment, Forests and Landscape) participated in drafting the new Management Plan.

The assessment of the success of the 1995 Management Plan shows that it was implemented in all cantons with relevant cormorant numbers (although only recently in two cantons). However, safeguarding the labour intensive scaring measures in the long term poses a problem.

As far as effect and achievement of objectives are concerned, the Management Plan is considered to be successful in the main, despite difficulties with the interpretation of field trials: on the one hand it was possible to reduce the influx of cormorants into river systems and thus the predator effect on fish stocks there, and on the other, birds over-wintering on the large lakes were not disturbed by scaring measures against cormorants. In the overlap area on the Upper Rhine, however, greater care must still be taken to ensure that prevent measures (and other disturbances) do not have negative effects on other waterbirds in this internationally important waterbird reserve.

The framework conditions for the 2005 Management Plan are based on the premise that:

- the consistently high breeding numbers in northern Europe will continue to lead to a winter cormorant population of some 5,500 birds on Swiss waters,
- the number of over-summering cormorants (without management) will rise and lead to more widespread and larger breeding colonies in Switzerland and adjacent areas in neighbouring countries,
- no uniform Management Plan affecting cormorant numbers in Switzerland will be applied at European level in the next few years.

As before, the 2005 Management Plan lays down classification into three types of waters for the winter:

- Rivers and small lakes with an area of up to 50 ha (**intervention areas**), in which protection of fish has priority and consequently cormorant scaring is permitted (in a three-stage level of intensity, depending on the importance of existing fish stocks).
- Lakes with an area of over 50 ha and dammed river sections (**non-intervention areas**), in which the protection of concentrations of over-wintering water birds has priority and consequently scaring of cormorants is not permitted to avoid disturbance of waterbirds (in a three-stage level of intensity, depending on the importance of over-wintering birds).
- Waters which have overlapping fishing and bird protection interests (**overlap areas**), leading to scaring measures in certain lake areas (e.g. shooting of cormorants at the nets of professional fishermen) or to relinquishing scaring measures on certain river sections (e.g. sites of importance for waterbirds on rivers).

The 2005 Management Plan lays down the following for the **summer**:

- Cormorants starting to establish breeding colonies and flying in to feed are scared on rivers and small lakes with an area of up to 50 ha (**intervention areas)**.
- Cormorants are allowed to enter and establish breeding colonies undisturbed on lakes with an area of over 50 ha and dammed river sections (**non-intervention areas)**.
- The existing legal provisions must be complied with.

Since the space-time dynamics of the formation of breeding colonies and the number of over-summering cormorants cannot be predicted and there are fears in the fishery sector of uncontrolled growth, a **Conflict Resolution Committee** (consisting of one representative each from SAEFL, Swiss Fishing Association, Swiss Bird Protection and the canton concerned) should meet when one of the following trigger criteria applies:

1. The number of colonies in Switzerland has increased to 5 or more breeding colonies, or the number of colonies on the same lake or in the same canton is more than 2.
2. The number of breeding cormorants in Switzerland has risen to 100 or more breeding pairs.
3. The damage to nets of commercial fishing on a lake has reached an unacceptable high level (joint assessment of the commercial fishermen and the cantonal fisheries agency).
4. A member of the working group "Cormorant and Fisheries" notes an extraordinary, regional problem in an intervention, non-intervention or overlap area.

There is no doubt that the commercial fishery on certain lakes is being adversely affected because cormorants take a considerable amount of fish from the nets and thereby cause holes in the nets. Professional fishermen also have to alter some of their working hours in order to set and safeguard their nets during periods of the day when cormorants are not active. However, no way of avoiding these problems could be found, either by removing the cause or by financial compensation. If, however, damage to nets by cormorants clearly reaches a high level, the Conflict Resolution Committee should also meet.

Download of the Management Plan 2005 (1.1MB):
www.umwelt-schweiz.ch/imperia/md/content/gefisch/fischerei/kormoranbericht.pdf

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Managing the Cormorant – A case study of failure of a European action plan to minimise the conflicts between great Cormorant and fisheries

The EU research project FRAP ('Framework for biodiversity Reconciliation Action Plans') deals with conflicts between conservation of large predators and human use of biological resources. Within this project, stakeholder discourses in different European countries were analysed. Perceptions about the necessity of European-wide management of the Great Cormorant population differed between the countries and the stakeholder groups, and calls for large-scale culling are frequent. This is not astonishing for a fast growing population of a European-wide migrating bird. Another part of the project modelled the European population and the effects of different management scenarios on the population and its viability. The modelling process showed just as well as the outcomes of the REDCAFE project that culling is not an appropriate measure to handle the increase of the population. A mix of summer culling, controlled by specific monitoring, with the limitation of breeding facilities appears to be the appropriate management scenario. To implement such a policy there is need for an international regulation to be developed.
Our presentation will show the efforts that have been undertaken to agree on a European management plan, and give first answers as to why this management plan never has been implemented. It shows why the discussions about establishing a new plan went into a deadlock, and, based on the modelling, that this non-development might be dangerous for the viability of the cormorant population.

Extra papers

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The status of cormorants in the Delhi region (India)

Three species of cormorant and one darter have been recorded from the Delhi region (encompassing Delhi and parts of the neighbouring state Haryana). Previous field studies-during 1989-92 (Urfi, 1993), recorded cormorant colonies at the Delhi Zoo (Urfi, 1993, 1997), Sultanpur National Park, Tilyar Lake and Bhindawas Bird Sanctuary. Okhla Barrage bird sanctuary (Urfi, 2003) and other stretches of the river Yamuna were recorded as important foraging grounds for cormorants. Recent surveys were conducted during 2004-05, the results of which are reported.
Nesting: In the Delhi zoo 20 and 44 nests of Little Cormorant (*Phalacrocorax fuscicollis*) and Indian Cormorant (*Phalacrocorax niger*) respectively, were recorded. Hitherto most cormorant nests were restricted to ponds 1, 2 and 3 of the zoo but during this study it was observed that a new colony, having nests of cormorant as well as other species of colonial waterbirds has formed in a rain fed depression lying close to the boundary wall of the zoo. The above species were also observed nesting at Sultanpur and Tilyar. At Bhindawas, ca 20 nests of Great Cormorant (*Phalacrocorax carbo*) were observed in Eucalyptus trees lining canals in the sanctuary. (The existence of 20 pairs of Darter at Bhindawas reported in the book ' Important Bird Areas of India' could not be confirmed but appears very doubtful). However, Darter (*Anhinga rufa*) nests were observed at Sultanpur (17 nests) and Tilyar (6 nests).
Status of foraging grounds: A decline in the number of cormorants visiting the Okhla barrage for foraging is noticeable. This could possibly be due to changes in the habitat due to progressive siltation and the increasing levels of aquatic pollution in the river Yamuna. In Sonipat district of Haryana where a number of surveys were made previously (Urfi, 1995), the conversion of traditional village ponds into aquaculture ponds is a visible change. How this will affect cormorant as well as other wetland birds remains to be investigated. At Bhindawas, fishing in the marshes where cormorants and other birds feed, was observed.

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Great Cormorants in China: A review of the current knowledge about their free-ranging and tame populations

Both free-ranging and tame great cormorants *Phalacrocorax carbo* occur in China. Tame Chinese cormorants have attracted substantial public interest, but little scientific information has been published in English on these two populations. We reviewed the English and Chinese literature as well as the Internet, and summarized the current knowledge about Chinese Great Cormorants. This information was supplemented by interviews of cormorant fishermen conducted in Eastern China. We assessed the distribution, population numbers, breeding biology and phenology of both populations as well as their respective interactions with humans. We conclude firstly that the population of wild Great Cormorants is probably increasing in China, while the population of tame Great Cormorants is probably decreasing. However, accurate population estimates are scarce. Secondly, we confirm that Chinese people developed a unique relationship with tame Great Cormorants. Quite interestingly this stands in striking contrast to the general public image of Great Cormorants in the Western world. However, increasing numbers of wild Great Cormorants seem to trigger hostile reactions among Chinese fishermen. Wild Great Cormorants being officially protected in China, further development of their populations might trigger management conflicts similar to those occurring in Europe and North America.

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Eco-physiological adjustments of Great Cormorants, *Phalacrocorax carbo*, diving in Greenland waters

We used implantable data loggers in five male great cormorants from Greenland to study their eco-physiological adjustments to arctic conditions. Despite logging failures, a specific approach allowed us to analyse all data sets. Bradycardia occurred during 30 +/- 19 % of dives (n= 2445). Hypothermia occurred during dive bouts (minimum recorded 17 ^{o}C). These physiological adjustments might enable cormorants to dive under harsh conditions despite their poor body insulation.
Implanted birds made shorter foraging trips than birds monitored using automatic nest-balances (n= 5). Implanted birds performed more dives and diving bouts per day than birds equipped with external recorders (n= 5). These differences might be due to technical constraints. The reproductive success of implanted birds and their survival rate one year after the trials were not significantly different from those of control groups (n= 70 and 15, respectively). We conclude that implantable data loggers are adequate tools to study the eco-physiology of polar endotherms.

Posters

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Finland's Great Cormorant population (*Phalacrocorax carbo sinensis*) continues to increase

The great cormorant has spread and increased its numbers very rapidly around the coasts of the Baltic Sea since 1980. Estonia's breeding population increased from 55 pairs in 1988 to around 10,000 pairs by 2003. In Sweden the breeding population has risen from 755 pairs in the 1980s to nearly 30,000 pairs in 2005.

Finland's breeding cormorant population has also increased very steeply since the first ten pairs were recorded in 1996. In 2004, a total of 2,909 pairs bred in Finland, and in 2005 the number of pairs rose dramatically again by almost 60% to 4,600 pairs, nesting in 26 colonies. Great cormorants occur throughout Finland's costal waters, except in the Sea of Åland, with about half the population breeding in the Gulf of Finland, and the other half in the Gulf of Bothnia. The Finnish breeding population only accounts for a couple of percent of the whole of the Baltic breeding population. Finland's wintering population is concentrated around Åland, with its numbers and distribution varying according to ice conditions.

Great cormorants' breeding numbers have been rising annually by an average of 117% (16%–408%), with new colonies formed every year. Breeding success rates are highest in larger colonies, where pairs raise an average of 2–2.5 young each summer.

The cormorants have not had any harmful effects on the breeding success of other bird species. For instance, the breeding numbers of guillemot, a threatened species, have increased by a third on the islands where Finland's largest cormorant colony (>800 pairs) nests. Cormorants typically form their colonies together with colonies of herring gulls on the almost treeless islands of the outer archipelago, although a few colonies consist of nests in trees.

Their nesting islands are of 0.5–3.5 ha, and the distances between colonies vary from 5 to 240 km.

Finland's cormorant colonies suffer from persecution each summer, with the birds' nests and eggs deliberately destroyed. This is largely due to fears that cormorants deplete valuable fish stocks, although some of their persecutors may be angered by their effect on trees and the landscape.

The diets of cormorants living in the archipelagos near Tammisaari and Dragsfjärd have been monitored in 1998 and during the years 2002-2005. The proportions of fish species in the birds' diet vary seasonally and from year to year, but dominant species are typically roach, eelpout and perch.

Cormorants' guano only destroys plants in the immediate vicinity of their nests. Flowers and grasses have not disappeared from their nesting islands. Where trees and shrubs are concerned, junipers have suffered most from their presence. Cormorants, nesting trees die within a couple of years, due to the birds' droppings and the loss of branches used in nests.

The great cormorant is a protected species in Finland.

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Recent situation of Great Cormorant *Phalacrocorax carbo sinensis* in Belarus

Review of the recent situation concerning the Great Cormorant in Belarus will be discussed: current number, distribution, population trends and interaction with fisheries (fish farms) using ringing data.

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A non-invasive method to sex hatchlings of Cormorants *Phalacrocorax carbo sinensis*

After hatching Great Cormorants remove from their nests most eggshell remains, thus collecting them regularly in the colony allowed us to measure egg width and to estimate timing of breeding. Applying a molecular method (Griffiths *et al*., 1998), we were able to sex hatched chicks based on the remains of the embryonic membrane – *alantochorion* often present in the shells. The method was verified first on sample of hen eggshells where sex of hatchlings was known (Goc *et al*., in prep.). Further the sample of cormorant shells collected in Kąty Rybackie colony (N=100) was tested and the proposed method seems to be highly effective. The method reduces birds' stress and has little or no impact on brood/chicks' condition and fate.

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Primary sex ratio in Great Cormorant (*Phalacrocorax carbo sinensis*) broods in the largest European breeding colony at Kąty Rybackie (N. Poland)

In many bird species, in particular those with a well pronounced sexual dimorphism, including cormorant congener – the Shag (*Phalacrocorax aristotelis*), bias in sex structure of broods has been observed (Velando et al. 2002), depending on environmental and internal factors. Thus, a similar bias may be expected in *Phalacrocorax carbo*. Most papers deal with the brood (post-hatch) sex ratio, but data on primary sex ratio (pre-hatch) are scarce. In 56 clutches (170 eggs) collected during breeding season 2005 we determined sex of embryos using molecular methods. Egg's volume, laying date and order as well as clutch size were considered as possible determinants of a sex bias. We found that none of the analysed factors influenced the sex ratio. Slight differences in eggs' volume between female and male eggs were recorded.

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Great Cormorant *(Phalacrocorax carbo sinensis)* on South-Bohemian fishponds (Czech Republic): population development and foraging habitat selection

The breeding population of Great Comorant *(Phalacrocorax carbo sinensis)* was established in South Bohemia (Czech Republic) in 1983. Since 1988, the breeding population seems to be stable without any remarkable trend. In 2000 – 2004, the breeding population size ranged between 117 and 162. The highest number of 217 breeding pairs was recorded in 2005. Nevertheless, the total number of birds occurring in the region culminated during spring and/or autumn migration, when 500 – 1000 birds were recorded annually.
The main aim of this contribution is to compare habitat preferences in two following seasons (2003 and 2004), which differ remarkably in numbers of Cormorants present. The study was based on data from regular census of Cormorants occurring on fishponds all year round during ice free period (from March to November). Cormorants occur preferably in larger flocks especially in years and months with higher numbers and they don't invade to other (sub-optimal) fishponds. Larger flocks (more than 25 individuals) were recorded only during both autumn (from September to November) and spring (March and April) migration. On the other hand, single birds or small groups of Cormorants prevailed in the breeding season (May and June).

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Characteristics of the distribution of the two European great cormorant subspecies in France, a sympatric wintering area

In Europe, the Great Cormorant is represented by two subspecies, the marine *Ph. c. carbo* and the continental *Ph. c. sinensis*. During the last two decades, the boom of breeding populations of the subspecies *sinensis*, from 5300 in 1970s to 47,000 breeding pairs in 1995, have induced an increase of the wintering population in France. This country, the mainly European wintering area of this species, was also a sympatric area of the two subspecies along the coasts and in estuaries (Marion, 1995), but recently the marine subspecies was suspected to follow the other subspecies in inland area. To test this hypothesis, we used here the appearance of the gular pouch as a discriminant factor to identify these subspecies (Newson, 2004).
We have studied a total of 1106 carcasses of Great Cormorants killed in 11 departments during the national management plan in winter 2000-2001 to 2004-2005. Each bird was sexed, aged and measured. Results confirm that the marine subspecies is not limited to the coast, but use the continental habitat in variable proportion. This subspecies is predominant in the northwestern studied departments (Brittany and Normandy), while the continental subspecies is logically largely predominant in the more continental departments. For each sex of the two subspecies, no differences were observed in the distribution of the adults and immatures between coastal and inland departments. No difference in body mass was observed between the groups for *sinensis* individuals of the same sex and age. However, birds of the marine subspecies that winter in continental area appeared significantly smaller than those wintering in the more traditional coastal area. We hypothesize these could be sub-dominant individuals, possibly excluded from the marine habitat by competition with larger (thus dominant?) individuals, and forced to use a sub-optimal habitat.

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Variation in breeding success of Cormorants within Kąty Rybackie colony (N. Poland)

In many colonial birds, including cormorants, intra-colony differences (variation) in breeding timing and success were found, often attributed to centre – edge sequence. In 2003-04 breeding timing and success of individual nests were investigated on 3 large plots (containing altogether ~10% of nests) in the big and increasing colony on the Vistula Spit near Gdansk, Poland. The number of fledglings decreased gradually from early to late broods. We found differences between seasons both in values and the ranks of plots (measured in relative breeding time and success). We compare also the breeding results of pairs using nests located at the same place within individual trees in consecutive years.

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The reproduction of the Great Cormorant (*Phalacrocorax carbo sinensis*) at the Fanel nature reserve on the southern shore of Lake Neuchâtel (Switzerland)

In 2001, Great Cormorants (*Phalacrocorax carbo sinensis*) established the first breeding colony in Switzerland in the Fanel nature reserve at the NE end of Lake Neuchâtel,. Nests are built directly on the ground (rare for the subspecies *sinensis*), on two artificial islands created in the 1960s. The number of breeding pairs in the colony increased quickly: 2 pairs in 2001, 7 in 2002, 23 in 2003, 53 in 2004, and 108 in 2005 with approximately 200 juveniles. The nature reserves of the “Grande Cariçaie” and the Fanel reserve, on the southern shore of Lake Neuchâtel, are wetlands of international importance for waterbirds. The large stretches of shallow water provide abundant and easily accessible food resources for the waterbirds, and it is not excluded that the Cormorants might colonize other protected areas of the lake as well. A monitoring programme is planned to follow the development of the population during the breeding period.

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Les Grangettes - an important roost site of Great Cormorants (*Phalacrocorax carbo sinensis*) in Switzerland

The most important roost of Great Cormorants in Switzerland lies in the waterbird reserve Les Grangettes, where the river Rhône enters Lake Geneva. Cormorants use the site all year round but numbers are highest during autumn migration (September to November) and lowest in spring. Small groups started to use the roost in the 1940s. In the 1980s numbers increased rapidly and reached a maximum of 5300 individuals in November 1991. Since then, numbers have fallen to below 2000 in autumn and 500-600 in mid-winter. Sightings of ringed birds indicate that most birds come from the breeding colonies in Denmark and to a lesser extent from the Netherlands.
Cormorants roosting at Les Grangettes search for food both on Lake Geneva and upriver along the Rhône and associated canals. While the roost in the Grangettes is situated in a hunting-free waterbird reserve, 100-300 birds are shot each year in the Rhône valley.

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Great Cormorant autumn migration across the Alps from the lower Rhône valley, Cantons of Vaud and Valais

The discovery of a major Cormorant migration route across the Alps from the Rhône valley near Monthey lead to an investigation into this passage point between the end of August and mid-December from 1995 to 2000; numbers of individuals were 4708 in 1998, and 6983 in 1999. 96.8 % followed the principal axis of the valley in the SSE direction. Birds were seen in the early morning and came from the major roost of Les Grangettes (Lake Geneva). Additional observations carried out at Martigny, a 16 km further up the valley, showed that three-quarters of the Cormorants chose a route leading them due south. The observations suggest that this route is more important than that previously considered predominant, in which the Cormorants fly along the Rhône valley downstream of Lake Geneva via the Fort l'Ecluse passage.

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Comparison of the Cormorants' diet in a breeding colony and a night roost located in the same area

The study was performed in a breeding colony on Lake Dobskie and a night roost on Lake Mamry (NE Poland). The distance between these two sites is about 15 km. The aim of the study was to determine the similarities in the food composition consumed by sexually mature and juvenile cormorants hunting their prey in the same area (water system of the Great Mazurian Lakes). A total of 4515 regurgitated remains of fish, representing 19 species (17 species in the breeding colony and 19 species in the night roost) and the crayfish *Orconectes limosus* Raf. were recorded. At both sites the dominant species, in terms of biomass, were perch *Perca fluviatilis* (43.0% in the breeding colony, 26.0% at the night roost) and roach *Rutilus rutilus* (36.9% and 42.0% respectively). However, their proportions in the cormorants' diet were significantly different ($p<0.001$). In the non-breeding assembly burbot *Lota lota*, 9% by mass) was in June the third most common prey fish species followed by tench *Tinca tinca* - 8.0%. These two species were of marginal importance in the breeding colony, where the third dominant species was the bleak *Alburnus alburnus*.

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Salmonid smolts removal by Great Cormorant (*Phalacrocorax carbo*) from Kąty Rybackie colony (N Poland) in 2000

Stocking with smolts is a part of the Polish salmonid management in the Baltic. Annually more than 700,000 sea trout (*Salmo trutta* m. *trutta*) and more than 200,000 salmon (*Salmo salar*) are released, mainly into Vistula River and its tributaries. During intensive study on Cormorants (*Phalacrocorax carbo*) conducted in Kąty Rybackie colony, some tags of salmonid fish were found. On the other hand, a negligible number of salmonids was recognised during standard cormorant food analyses. That is why special methods to estimate how many tagged fish were eaten by birds, had to be found. During 2000 breeding season two methods of study were conducted. One method was based on blind sample of 1000 tags scattered randomly in the colony. There were found 25 tags from fish eaten by cormorants and only nine from scattered tags. Estimated total number of tags brought by birds in 2000 was calculated as 2.778 (25/0.009).
Fish tags were also collected on nine plots (644 m² under 56 nests from 7,995 in whole colony) covered by dense plastic mesh to find everything dropped by birds. 18 tags were found on the plots (0.3214 per nest) and estimated total number of tags brought by birds to the colony in 2000 was calculated as 2.70 (0,3214*7995).
About 37% of all found tags from fish (43) originated from salmon smolt (the same as the proportion of tagged fish).
548,867 Trout (all ages) and 46,542 salmon (age 2+) were released in Vistula mouth and Vistula tributaries during the breeding season 2000. Predation of Cormorants on particular stocked schools varied from 0% (salmon releases 200 km upriver) to ca. 20% (salmon or trout releases in the end of March in Vistula mouth). Based on both estimations of total number of tags brought to the colony, about 8% of 33,000 tagged fish were eaten by cormorants, so the total number of eaten fish is about 4,000 salmon smolts and 45.000 trout smolts. The number of eaten younger salmon (age 1+, 90,960 stocked, not tagged) is not known.

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Mass marking of fish versus studies on the feeding preferences of Cormorants

Mass marking with fluorescent dyes (alizarin red S, oxytetracycline) is a common technique applied to test the stocking efficiency of fish. Due to the specific mechanism of otolith growth, the marks obtained in this way are durable and remain visible over the entire life cycle of fish. The aim of the present study was to determine whether such marks are also detectable in otoliths contained in regurgitated fish and pellets. In the years 2000 - 2001 Lake Wigry (Wigry National Park, NE Poland) was stocked with 12 million of vendace (*Coregonus albula* L.) marked by the above method, which accounted for approx. 40% of the total number of released fish larvae. 128 otoliths were isolated from 283 pellets of vendace remains regurgitated by Cormorants. The otoliths were ground and examined under a microscope with a fluorescent light source. Four of them had alizarin marks. This indicates that fluorescent marking can be applied to determine the degree of predatory pressure of cormorants on fish populations in selected water bodies, and to estimate the damages caused by their feeding on recently stocked fish.

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Round goby (*Neogobius melanostomus*) in the diet of Cormorant at Kąty Rybackie breeding colony in Poland (1998 – 2002)

The appearance of an invasive species, the round goby (*Neogobius melanostomus*) in the Polish waters of Gdańsk Bay and Vistula Lagoon resulted in a continuation of the studies of a cormorants diet in the colony of Kąty Rybackie in 1998 – 2002. The birds' diet composition was estimated based on fish bone elements in the pellets (1724) and regurgitated fish (1579) found at the area of the colony. Ruffe (*Gymnocephalus cernuus*) was the dominating species constituting 52.2% by fresh mass. In terms of importance, the next was round goby 19.0% respectively. Less significant species were perch (*Perca fluviatilis* 5.7% by mass) and roach (*Rutilus rutilus* 5.2%). The species of a great economical importance recorded in analysed food were: pikeperch (*Stizostedion lucioperca* 2.1% by mass and eel (*Anguilla anguilla* 2.7 % by mass). Over the five years of the study a decrease in the share of ruffe in the diet occurred, from 55.6% in 1998 to 45.3% in 2002.

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An invasive fish species in the diet of Double-crested Cormorants in the North American Great Lakes

The round goby (*Neogobius melanostomus*) is an invasive fish introduced into the North American Great Lakes from Europe. Since first detected in North America in 1990, its population has increased dramatically, and is likely displacing native fish from aquatic food webs. To test this hypothesis, we stimulated regurgitation by Double-crested Cormorant (*Phalacrocorax auritus*) nestlings in colonies in western Lake Ontario during 2002 to 2004 breeding seasons. We identified all fish species present in regurgitated boluses. Alewife (*Alosa pseudoharengus*) was the most abundant species present. The second most abundant species was the round goby, present in the boluses of chicks in 18, 21, and 26% of nests surveyed, and comprising 11, 7, and 17% of all individual fish specimens identified in 2002, 2003, and 2004, respectively. Our results suggest that cormorant diet may be a useful tool for examining the prevalence of invasive fish species in aquatic food webs.

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The influence of Cormorants (*Phalacrocorax carbo sinensis* (L.) on fishery management by example of the colony at Wulpinskie Lake

The studies were conducted from March 1999 determined to September 2000 in the Cormorant colony on the Wulpinskie Lake. The food composition was based on pellets and regurgitated fish. The presence of 17 fish species was recorded in the food of Cormorants. The dominant species were: Roach *Rutilus rutilus* 38.1 % and Perch *Perca fluviatilis* 21.9 %. Bleak *Alburnus alburnus* reached 15.2 % by numbers and Eel *Anguilla anguilla* 7.7 % by mass. The greatest biomass of Pike *Esox lucius* was noted in April (8.4 %), Eel in August (20.7 %), Tench *Tinca tinca* in June (4.6 %) and European Whitefish *Coregonus lavaretus* in May (2.0 %).
The total consumption of the colony in the examined period amounted to 41.4 tons (from 3.1 t in March to 5.2 t- July-October). Fish of marketable size contributed 28.1 % of Cormorant food by mass.
The consumption of undersized fish by Cormorants reduced the size of future harvestable population of 3.9 tons, including Pike- 2.3 t, Tench- 0.93 t and Eel- 0.71 t.

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Monitoring Great Cormorants *Phalacrocorax carbo sinensis* and fish populations along the Serchio river (Tuscany, Italy) in relation to the application of ecological mitigation measures

Since 1996 the Serchio river (Tuscany, Italy) hosts about 500 wintering cormorants. Their arrival immediately triggered a conflict that involved fisheries, fishponds and aquacultures. The Province of Lucca faced the problem in two phases: 1. assessment of the impact of Cormorants on fish populations; 2. a multidisciplinary project for monitoring the status of the natural fish stocks, to apply ecological mitigation measures, and to develop a dialogue among s*takeholders*. Fish stock analyses revealed stable populations until 2004. The Cormorant population, which had been growing since 1996, decreased by 42% during winter 2004, when dissuasive measures were applied. During 2005, in absence of mitigation attempts, cormorant numbers grew by 28% and the middle-sized stocks of some cyprinids declined. The success of the mitigation methods can be explained by the geomorphology of the Serchio basin, that works as a one-way escape corridor towards the coastal roosts.

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The killing of Great Cormorants (*Phalacrocorax carbo*) in Italy under derogation of the art. 9 of the 79/409/EEC "Birds Directive"

Since the early 1980s, the large increase of Great Cormorant numbers occurred all over Italy has been accompanied by a plethora of complaints from stakeholders having some interest in fish. Human-cormorant conflicts arose in most coastal wetlands, some inland lakes and several upper and medium river courses in northern and central Italy. Following the strong pressure made by fish-farmers and anglers, some regional administrations allowed actions directed to reduce cormorant numbers and to prevent roost and colony establishment. Nowadays, although six regional administrations allow cormorant shooting, the number of cormorants legally shot in Italy is still relatively low (2,000-3,000 in last four years, overall about 14,000 since winter 1994/95 up to 2004/05) when compared to the number of cormorants counted in winter (about 64,000 in January 2000) and control activities carried out in other countries inside the EU. In this work we report the change of management policy related to distribution of cormorant numbers and conflicts, with special emphasis on shooting and other measures to control population size under derogation of the "Birds Directive".

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Overview of the USDA wildlife services research project for reducing cormorant predation to fish farms in the southeastern United States.

The Wildlife Services Program in the United States Department of Agriculture has the primary Federal responsibility for managing damage to agriculture caused by wildlife. Under this authority, the National Wildlife Research Center initiated a research project in 1988 to reduce predation on aquaculture production, especially catfish (*Ictalurus punctatus*). Scientists on this project conduct research estimating the economic impacts of predation, develop techniques for estimating cormorant abundance on farms, and study the general ecology of cormorants as it relates to aquaculture impacts. We will present descriptions and summaries of current research being conducted to resolve these issues.

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