A review of the issues relating to control of cormorant populations at the pan-European level

Introduction

Large increases in cormorant populations have occurred across Europe over the past 30-40 years, particularly birds of the *sinensis* sub-species in Western Europe. Cormorants have also greatly extended their breeding and wintering ranges into areas where they had previously been scarce or even absent for some time, with many more birds accessing inland fisheries. This has resulted in widespread conflicts with fishery interests. Conflicts occur at different sites and different times of the year, partly reflecting large variations in cormorant numbers as birds move between breeding and wintering areas. A diverse range of fishery interests are affected by cormorants in marine, brackish and – particularly - freshwater habitats, and including commercial fisheries, fish farms (intensive and extensive) and recreational angling. Cormorant predation can have serious economic implications by damaging fish stocks, reducing catches, limiting aquaculture production and through other social and economic effects. In many cases, serious damage can result and justify management action (see guidance document).

Many angling and fishery stakeholders, including the European organisations involved in the CorMan Stakeholder Liaison Group, believe that the current cormorant population size of the *sinensis* sub-species in Europe represents an unacceptable and unsustainable threat to fishery interests. They believe that a form of long-term, internationally co-ordinated cormorant control, preferably at the pan-European level, is needed, focusing in particular on actions taken at breeding sites. The aim would be to reduce the *sinensis* population to a size at which damage to fisheries was reduced to a more acceptable level.

This document seeks to further explore the issues around the possible management of cormorants at the European scale.

What form might such a pan-European plan take?

Advocates of a pan-European approach to managing cormorants suggest that this might be achieved by agreeing on an appropriate population 'reference' level, or population range, around which bird numbers would be managed. From a legal perspective, such management decisions would fall within the competency of Member States. It is thus likely that reference levels would need to be set separately by each country, although this could be based on compatible principles and in consultation with neighbouring countries. Under such an approach, relevant national authorities would need to reach consensus on general criteria, establish appropriate reference levels and agree a number of associated issues. These would include decisions about the geographic scale for the 'target' population (or populations), monitoring arrangements to assess population status and the co-ordination and evaluation of management activities. It is stressed, however, that cormorant population management would not be the main objective in itself; rather, the aim would be to reduce the incidence of serious damage at fishery sites. So, fisheries would also need to be monitored to ensure there was a benchmark against which the efficacy of the measures could be assessed as a basis for ongoing management decisions.

The calls for cormorant management put forward by fishery stakeholders typically advocate population management measures targeted at breeding colonies, rather than in wintering areas when birds are more widely dispersed, since this is considered more effective and would enable better control. These calls further advocate the use of measures such as egg oiling rather than

shooting as the primary means of control (e.g. **EIFAAC report**). Such measures are seen as particularly appropriate for use in cormorant ground-nesting colonies, although alternative methods (e.g. disturbing birds to make eggs cool off) could also be applied effectively in tree-nesting colonies, although at greater expense. The extent of ground-nesting, as opposed to nesting on trees, varies considerably between countries.

Monitoring, including assessments of damage, would be a key requirement alongside any population control measures, as this would be necessary to inform ongoing management decisions and enable the efficacy of any such strategy to be assessed and modified as necessary. This would also ensure that the plan was in line with the requirements of the Birds Directive, that a secure status of the species is maintained, and that there was a reduction in the incidence of serious damage at fishery sites. This monitoring and feedback process, known as *adaptive resource management* is increasingly used in managing wildlife resources - for example, in respect of hunted duck and goose populations in North America. It has been suggested that such a strategy would also be broadly similar to the biological reference points and associated assessment and management procedures that are used in the sustainable management of many fish stocks.

Has a pan-European plan been discussed previously?

Yes, back in the 1980s and 1990s there were increasing calls from some fisheries interests for measures to reduce the population size of cormorants, particularly by stakeholders from regions where the birds over-winter. In particular, the governments of Denmark and the Netherlands were urged to address the issue, since at this time a substantial proportion of European *sinensis* cormorants bred in these countries. Subsequent discussions were aimed at placing cormorant management in the international legal framework of the Bonn Convention (Conservation of Migratory Species of Wild Animals). Later, a draft recommendation on the management of cormorants in the African-Eurasian region was adopted by the Conference of Parties at the fourth meeting of the Bonn Convention in 1994.

In February 1996, the European Parliament adopted a '*resolution on the cormorant problem in European fisheries*' which requested *preventative action to restrict the reproduction of cormorants* and also asked for the removal of the *sinensis* sub-species from Annex I of the Birds Directive because its enhanced status no longer necessitated these special protection measures (LINK to EP Resolution B4-0138/96[1]). Subsequently, there was a workshop '*Towards an International Conservation and Management Plan for the Great Cormorant*' in the Netherlands in October 1996, under the auspices of the Bonn Convention. In April 1997, the European Commission removed the *sinensis* subspecies from Annex I, in particular taking account of the fact that *this subspecies has reached a favourable conservation status* (LINK to Commission Directive 97/48[2]).

An international meeting of experts was also held in Denmark in September 1997 to complete an Action Plan for the Management of the Great Cormorant in the African-Eurasian Region. Some parties at the meeting favoured direct action to reduce the cormorant population, but the majority of parties considered that this was not an appropriate objective for the Action Plan. Thus, the Plan agreed by the majority aimed to minimise the conflict between fisheries interests and cormorants by "*ensuring that best practice is followed in mitigating, preventing and reducing their reported impacts on fisheries, while maintaining a favourable conservation status for the species.*" The Action Plan also

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:51996IP0138:EN:HTML

[2] Commission Directive 97/49/EC of 29 July 1997 amending Council Directive 79/409/EEC on the conservation of wild birds, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31997L0049:EN:HTML

stated that Member States should try to achieve this in the following order of preference: (a) appropriate site-specific management; (b) local management and control of cormorants; and (c) co-ordinated management and control of cormorants between Member States.

The Action Plan was circulated to all European Member States with a request to implement the recommendations, although actions were left to the discretion of individual countries. In practice, Member States largely continued with their own regional or national cormorant mitigation policies and there was little, if any, facilitation to co-ordinate implementation of the plan at the international level. Thus, for many affected by the 'cormorant problem', this Action Plan appeared ineffective.

More recently, in response to the growing concerns from fishery interests, the European Parliament adopted a Resolution (P6_TA(2008)0583) in December 2008 for a European Cormorant Management Plan to minimise the increasing impact of cormorants on fish stocks, fisheries and aquaculture (see Kindermann report). The European Parliament called on the Commission to consider all the legal means at its disposal to reduce the negative effects of cormorants on fishing and aquaculture and to submit a management plan co-ordinated at the European level.

In responding to this request, and after widespread consultation, the European Commission considered that an EU-wide management plan would not be an appropriate measure to address the problem. Rather, the Commission considered that the existing derogation provisions of Article 9 of the Birds Directive provided Member States with adequate powers, and that cormorant problems were best addressed at a regional scale.

Although this remains the current position of the European Commission, many fishery stakeholders continue to believe that some form of pan-European or internationally coordinated management plan is still required to reduce cormorant numbers at the population level across Europe.

The legal position

Like all wild birds species in Europe, the Great Cormorant is protected under European Directive 2009/147/EC (the Birds Directive). Its deliberate capture and killing, disturbance, destruction of its nests or taking of its eggs can only be allowed by Member States if this is done in accordance with the derogation system set out in Article 9 of the Directive. Article 9 provides that Member States may derogate for a number of purposes, including preventing serious damage to crops, livestock, forests, fisheries and water, or the protection of flora and fauna, provided that there is no other satisfactory solution. The European Commission has recently developed a non-binding guidance document regarding application of the derogations in Article 9. This document is available here.
Population management is considered to be a legitimate option under the derogations within the Birds Directive, provided it is designed to prevent serious damage and is consistent with the objectives and requirements of the Birds Directive, including maintaining the population of a species at a satisfactory level.

The derogation system is already being widely used by Member States to reduce or prevent serious damage by cormorants. However, there are significant differences in the way this is done, both in terms of the choice of sites where control actions are undertaken and on the methods used. Some Member States use the derogation possibilities extensively, including actions at breeding colonies, whilst others do not allow scaring measures or control of cormorant numbers at all. In line with the subsidiarity principle, the implementation of the derogation system lies within the competence of Member States.

The current position of the European Commission

Given that cormorants are spread widely throughout Europe and may undergo large-scale migrations between breeding areas and wintering areas, any implementation of a pan-European management strategy would require collaborative action and planning by a large number of European countries for such a plan to be applied across the broad scale necessary. This would depend on independent decisions at a national level. As noted previously, the implementation of the derogation system lies within the competence of Member States. Thus, countries which might be opposed to using the derogation scheme or to participate in any pan-European plan to control cormorant populations cannot be compelled to do so, irrespective of whether or not they are members of the EU. Of course, it would still be possible for the Commission to develop a plan, should it be so minded, and use this as a basis for discussion and consensus building with Member States.

In response to concerns from fishery stakeholders, the Commission has stated (see doc ref. SP(2009)401 here) that "*While [they are] not persuaded of the need for such a management plan, it is apparent that in several Member States the size of the cormorant population is giving rise to increasing conflicts. However, there is no consensus between Member States on the type of action to take. Whilst some Member States or some regions are supportive of an EU-wide management plan, others are not persuaded that there is a problem or that there is no need to address it at EU level. If one Member State decides that there is no need for measures, the Commission cannot change that position. Also the Commission is not in favour of an EU wide strategy as the problems are localised. Therefore, it is not proportionate to argue for action at EU level to solve a problem of regional scale. An alternative way to address this issue could be found in the existing mechanisms that are available under the provisions of the Birds Directive*."

Thus, where necessary, the European Commission is encouraging Member States to consider the potential for co-ordinating management actions against cormorants across broader scales through bilateral (or perhaps larger) agreements, and it has indicated that it would be prepared to help facilitate such arrangements.

Biological considerations relevant to possible pan-European cormorant management

i. Predator/prey interactions

Predator/prey interactions are a natural part of the complex relationships that take place within ecosystems. Thus, predation on fish by cormorants and other fish-eating birds, and predation by fish on other animals, is a normal part of the natural interactions that occur between species in aquatic habitats (see chapter 7 and chapter 10 in the **INTERCAFE Field Manual**). In a natural, 'unmanaged' situation predator numbers would typically be closely linked to, and governed by, the availability of suitable prey species. Where prey is readily available and abundant, predator numbers typically increase, either through an increase of the population (e.g. due to better survival or increased breeding output) and/or as a result of predators moving into an area. Conversely, in the absence of good access to ample prey, predator numbers fall. Similarly, this can be as a consequence of a reduction in population size (e.g. higher mortality rates, reduced breeding output) or due to bird movements out of a particular area.

In simple situations (e.g. one predator and one prey population within a closed area), these processes often result, in the long term, in predator/prey numbers oscillating around a particular level – the predator/prey equilibrium. In practice, predator/prey interactions are rarely so simple and any such natural equilibrium level, even if attained, may be unacceptable where the resource

(the prey) is also of interest to man. In such circumstances the predators are viewed as competitors for the same resource as they conflict directly with man's use of the resource, with potentially wider social and economic implications.

ii. Cormorant population dynamics

The European cormorant population has increased rapidly and the breeding population has gradually expanded into parts of Europe where the species was absent or scarce for many decades. The pattern of expansion illustrates the capacity of the *sinensis* sub-species to newly colonise or recolonise suitable breeding areas and respond positively: (a) to protection against persecution and pollution; (b) to access to safe breeding and roosting sites; and (c) to easy access to waters rich in fish. Adult Great Cormorants that are not exposed to shooting will normally have a high probability (80 - 90%) of surviving from one year to the next (although they may suffer higher mortality in cold winters). In addition, when food conditions are favourable they are able to breed when two years old and raise 2 to 4 young to fledging, whereas the age of first breeding is delayed and the fledgling numbers are less when the birds' diets are more impoverished. Consequently, cormorant populations can increase by more than 25% year-on-year. Furthermore, birds can respond quickly to deteriorating food conditions by changing their choice of foraging sites. They can also move to alternative breeding sites, but such responses will typically be from year to year.

Nonetheless, several studies have shown that cormorants can become seriously constrained by limitations in the access to safe breeding sites and rich feeding areas. For example, cormorant breeding performance can decline markedly if a colony continues to increase and/or foraging conditions nearby deteriorate as a consequence of predator/prey cycles or other developments. This is one of several ways in which natural density dependence can operate and cause a transition from growth to decline and subsequent stabilisation within a colony or population.

Almost all cormorant breeding populations in Europe will - after some years of growth - become limited in size and further growth by the amount of food available around the existing colonies and the access to hitherto uncolonised, attractive and safe breeding sites. In theory, and given enough consistent effort, humans could influence these factors in a number of ways and thereby affect the size at which cormorant populations begin to stabilise.

In light of the above, a key factor that can be expected to influence the efficacy of any possible pan-European management strategy is the extent of density-dependent population regulation and the strength of the compensatory (feedback) mechanisms that might apply.

For example, our knowledge of cormorant population dynamics indicates that a reduction in numbers of breeding birds in an area (not caused by food shortage) often leads to an increase in the numbers of young birds per nest that are fledged successfully by those birds that do breed there, and where productivity is below maximum potential. This is a consequence of reduced competition among cormorants for food and the greater availability of fish with which adults can feed their offspring. Under such a scenario, the greater the (downwards) 'pressure' that is applied to reduce bird numbers, the stronger will be the (upwards) compensatory mechanisms (within limits) that will operate to re-build population sizes. Such factors make it more difficult to predict the impact of population reduction measures and would make reducing numbers over large areas or at the population level a challenge.

Some population management strategies for cormorants seek to avoid the problem of constantly working against compensatory mechanisms by working with density dependence. Thus, a management approach is adopted where the objective is to restrict birds to a particular area and

limit their expansion to other surrounding areas through control measures. In such a scenario, population size in the 'permitted' area would, in effect, become regulated by the available resources (e.g. food and breeding sites) and numbers would be expected to fluctuate about some equilibrium or carrying capacity level within the more limited area available to the cormorants. Active measures would be required outside this area – for example, preventing new colonies and/or new roosts establishing and/or the use of active deterrents at feeding sites – in order to restrict expansion. Of course, preventing such expansion of the population would not normally be easy, particularly at a larger scale. Nonetheless, such an approach has been applied successfully in certain countries and situations. Thus, preventing the formation of new breeding colonies in Denmark has been used to restrict the fish resources available to cormorants during the breeding season and thereby limit the population from further expansion and reduce impacts on fisheries in particular areas.

The practicalities of possible pan-European cormorant control

The possibility of pan-European control has been the subject of previous theoretical assessments using population models. A simple model based on the 1998-99 continental cormorant population was developed to predict the effect of different levels of culling. However, one drawback of this early model was that it did not take into account any geographical variation in culling intensity. A later model included some geographical sub-division of the winter range (France vs. the rest of Europe), because, in recent years, culling intensity has been greater in France than elsewhere in Europe. This model indicated that the effects of culling are highly dependent on the extent of immigration into an area. The modelling investigations suggested that some form of pan-European population control might be feasible, in principle, but presented a number of challenges.

In practice, there are many reasons why attempts to reduce the continental cormorant population (see here), and manage this around some 'acceptable' level, would be difficult on such a broad scale. For example, the large territory, widespread breeding populations and further mixing and dispersing of the birds in winter (see here) means that there will be no simple relationship between management actions in a restricted part of the breeding areas (e.g. in one country) and the consequences of these actions in wintering areas, or *vice versa*. Furthermore, since numbers and distribution patterns of the birds are partly determined by density-dependent factors operating both within and outside the breeding season, there is considerable potential to compensate for reductions in numbers through changes in both the distribution of the birds, and their fertility and mortality rates. Public acceptability and ethical concerns would also need to be considered.

Any use of lethal techniques for population control at a broad scale would need to take account of a range of factors, including the level of mortality achieved relative to immigration and breeding rates, migratory patterns and the relative levels of controls in different areas. This would make it difficult to achieve a successful, pre-determined outcome. Population control has typically proved most cost-effective and long-lasting where the bird species causing problems has been contained in relatively small, localised populations. The widespread nature of cormorant breeding populations, with birds mixing and dispersing across Europe in winter, makes it a challenging task to develop models that can predict realistic outcomes from different management strategies. However, the fairly new approach of individual-based modelling offers potential for addressing these difficulties. For example, in attempting to predict future changes in distribution of cormorants in Europe outside the breeding season, these types of models can incorporate knowledge and assumptions about how cormorants respond (in their choice of staging and wintering sites) to factors such as changes in the climate, intensity of competition for food and changes in levels of disturbance.

Adaptive Resource Management

A general conclusion of population modelling is that constant population management with fixed rules, quotas or rates is typically either too ineffective in terms of population reduction or poses risks for population viability. Fishery stakeholders consider that any broad-scale population reduction plan for cormorants would need to be adaptable, tightly monitored and consistent with Birds Directive objectives. This is also consistent with the adaptive resource management approach that is commonly now advocated for managing many wildlife species. With increased levels of monitoring in place, management measures are reviewed and updated in light of population changes. Such an approach is judged to be both effective and safe, since it provides feedback mechanisms and the opportunity to stop control measures, should this be necessary, before a population becomes critically reduced. For cormorants, this would allow management rules to be adopted taking into account the current state of the cormorant population, as well as whether the management actions are reducing the incidence of serious damage at fishery sites as planned.

A recent example of adaptive resource management is provided by the International Species Management Plan that has recently been agreed in relation to the Pink-footed Goose. Further details are provided below and here.

Another example of the application of modelling and an adaptive resource management approach is provided by the cormorant licensing strategy used in England in recent years to determine a 'reasonable' upper limit of cormorant numbers allowed to be shot each year. The approach relies on a simple population model, informed by annual wintering counts, to assess the effect of different levels of shooting. This allows the number of birds permitted to be shot in the following year to be reviewed and, as necessary, adjusted. The process benefits from the fact that the wintering population in England is relatively small and has limited immigration relative to mainland Europe, and that it operates within a single national jurisdiction. It is unlikely that the same approach could be readily applied to the much larger, more migratory populations across Europe.

How might a reduction in cormorant numbers affect levels of damage to fisheries?

It is unclear how any overall reduction in cormorant numbers might affect degrees of damage at fisheries. It is generally accepted that cormorants are attracted to, and will attempt to exploit, feeding sites where they can forage in the most energetically efficient manner and in relative safety. However, other factors may also influence site selection. Thus, for migrating birds, there is evidence, for some areas at least, that the bird's first choice may be large water bodies, with birds expanding from these to smaller water bodies subsequently. It is perhaps less clear whether these first choice sites represent optimum foraging sites or reflect, in part at least, the use of rivers and large waterways as migration corridors. It is also uncertain whether the subsequent spread to smaller foraging sites is driven by increasing numbers of birds, and thus competition for resources, or the fact that foraging opportunities are better at these other smaller sites and new 'habits' develop.

Biologically, it can be assumed that cormorants (as with most animals) select their foraging locations on an energetic basis – put simply, they are likely to try to maximise their energy intake through encounters with prey and food consumption, and minimise their energy expenditure on things like travel to foraging sites, diving times and prey capture. Even at this simple level it is clear that some foraging sites will therefore be 'better' than others (through the abundance of prey and its availability) and so biologists often refer to foraging (and other) locations as being either optimal or sub-optimal. Just as some foraging sites are 'better' than others, some individual birds are 'better' foragers than others – at its simplest and most general, young (i.e. first-year) birds tend to be less efficient foragers than older individuals, for instance. A consequence of all this is therefore likely to

be ‘competition’ between individual birds in any particular area for specific foraging sites, with the most efficient/experienced birds dominating at optimal sites and less efficient/experienced ones being forced to feed at sub-optimal sites. Furthermore, at some point along this spectrum of declining site quality, it will become unprofitable for an individual bird to forage at a specific site and they will have to move to another one.

Cormorants consistently and predictably turn up to forage at particular sites, and numerous conflicts arise with fisheries interests where these are the sites most valued by recreational anglers, commercial fishermen or fish farmers. This is because the sizes of fish consumed or damaged by the birds often coincide with those that are of interest to users. Given this situation, it might well be assumed that these sites are also optimal foraging sites for cormorants and/or are sub-optimal sites used frequently by the birds. In other words there is some sort of ‘pressure’ on the birds to be foraging where they do at what might be termed ‘prime’ sites. Because of the mobility of cormorants, killing or scaring birds at such prime sites commonly creates opportunities for new birds to replace those that have been killed or scared. Even where large, organised cormorant culls take place each year, bird numbers can recover quickly as replacement individuals move in, particularly at sites that are on established cormorant migration routes. This suggests that large-scale killing of birds may not necessarily provide the ready solution to local cormorant conflicts that is often imagined.

A reduction of the cormorant population to a lower, more acceptable level would reduce the overall impact of the birds on fish stocks and fisheries - fewer cormorants across Europe would eat fewer fish. This is unequivocal. However, scientific opinion suggests that the decline in the pressure on fisheries would be less than the decline in bird numbers might suggest, as birds are likely to continue to favour high quality habitats that offer the best foraging potential. Ecological theories and our limited understanding of cormorant movements and foraging-site choice suggest that, where cormorant populations are constrained by available resources, a reduction in bird numbers results in the abandonment of marginal, sub-optimal, foraging areas first. Thus, although fewer birds should mean fewer fisheries with problems, conflicts may well persist at many of the ‘prime’ sites. Since such sites are often those that are most valuable or desirable to fisheries stakeholders, the reduction in conflicts may be disproportionately small.

On the other hand, in this situation where scientific evidence is incomplete, some fishery stakeholders believe that a reduction of cormorant numbers would result in a significant reduction of damage at most fisheries, not least those which currently suffer the heaviest damage because local on-site management measures are not effective. This expectation is based on their general assumption that population management would reduce cormorant numbers at breeding colonies and wintering roosts to a level which prevents the over-exploitation of adjacent waters. In breeding areas the effects of population reduction are seen by some fishery stakeholders as being relatively easy to predict: If management succeeds in holding colony size at a level which prevents over-exploitation this would ensure that cormorant predation stays below the threshold of 'serious damage' and consequently would result in higher prey availability in adjacent waters. This, they claim, would reduce the need for birds to commute relatively long distances to forage and so fisheries more distant from a colony would see a disproportionally large reduction in levels of damage. Effects in wintering areas are more difficult to predict, but fishery stakeholders believe it is not unreasonable to expect that a reduction of the overall population would, to a certain extent, reverse the geographical expansion of cormorants, or at least reduce the predation pressure in newly colonised areas.

There is also a belief among some fishery stakeholders that a reduction of cormorant numbers in a particular area could result in an over-proportional reduction in damage at fishery sites. This is

based, in part, on the view that the pressure to abandon larger water bodies would be reduced or removed if bird numbers were lower, resulting in reduced pressure on fishery resources in other smaller sites more distant from roosts. Such arguments are also based on the fact that the damage at many of these smaller sites can be of greater significance, on the grounds that the fish populations are of higher commercial value, recreational interest and/or conservation concern than those in many large water bodies. It is clear that economic and conservation considerations will be important in the context of assessing damage (and in targeting management action), and such arguments may be valid, for example, in the case of alpine river fish populations in central Europe. However, not all stakeholders subscribe to this opinion, and it is not the case universally across Europe that smaller water bodies are of the highest commercial or recreational interest (and, in some cases, the opposite is true).

Practical considerations related to the timing and scale of cormorant control measures

i. Control of cormorant numbers at breeding sites

There is general consensus that any attempt at pan-European control would need to be targeted at concentrations of breeding birds because only when the birds are congregated together could measures be applied on a sufficiently large scale. Measures against breeding birds are already employed in some countries (e.g. Denmark), typically through egg destruction in ground-nesting colonies, where nests can be accessed with relative ease. However, measures at breeding colonies aren't necessarily restricted to ground-nesting birds as, for example, actions could perhaps be used to scare birds from their nests in trees such that eggs become cold and embryos fail to hatch, although this would be more difficult and costly.

Nest or egg destruction, or actions against birds at breeding colonies, over a sufficiently broad scale will reduce the breeding output of the birds. It follows that with fewer fledged birds at the end of the breeding season, a reduced number of older birds will visit fisheries in winter, and, in subsequent years, fewer adult birds will recruit to the breeding part of the population. However, such measures would need to be applied each year to achieve a lasting effect; the effect on recruitment in any year may be less than expected if there is a surplus of younger birds in the population.

Eggs can be destroyed by several methods: egg removal, egg pricking or egg oiling, although oiling is the method most commonly used and generally regarded as cheaper, more effective and more humane. Investigations have demonstrated that egg destruction can be effective at reducing local populations of cormorants, although the results can be variable and studies in North America have shown that there may be an increase in dispersion of cormorants away from nesting colonies where oiling takes place.

A number of factors can influence the efficacy of different egg destruction methods. The oiling of eggs usually has the advantage over egg-removal or destruction in that the adults will commonly not lay a new clutch and will continue to sit on the oiled eggs until it is too late in the season to lay a replacement egg clutch that year.

The management methods used to reduce breeding numbers will thus vary and depend on factors such as whether cormorants are nesting in trees (where nest/egg destruction is likely to be very difficult and expensive) or on the ground, and whether or not the particular methods are acceptable and permitted. For example, the killing of adult breeding birds has been used to reduce cormorant populations in a few colonies in Japan. However, in parts of Europe such actions may be considered unacceptable or inappropriate and attract opposition on animal welfare, ethical or other grounds. In

any event, the experience from parts of Europe, North America and Japan is that success generally requires actions that are repeated over several years and which affect a large proportion of the breeding birds; this can be counteracted by sudden changes in food availability.

ii. Control of wintering cormorants

The large-scale control of cormorants over the winter period when birds are widely dispersed across Europe would present a huge challenge. Experiences at sites in Europe where relatively large-scale shooting has previously been carried out on cormorants migrating between breeding and winter feeding areas (e.g. Bavaria and France) have indicated that shooting was not generally effective in reducing cormorant numbers in the area over the remainder of the season, with shot birds being rapidly replaced by individuals from elsewhere, especially at attractive feeding sites. The fact that these areas are on migration fly-ways is seen as a key reason for the apparent rapid replacement of shot birds. The chances of achieving a decline in the numbers of birds appearing in later seasons are not high, and it has so far been impossible to clearly demonstrate any impact of such regional shooting on the wider population as a whole.

Any pan-European measures at winter feeding grounds would be expected to require repeated and intensive intervention at day and/or night roosts on a wide scale, and would likely be most effective if undertaken at a majority of sites. Such efforts would be very demanding, especially where cormorants respond by dispersing within an area, thus establishing a greater number of roosts each containing fewer birds. Pan-European control measures could, of course, be applied on both breeding and wintering birds.

iii. Management of numbers at a regional scale

In the absence of any plan to manage the size of the Great Cormorant population on a pan-European scale many fishery stakeholders focus on options for managing numbers at local or regional scales. The Birds Directive offers possibilities for taking steps aimed at lowering numbers locally or regionally. Furthermore, as already mentioned, the European Commission is encouraging Member States to consider the potential for co-ordinating management actions against cormorants across broader scales through bilateral (and larger) agreements.

Previous experience suggests that national or regional authorities can be successful in reducing breeding numbers within an area or region, whereas the chances of successfully controlling the numbers of cormorants that appear in areas and regions used for staging and/or wintering are likely to be more limited. The main methods used to reduce regional bird numbers outside the breeding season typically involve killing or scaring of birds on their feeding grounds and/or roosts. This is likely to be most successful if intensive disturbance is targeted at the majority of such sites.

Intensive scaring at feeding sites and/or at night roosts has, in some cases, been shown to result in marked reductions in the number of cormorants appearing in a particular area or region during the remainder of the season, although as noted in the previous section this may not always occur. In other instances, such efforts have resulted in fragmentation, with birds establishing many smaller roosts in surrounding waterbodies. The likelihood of success with such actions will likely be affected by the area under consideration, but seems to depend partly on whether the cormorants use the area or region as a staging place to ‘stop over’ during their migration, or whether they are wintering permanently in the region. In the latter case, actions at numerous sites may, in theory, be more likely to affect national populations. The location of the area or region in relation to broader European migration patterns is thus important in considering the possible outcome of intensive scaring. In any event, scaring and harassment would normally, as a minimum, have to be repeated

both during the season and in subsequent years to have a lasting effect. Such efforts may need to be pretty much continuous on sites located on migration pathways, at least for the duration of the migration period.

As noted previously, an alternative strategy that can be appropriate at a regional scale is to restrict birds to a particular area and limit their expansion to other surrounding areas through control measures. Local scale actions in Switzerland provide an example of such an approach, where birds are allowed to forage freely on certain lakes but are actively scared from small rivers. In this way, the local bird population within the 'permitted' area is regulated by available resources (i.e. the carrying capacity of the area) and expansion beyond this area is prevented by targeted actions. This approach has the benefit that it works with density-dependent regulatory mechanisms rather than against them.

Practical (and other) considerations

Aside from the biological issues, broad scale population reduction through culling, nest destruction or egg oiling raises practical, economic, political and ethical issues.

The application of all lethal (and non-lethal) techniques requires repetitive use of manpower, so costs depend to a large extent on whether or not responsibility for payment is made by or to those involved in any control programmes. Costs can be substantially reduced where manpower is available on a voluntary basis, or where it may be possible to implement controls in conjunction with other activities (e.g. hunting or as part of normal fish husbandry activities). Where dedicated expenditure is incurred, costs will be relatively high, and the costs of guns and ammunition can also be substantial. Beyond this, the costs will mainly be dependent on the scale of the programme. In the absence of any current plan, there is little, if any, information on which to assess the likely cost of a co-ordinated cormorant management plan operating across Europe. Although there are no readily-available cost estimates for such management options in the public domain, some fishery stakeholders argue that actions targeted at limited numbers of breeding colonies should be considerably lower than the cost of shooting and deterrent measures employed at thousands of individual foraging sites. However, even if cheaper, it is unclear whether such management in the summer would reduce the damage cormorants are considered to have on fisheries at other times of year, especially in the winter.

If lethal measures were to be employed on a larger scale, an additional practical consideration would be the need to co-ordinate actions effectively. This may require the establishment of collaborative stakeholder groups and real-time communication networks to ensure that efforts are targeted to best effect at appropriate times and places. Alternatively, agreements might be established between national governments or regional authorities. In addition, it would be necessary to decide who might fund any culling and who actually carries it out. This is relevant because conflicts tend to occur at bird foraging sites where shooting is the only practical lethal control measure, whereas the control of cormorant populations at nesting sites would often be required in countries and, sometimes, at sites other than where the conflicts actually occur.

The acceptability of lethal control measures depends to some extent on the viewpoint of the stakeholders involved. For a fishery owner or fish farmer faced with a cormorant problem, shooting to kill may be seen as a more acceptable option. For some other stakeholders (e.g. conservationists) lethal measures will be less acceptable or even unacceptable.

Wildlife management is carried out throughout Europe with actions ranging from attempts to eradicate invasive non-native species and control pest species to species conservation and

restoration activities. Such activities occur over various geographic scales, sometimes requiring collaboration between countries (e.g. the large carnivore Initiative for Europe). The majority of citizens recognise the validity of such actions and accept that lethal control measures can be a legitimate activity where this is done in support of a reasonable objective, is undertaken in a proportionate and legal manner, and implemented as humanely as possible.

In the context of cormorants, the use of lethal control measures to address localised or short-term conflict issues is typically seen as a necessary and acceptable management option and has general support across stakeholder groups. Large-scale population control at a national or pan-European scale is more contentious, raising concerns not only about its necessity / likely effectiveness, but also in relation to the potential degree of impact on cormorant populations. This would be expected to attract differing views among stakeholders and politicians, and the killing of any wildlife can also attract comment, criticism and opposition from the general public on ethical grounds. Many fishery stakeholders believe that a co-ordinated and appropriately regulated pan-European population control plan, particularly one principally concerned with reducing breeding output, would be the best way to allay such concerns, and they advocate this as the preferred management option.

An example of pan-European population management of a bird species

While wildlife management is practiced widely across Europe, there appear to be few examples of co-ordinated action on a European scale to regulate a bird population. However, management of the population of one goose species which is in conflict with agriculture and causes damage to high-Arctic tundra vegetation might prove informative in further assessing the likely success of any pan-European cormorant management plan. A new adaptive international management plan concerning the population of Pink-footed Goose breeding on Svalbard (Norway) and staging and wintering mainly in four countries (Norway, Denmark, the Netherlands and Belgium) has been initiated under the Asian-Eurasian Waterbird Agreement (AEWA). This involves shooting of geese (mostly in Norway and Denmark) to stabilise the population size within an agreed range. It also encompasses habitat management and co-ordination of various other management efforts.

The plan has four objectives:

1. Maintain a sustainable and stable Pink-footed Goose population and its range;
2. Keep agricultural conflicts to an acceptable level;
3. Avoid increase in tundra vegetation degradation in the breeding range; and
4. Allow for recreational use that does not jeopardise the population.

The target for Pink-footed Geese is to maintain the population over the long term at around 60,000 individuals such that the favourable conservation status is maintained but the risk of population explosion avoided.

There are a number of key differences between this plan for the Pink-footed Goose and any potential plan in respect of cormorants. In particular, the Pink-footed Goose is considered a threat to itself – a rapid population increase would reduce the quality of its limited breeding habitat and could lead to a subsequent population crash. From a practical perspective, the goose population is fairly easy to monitor compared with Great Cormorant populations, and the number of countries that have to agree on goals, objectives and management actions is relatively limited. Further, the cormorant population could already be said to have 'exploded', meaning that the initial focus here would need to be on population reduction rather than largely maintaining a status quo. There are also resource use issues in respect of the goose, due to its recreational interest (i.e. for hunting).

There are, however, also similarities between the two species – both are successful migratory birds which cause localised economic and ecological damage. Thus, the goose plan will provide Europe with more experience about how to flexibly manage migrating populations of birds that are in conflict with human interests. This, in turn, may prove informative in further considerations related to the potential management of cormorant populations at a pan-European scale.