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What does three years of hunting Great Cormorants *Phalacrocorax carbo* tell us: shooting autumn-staging birds as a means of reducing numbers locally

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Abstract

BACKGROUND: The population of Great Cormorants *Phalacrocorax carbo* has increased markedly in Europe in the last 30 years, creating conflicts primarily with fisheries interests. Some advocate that there should be a reduction in bird numbers on anything from local to regional and pan-European levels. The effect of attempts to reduce cormorant numbers by shooting to kill and by shooting to reinforce the scaring of birds in two Danish fjords was studied.

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RESULTS: A total of 308, 364 and 459 cormorants were shot in the two fjords during each of three annual hunting seasons. When shooting was intensive over a series of days near to the birds' main roosting and sleeping place, numbers dropped significantly compared with non-shooting years. No significant scaring effect was detected when shooting was carried out only at random along the shores of the fjords. None of the shooting treatments had effects on the number of cormorants occurring in subsequent years.

CONCLUSION: These results indicate that large efforts can be invested in shooting to scare and kill cormorants without reaching any desired reduction in numbers, in particular when the shooting is not coordinated in time and space and not undertaken at key roosting sites.

Keywords: cormorant; *Phalacrocorax carbo*; disturbance; shooting; management; scaring; roosts

INTRODUCTION

The Great Cormorant, *Phalacrocorax carbo*, is a migrating, generalist, fish-eating bird.[1] The European population of the 'continental' subspecies *P. c. sinensis* numbered approximately 4,000 breeding pairs in the early 1960s.[2] However, after it was placed under protection during the 1970s and early 1980s the population in Europe expanded, reaching at least 285,000 pairs by 2006.[3] The population increase, and associated expansion in geographical distribution, resulted in cormorants being heralded as a nature conservation success by some, while others, in particular various fishery sectors, voiced their concerns over the negative impact that cormorants can have on their livelihoods and way of life.[4] Cormorants are widely distributed across Europe, especially outside of the breeding season, and human-cormorant conflicts occur in breeding, staging and wintering areas throughout the continent. The birds forage in a diverse range of freshwater, brackish and marine habitats, including those holding fish farms (intensive and extensive) and used by people for recreational angling.[1,5-7] As a result of their flexible foraging requirements, cormorants are thought to affect a similarly diverse range of human fisheries interests. Cormorant predation can have potentially serious economic implications by damaging fish stocks, reducing catches and limiting aquaculture production. Such direct predation is also claimed to negatively affect some endangered and rare species or sub-species of fish, particularly in mountain streams in central Europe. Cormorants may also have 'indirect' effects on fisheries – by damaging fish that are caught but not swallowed and by making them change their location (and sometimes behaviour) in an attempt to evade these predators.[7]

The EU and Member States have shared legal competence – shared responsibility – in forming and implementing legislation for the environment. This legislation aims to protect animal and plant species of European importance and the habitats which support them. In relation to wildlife and nature conservation, two key Directives have been adopted by the European Union, namely: Directive 2009/147/EC on the Conservation of Wild Birds (the Birds Directive) and Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive). Although stakeholders are often free to apply non-lethal measures to protect fisheries or reduce cormorant impact, cormorants – like almost all European wild birds – are protected under the Birds Directive. This legislation allows exceptions to be made (technically, these are called derogations) to authorise the use of specific non-lethal or lethal measures where the birds are causing "serious damage" to a site, or where there is a reasonable expectation that this will happen, or for the protection of flora and fauna, and where there are no other satisfactory solutions. Further information has been provided by the Commission on the EU Cormorant Platform, see http://ec.europa.eu/environment/nature/cormorants/management.htm

There is much debate over the likely effectiveness (both practical and theoretical) of so-called site-specific versus pan-European management actions taken against cormorants with the aim of reducing or eliminating the damage these birds cause to fisheries.[8,9] At the root of much of this discussion are the issues of the scales at which management actions might be taken and the ultimate aims of such actions. At its simplest, this may be a discussion of actions that attempt to stop birds getting to the fish or which reduce the food available to the birds or the 'costs' of foraging for it (at least at certain times and in certain places) versus reducing the overall number of cormorants on a continental scale. Despite the lack of agreement on the scale of damage caused by cormorants (see discussions in [7,9]), there is considerable lack of information on whether a reduction in bird numbers would lead to a measureable reduction in damage.[10]

To date, the European Commission has stated (see http://ec.europa.eu/environment/nature/cormorants/Background-and-Activities.htm) that cormorant problems are regional ones and do not require a coordinated pan-European management plan (involving coordinated actions across countries) and stress the option of working within current legislation. To this end, one obvious thing is to try to reduce cormorant numbers 'locally' in places holding water bodies and/or fisheries where cormorants cause damage – sometimes over reasonably large geographic scales of perhaps 10s to 100s of km^2. Whilst the national laws will determine who might shoot cormorants, it is often thought that the job of controlling cormorant numbers would be undertaken by 'hunters', especially those already involved in waterfowl hunting.

In order to maximise the chances of success when applying lethal measures, such approaches need to be underpinned by sound science.[11] However, few attempts have been made to assess the impact of shooting as a measure to control cormorant numbers outside the breeding season.[12] At a local level, shooting has been shown to affect cormorant numbers.[13] This paper describes a situation in Denmark where for three years, hunters were encouraged to shoot cormorants during the hunting season in an attempt to reduce cormorant numbers in order to lower the consumption of Flounder *Platichthys flesus* and the predation of young Atlantic Salmon *Salmo salar* migrating towards the sea.[14] The aim of this paper is to test the effect of two different types of shooting on the within and between year development of cormorant numbers. The experiences gained by this experiment may be useful in other situations where similar actions might be carried out.

METHODS

2.1 Experimental areas

There has been no open hunting season for the Great Cormorant in Denmark since 1980. However, during the 2002 revision of the Danish management plan for cormorants, it was decided to test whether shooting the birds during the autumn hunting season could be an applicable tool to lower cormorant numbers within limited areas where conflicts with fisheries were intense. It was decided to explore the efficiency of shooting to kill and scare cormorants over three hunting seasons (2002/03-2004/05) in the two Danish coastal lagoons or fjords 'Ringkøbing Fjord' covering 294 km^2 and with a coastline of 110 km, and 'Nissum Fjord' covering 65 km^2 and with a coastline of around 70 km. Both fjords are located in west Jutland (Fig. 1).

2.2 Hypotheses and experimental setup

We hypothesised that: (1) shooting of cormorants at random – or at least opportunistically – along the shores of the fjords ('treatment I') will trigger a large proportion of the birds to advance their timing of departure for more southern wintering areas. The predicted consequence of this will be that the overall number of cormorants in the fjords will decline faster where shooting occurs in the autumn than if no hunting of cormorants took place, (2) supplementing the above method of shooting with coordinated, intensive shooting near to the main night roosts ('treatment II') will cause greater disturbance, and the predicted effect will be an even greater decline in overall numbers of cormorants than by treatment I, and (3) the disturbance and killing of cormorants caused by shooting (treatments I and II) will not affect the size of the populations from which most of the autumn staging cormorants originate. It is therefore predicted that the hunting of cormorants will have no influence on the number of cormorants using the fjords in subsequent autumns.

Hypotheses (1) and (2) were tested by a temporal setup consisting of four years where no hunting of cormorants took place, followed by three years with hunting, which were again followed by three years without hunting. For both fjords and for each of the ten study years, we used results from our counts of cormorants to quantify the temporal development of numbers over the autumn. Numbers generally declined over the autumn as more and more birds left for more southern wintering quarters. Hypothesis (1) was tested in Ringkøbing Fjord (based on the years 2002-2004 with treatment I) and in Nissum Fjord (based on the years 2002 and 2004 with treatment I). Hypothesis (2) could only be tested in Nissum Fjord based on one year (2003) with treatment II. In Ringkøbing Fjord, permission to shoot intensively near to the fjords' main day and night roost was not given because it was expected to cause disturbance to thousands of other staging waterbirds.

Hypothesis (3) was tested by comparing average numbers of cormorants during the first four years (prior to any hunting) with average numbers in the three years that followed the years of disturbing and killing cormorants.

2.3 The hunters and their activity

The local fishermen and the hunters' associations, as well as individual hunters, were informed of this experiment and the temporary change in policy, giving them an opportunity to shoot cormorants during the normal hunting season, which lasts from 1st of September to 31st of January. Every hunter and hunting club who applied for dispensation was given a license, on condition that the National Environmental Research Institute would receive the head and a wing from all shot cormorants for identification of sub-species and age-determination purposes. Each hunter was paid 5 Euro for each head and wing submitted (beyond expenses associated with postage). The hunters were given special envelopes (for postage of heads and wings) as well as maps on which to note the location where each individual cormorant had been shot. In each of the three hunting seasons, between 190 and 290 hunters were given dispensation to shoot cormorants in the two fjords. Consequently, given these numbers, we judged that the majority of the hunters who went hunting in the fjords had a dispensation to shoot cormorants.

Under the hunting regime referred to as 'treatment I', shooting was carried out by letting each hunter with a license shoot opportunistically at cormorants whenever a bird passed by within shooting distance. Most hunters were hunting from positions at the edge of reed beds, and this shore-based shooting occurred at many spots along the coastline of the fjords. Furthermore, some fishermen and a few hunters shot cormorants from hunting punts or motorized boats. Shooting activity was thus uncoordinated and occurred essentially at random. Most cormorants were shot when they flew to or from feeding sites in the morning[15].

Under the hunting regime referred to as 'treatment II', shooting was coordinated among four hunters who organized cormorant shooting 'sessions' from various positions within 200-700 m of the islet where the cormorants in the fjord were roosting on the ground during night-time. Most of this shooting took place as the cormorants flew from the night roost in the morning. The shooting was carried out with 1-2 day intervals within the first 10 days of the hunting season whereafter the hunters decreased their intensity of shooting.

2.4 Geographical origin and age of birds shot

In order to explore whether the birds shot in the 5-month autumn/winter hunting season originated from a widely distributed breeding population, 11,600 cormorant chicks were ringed in local, as well as more distant, Danish breeding colonies during 2002-2004 (Fig. 1, Table 1). By considering the probability of recovering a ringed bird in one of the two fjords in its first autumn as a binomially distributed response (a ringed bird can be recovered or not recovered), we tested whether recovery probability differed between sites and which sites where significantly different from the overall mean recovery rate. To further explore from which breeding populations the autumn staging cormorants in these Danish fjords originated, the presence of Norwegian cormorants was also investigated. Birds shot during the three years, as well as those found drowned in fishing nets and collected by fishermen, were examined so that the subspecies could be identified. The vast majority of Norwegian cormorants belong to the subspecies *P. c. carbo* which are larger than the continental subspecies *P. c. sinensis* that breeds in Denmark and other Baltic countries. These two subspecies also differ with respect to measures of the bill and gular pouch.[16] The shot birds were also aged (first-year bird or older), based on characteristics of the feathers in the wing and the head.[15,17,18] Furthermore, whenever possible a variable proportion of the cormorants counted during the autumns of 2002-2004 were aged (first-year bird or older) in the field based on characteristics of the plumage.[17]

2.5 Analysis of effects on numbers

Cormorants were counted at their roosts twice each month during the ten study years, except for 2003 and 2006 when 3-6 monthly counts were undertaken.

To evaluate the effect of the two different ways of organizing the shooting of cormorants (i.e. the treatments) we calculated the decline in cormorant numbers from a pre-shooting situation (August) to the first month of the period with shooting (September). The changes in numbers for treatments I and II were compared to the change in numbers in the control years when no shooting of cormorants took place. As the number of cormorants was stable throughout the ten study years in both Nissum Fjord ($F_{1,51}$ = 0.630, P = 0.431) and Ringkøbing Fjord ($F_{1,41}$ = 1.776, P = 0.190), different years with the same treatment were pooled, but the data from the two fjords were analyzed separately. The average August numbers (i.e. the 'baselines') were calculated from between 2 and 6 counts in August conducted each year during the 10-year study period, and for each year the August average was compared with each of the 2-5 counts conducted in September. The hypothesized effects of the treatments were tested with pair-wise comparisons (t-tests) between treatment means. Comparisons were only made between treatments within fjords, because the count data revealed differences between the fjords in the typical pattern of phenology during autumns without shooting.

To test hypothesis (3) – whether the three years with disturbance and killing of cormorants affected cormorant numbers in later years – we compared the August-September numbers of cormorants during the four years before the shooting (1998-2001) with numbers recorded in the fjords during the three years after the shooting (2005-2007).

3 RESULTS

3.1 Shooting

The number of hunters that successfully shot one or more cormorants in each fjord and year varied between 22 and 59. This corresponds to a maximum of 26% of the hunters that obtained a license to shoot cormorants. Summed over the three seasons, hunters shot a total of 308, 364 and 459 cormorants in the two fjords; a grand total of 1,131 birds. Equal numbers were shot in the two fjords in the first and last season, but due to the presence of dedicated ’cormorant hunters’ in Nissum Fjord in the second season, almost twice as many were shot there than in Ringkøbing Fjord that year. In every season a few (i.e. 3-4) hunters shot relatively large numbers of cormorants (some 30-124 birds each), but the great majority of hunters shot few (1-5) cormorants per season. In both fjords and all three seasons, most cormorants were shot in September (53-91%), fewer were shot in October and November (7-46%) and only a few were shot in December and January (2-7%). Thus, the shooting of cormorants was very much concentrated in the first month of the hunting season when there were most hunters in the fjords (JP Hounisen pers. comm.).

3.2 Within-year and long-term effects of shooting

The random opportunistic treatment I shooting in Nissum Fjord, which took place in 2002 and 2004, did not lead to any marked decline in cormorant numbers subsequent to the start of the hunting season, and the decline in numbers from August to September was not significantly higher than the decline observed in the control years when no shooting took place (Table 1).

The random opportunistic treatment I shooting in Ringkøbing Fjord, which took place in 2002-2004 had no significant effect on cormorant numbers there either (Table 1).

Treatment II, which included shooting birds near the main day and night roost at Nissum Fjord in 2003, lead to an abrupt decline in the number of cormorants present in the fjord in the first few days after the onset of shooting on 1st September: Numbers dropped to almost one quarter of the numbers present during the weeks immediately before (Fig. 2). The decline in the number of cormorants present in the fjord from August to September was significantly higher than in the years where no shooting took place and also higher than in the years with the treatment I shooting (Table 1; treatment I vs II: t_{23} = -3.075, P = 0.0054).

The number of cormorants occurring in the two fjords was not lower in three post-shooting years than during the four pre-shooting years (Nissum Fjord, t_{23} = 0.792, P = 0.346; Ringkøbing Fjord, t_{24} = -0.978, P = 0.339).

3.3 Geographical origin and age of the shot birds

Out of the 11,600 cormorant chicks ringed in Danish breeding colonies during the three study years, 114 were recovered in the two study fjords in their first autumn of life. The probability of being recovered was significantly dependent on ringing site (χ^2_4 = 105.15, P < 0.001), and deviations from the overall mean recovery probability were found for Ringkøbing Fjord (recovery probability significantly higher) and Southeast Denmark (recovery probability significantly lower, Table 2). The proportion of Norwegian birds, as determined from identification as the *carbo* subspecies, among those dead birds collected during the three hunting seasons was 8.3% (based on sub-species determination of 2,023 birds shot or found drowned in fishing gear in the two fjords).

The majority of the cormorants shot by hunters were in their first autumn of life. Thus first-year birds constituted 70%, 67% and 51% of the cormorants killed in each of the three years of experimental hunting (N = 257, 294, 408 birds aged, respectively; χ^2_2 = 30.52, P < 0.001). A comparison with the age-ratio recorded among cormorants present on the day-roosts (15-

55% first-year birds depending on date and location) suggested that young (presumably inexperienced) birds were more likely to be shot than the older birds.

4 DISCUSSION

4.1 Within-season effects

A commonly used method to reduce cormorant numbers outside the breeding season involves so-called lethal control (shooting) in order to scare the birds away from – or reduce their numbers at - feeding grounds and/or roosts. Intensive scaring at feeding sites and/or night roosts has, in some cases, been shown to result in marked reductions in the number of cormorants appearing in the following weeks or months.[13,19,20] Based on this we hypothesized that shooting in the fjords would cause a subsequent reduction in numbers. However, our data refuted hypothesis (1) – we found no evidence that low intensity shooting occurring (opportunistically) at random along the shores of the fjords affected the number of cormorants present in the fjords. There was no evidence that this type and intensity of disturbance and shooting was sufficiently high to induce a measurable proportion of the birds to advance the date of their migration for wintering areas further south in Europe.

On the other hand, our data were able to confirm hypothesis (2) – that high intensity shooting occurring near to the main night roost would affect the number of cormorants present in the fjord. Here, cormorant numbers dropped to one quarter of pre-shooting levels when the shooting was intensive and targeted at disturbing the birds near to the night roost. Numbers remained low during the remainder of September-October at Nissum Fjord, probably because few new birds arrived at this relatively northern site after the end of the main migration period.

4.2 Between-season effects of shooting

Data from regions in Europe where relatively large-scale shooting of cormorants has been carried out (e.g. parts of Germany, France, United Kingdom) have shown that shooting was not generally effective in reducing cormorant numbers from winter to winter.[11,21] Based on this we hypothesized that shooting in the western Danish fjords would not significantly influence the number of cormorants using these places in subsequent autumns. This hypothesis was confirmed, but bird numbers in the fjords did vary from year to year, probably partly because food availability (and thus the duration of stay) for individual birds varied between years[18].

To further explore the effects of shooting, we attempted to theoretically assess whether it might alter the numbers of experienced birds coming back to the two study fjords in subsequent seasons. This assessment was based on a number of assumptions including: (1) that all cormorants shot by hunters were reported, (2) that the mortality of birds was 40% for juveniles and 20% for older birds until the subsequent autumn (as gathered from the literature[22]), and (3) that the probability of a cormorant returning to the fjord the following season was 85%, provided it survived until then (partly based on Frederiksen et al.[23]). From these calculations it was estimated that the shooting actions had resulted in 194, 355 and 486 fewer cormorants coming to the two fjords during the autumns of 2004, 2005 and 2006. It was also predicted that the effect of shooting would be greatest in the autumn of 2006 because a cumulative total of 1,131 cormorants had been shot over the course of the previous three hunting seasons. However, no effect on the numbers of cormorants counted was detected. This may have been because individual birds extended their length of stay in the fjords (i.e. delayed their autumn migration) and/or because 'turnover' increased and many 'new' birds migrated into the fjords and replaced those that had been shot in previous years.

The recoveries of rings from dead cormorants demonstrated that some of the young birds from local colonies were still present in the fjords in September when most of the shooting took place. As expected, given the prevailing direction of post-breeding migration in northern Denmark,[24,25] many of the cormorants killed originated from colonies located in Limfjorden – to the north of the two study fjords (area B in Fig. 1). However, cormorants from this region were only 1.5 times more likely to be recovered dead in the two study fjords than were cormorants originating from colonies located in Kattegat (area C and D in Fig. 1, see Table 2). This suggested that a fairly large number of the Kattegat cormorants were migrating through Limfjorden or crossing the land mass of Jutland as they dispersed from their breeding colonies in late summer and autumn. The significantly lower occurrence of birds from southeast Denmark in the sample of dead birds from the study fjords is in concordance with earlier findings that few of the cormorants from this region disperse to west Jutland after the breeding season[25]. Overall, together with the sub-species identifications, the recoveries of rings among shot birds confirmed that the cormorants present in the two study fjords in autumn came from a large breeding area. The results showed that a large number of birds in the study fjords came from breeding colonies located in the Kattegat region of Denmark as well as along the coast of Norway, regions holding 16,000 and 30,000 breeding pairs, respectively, in 2006.[26] Therefore the shooting of cormorants in west Jutland is unlikely to have had more than a marginal effect on the size of the very large breeding populations from where the first-year birds originate. We assume that a large number of first-year birds would annually migrate to the fjords in late summer and autumn regardless of how many cormorants had been shot in the fjords in previous years.

It might be expected that the annual shooting of 300-450 cormorants in the two study fjords would have had an impact on the development of the local breeding colonies, if a large proportion of the shot cormorants had been breeding birds from these colonies. However the shot cormorants were mostly young birds from other colonies. This was probably because the majority of the local breeders and fledged juveniles had started their autumn migration to the south before the beginning of the hunting season on the 1st of September.[15,25] As long as the shooting of cormorants in the study fjords was limited to the general hunting season, it appears to have little effect on local breeding numbers as there are few local birds remaining in the area by then.

4.3 Effects in relation to alleviating damage to fisheries

Atlantic Salmon are only exposed to predation from cormorants during the smolting period in early summer[27] - whilst the shooting activities occurred September to January. Thus, shooting cormorants almost certainly had no influence on the development of breeding colonies or on smolt predation. Similarly, there was likely to have been only a small reduction, if any, on the predation of Flounder by cormorants as shooting by treatment I did not significantly reduce the actual numbers of birds in the study fjords. The population of small Flounder in the two fjords varied extensively from year to year[18] and there was no empirical evidence that the occurrence of Flounder of a size that would be of interest to local fisheries improved in association with the cormorant shooting.[18]

4.4 Factors affecting success of shooting for fisheries

One of the major factors that limit the chances of success is that cormorants are highly mobile. It is not uncommon to find that birds shot or scared away from prime foraging sites are replaced quickly by new birds arriving from neighbouring areas. Even where large numbers of cormorants have been shot, bird numbers can recover quickly as replacements move in. This is particularly common in areas of high turnover where many cormorants are passing through on migration. The location of the area or region where shooting is undertaken is thus important in relation to broader European migration patterns. In any event, shooting efforts would need to be repeated both during the season and in subsequent years. Successful measures are expected to require repeated and intensive shooting and scaring at day and/or night roosts, and would be most effective if undertaken at a majority of sites. Such efforts would be demanding in terms of effort, especially if cormorants disperse, and actions would need to be coordinated effectively. As pointed out by Parrott et al. 2003[13] shooting regimens need to be designed in relation to local conditions in order to maximize effectiveness. In the present study, apart from a small (5 euro) financial incentive, hunters were free to shoot (or not to shoot) cormorants as they chose. Thus, shooting intensity was ultimately governed by hunters' desire and choice to shoot cormorants *per se* rather than by their desire to improve fisheries' catches. Cormorants were shot by waterfowl hunters, but mostly at the very beginning of the hunting season and very few hunters chose to shoot more than a few birds. Generally waterfowl hunters in Europe appear not to want to shoot cormorants because they are not a traditional sporting quarry, have no commercial value and are very rarely regarded as an edible species (DNC/INTERCAFE unpublished information).

4.5 Conclusions

Shooting is of limited efficacy as a tool for scaring cormorants for large water bodies (e.g. an entire fjord or a long stretch of coastline) especially if it is impossible to scare the birds (a) at or near to their day and/or night roosts or (b) simultaneously over the entire waterbody. Thus, low-intensity shooting carried out over a large water body cannot be expected to achieve a scaring effect which affects cormorant numbers. On the other hand, if intensive shooting of cormorants is carried out near their day and/or night roosts, shooting may result in cormorants leaving the area significantly earlier than they otherwise would have. The need for repetitive shooting and scaring and the likely effects of such management will depend on the numbers of new cormorants that arrive in the area as the management proceeds.

There is a pressing need for research that assesses whether lethal control has the desired effect on reducing cormorant numbers (e.g. either directly through mortality or indirectly through disturbance). Empirical evidence is needed on whether such cormorant management reduces cormorant numbers, predation rates on fish, increases fish catches and to calculate cost-benefit estimates for relevant management approaches.

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Tables

Table 1. Effects of random shooting (treatment I) and of coordinated shooting near to the night roost (treatment II) on the decline in cormorant numbers from August to September in Nissum Fjord and Ringkøbing Fjord compared with years without shooting (Control). LCL – lower 95% confidence limit for the decline in absolute numbers; UCL – upper 95% confidence limit of declines in cormorant numbers. Change (%) – the decline in % of numbers present in August. SE – standard error for the proportional decline.

	Treatment	Mean decline	LCL	UCL	P value	Change (%)	SE
Nissum Fjord	I	319	-21	657	0.662	-35.3	14.7
	II	920	835	1004	0.001	-71.5	2.4
	Control	250	39	461	-	-29.0	8.1
Ringkøbing Fjord	I	526	12.6	1039	0.295	-17.7	7.0
	Control	165	-400	729	-	-4.1	11.2

Table 2. Numbers of cormorant chicks ringed in 2002-2004 and numbers and proportion recovered in the two study fjords (Ringkøbing and Nissum Fjord) in their first autumn (July-December) during 2002-2004. The locations of the ringing areas are shown in Fig. 1. The number of colonies denotes the number of colonies where cormorant chicks were ringed.

Area	Number of colonies	Numbers ringed	Numbers recovered	% recovered
A Ringkøbing Fjord	1	1166	40	3.43*
B Limfjorden	4	2972	40	1.35
C Nordwestern Kattegat	2	1200	9	0.75
D Southwestern Kattegat	3	2585	23	0.89
E Southeast Denmark	3	3673	2	0.05*

* Significantly different from the overall mean recovery probability of 0.98 %

Figures

Figure 1

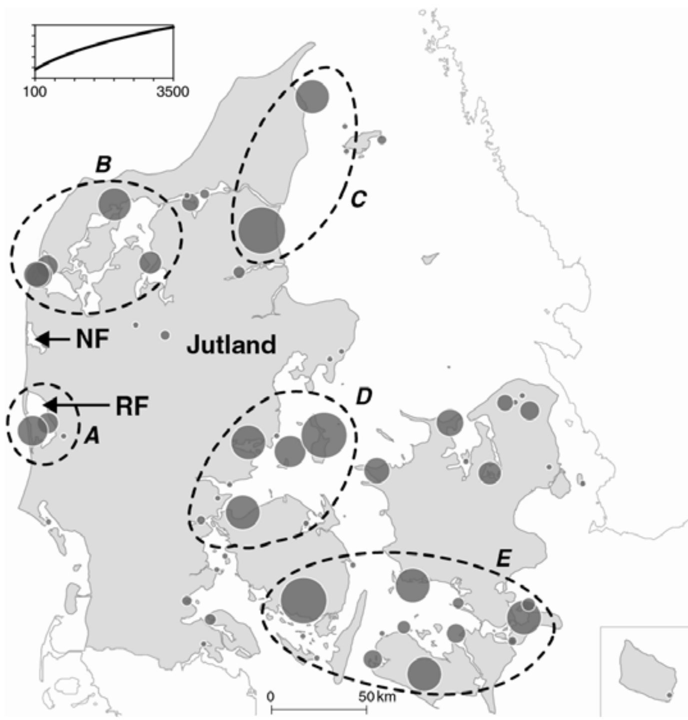

Figure 1. Location and size of cormorant colonies in Denmark in 2004 with denotion of borders of the five areas where cormorant chicks were ringed in 2002-2004. The two arrows indicate the location of the two study fjords Nissum Fjord (NF) and Ringkøbing Fjord (RF). The size of the circles is proportional to the number of nests (see inset scale at top). Upper case letters A-E denote the areas referred to in Table 2.

Figure 2

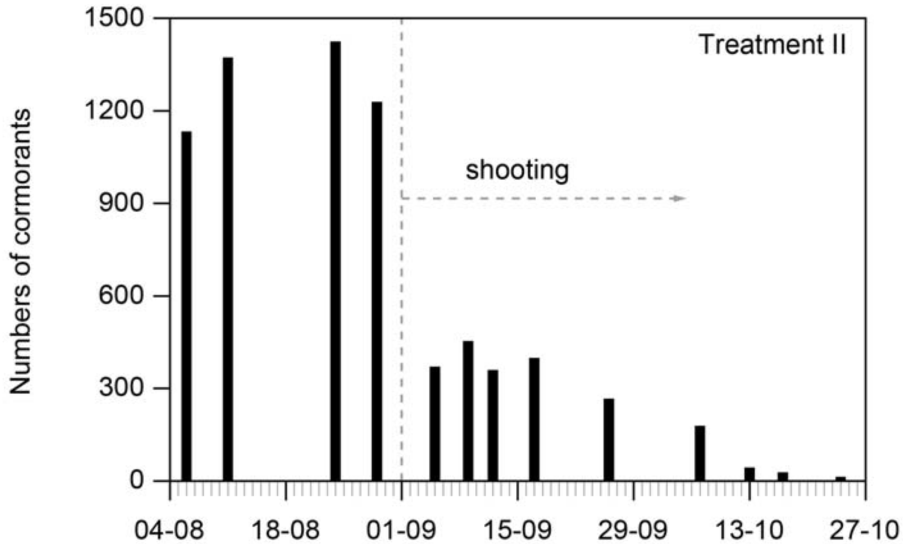

Figure 2. Numbers of Great Cormorants counted in Nissum Fjord during August (before onset of the hunting season) and September-October (with shooting) in 2003 when shooting took place near to the night roost.