Reducing the conflict between Cormorants and fisheries on a pan-European scale

REDCAFE

Final Report

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0 Executive summary

0.1 Background to the project

Two subspecies of Great Cormorant (hereafter 'Cormorant') occur in Europe: the 'Atlantic' subspecies *Phalacrocorax carbo carbo* and the 'Continental subspecies *P. c. sinensis*. Latest (1995) breeding estimates for *carbo* are of 40,000 pairs, mostly on the coasts of Norway, UK, Ireland and northern France. The *sinensis* population (1995) is estimated to be over 150,000 pairs throughout the region, a dramatic increase since the 1960s. It is likely that the species is now more numerous across Europe than ever before. The geographical range of these populations has also expanded with Cormorants returning to some areas after a long absence and also moving into previously unoccupied area. The reasons for such expansion are unclear but possible causal factors include a "non-limiting food supply" and protective legislation, particularly EEC Directive 79/409 on the Conservation of Wild Birds. Cormorants are generalist fish-eating predators taking a wide variety of species in shallow coastal seas, running and standing freshwaters, and both traditional/extensive and intensive aquaculture systems. In almost all countries where Cormorants occur, their increasing numbers and geographical spread has led to a growing number of conflicts with commercial fisheries and recreational angling interests.

0.2 Aims and set up of the project

Although there are several national and/or international Cormorant management plans aimed at reducing such conflicts with Cormorants, there is no co-ordinated implementation at the international level and, in practice, and certainly for many affected by the 'Cormorant problem', these plans appear ineffectual. The REDCAFE project (December 2000 – November 2001) was designed to complement and develop previous work through synthesising available information on Cormorant conflicts and aspects of Cormorant ecology leading to them, through identifying methods of reducing the current Europe-wide conflict between Cormorants and fisheries interests and collating expert evaluations of their practical use. The project also addressed a specific Cormorant-fisheries conflict case study involving recreational angling in S. E. England. REDCAFE took a novel approach to delivering solutions to these problems by, for the first time, bringing together avian, fisheries and social scientists and many other relevant 'stakeholders' to discuss and report on these issues in a rigorous, co-ordinated and equitable manner. With these aims in mind, a pan-European network of project participants was established comprising 49 people representing 43 organisations from 25 countries and including seven main stakeholder groups: commercial fishermen, recreational fishermen, aquaculturists, avian/wetland conservationists, fisheries scientists, avian ecologists and social scientists.

0.3 Cormorant conflicts with fisheries

Various stakeholder groups often hold different values and, consequently, have different preferences for the use of limited natural resources: conflict is thus often inevitable. In addition to addressing environmental conflicts from a biological perspective, the social and cultural dimensions of human society that influence such conflicts also demand equal attention. Successful conflict management depends on conflicting parties opening communication channels and developing networks of trust for effective participation, dialogue and collaboration. Thus, wherever possible, information for the synthesis of Cormorant conflicts was provided by stakeholders affected directly by Cormorants. The provision and collation of information for the present conflict synthesis formed the basis for REDCAFE's pan-European dialogue with stakeholders. This process also highlighted the difficulties involved in creating and managing dialogue between stakeholders from many countries and diverse backgrounds and these issues are discussed.

0.4 Cases of Cormorant conflicts

REDCAFE sampled Cormorant conflicts in 24 countries and collated information on 235 conflict cases. Cormorant conflicts were reported from a wide variety of habitats and fishery types: rivers, lakes, freshwater aquaculture ponds, coasts, and coastal aquaculture sites. This demonstrated the widespread geographical distribution of conflicts. Conflicts were reported by four different stakeholder groups representing recreational, commercial and nature conservation interests and covered a wide variety of fishery types, suggesting that the nature of conflicts also differed on a geographic scale.

0.5 Habitat features of conflict cases

Two species of cormorant were recorded in conflicts: both races of the Great Cormorant and the Pygmy Cormorant (*P. Pygmeus*). The geographical distributions of both species, as recorded in conflicts, followed closely their known breeding and/or wintering distributions. Cormorant conflicts were reported mostly from lower altitudes (< 500m). Within river systems, Cormorant conflicts on a pan-European scale showed similar distribution patterns. They were very much restricted to the lower and middle reaches, and hence relatively wide (i.e. 10-50m) stretches, of rivers. Similar, restricted distribution patterns were clear for conflict cases on the coast which were restricted to those localities with access to shallow (< 50m deep) inshore coastal water. Overall, most conflict cases were reported on nutrient-rich (i.e. eutrophic) waters, particularly freshwater aquaculture ponds, lakes and coasts, supporting the idea that Cormorant distribution is, in part at least, determined by the nutrient status of these waters.

0.6 Conflicts in time and space

Information on the seasonality of Cormorant conflicts showed patterns that fitted closely with the known seasonal movements of birds across Europe. As a consequence, the broad pan-European picture of Cormorant conflicts has three elements. First, winter (October-March) conflicts in those countries where birds overwinter, either towards the north west or south east. Second, summer (April-September) conflicts, presumably involving breeding birds, in the Netherlands and almost all countries bounding the Baltic. Third, conflicts throughout the year in the 'centre' of Europe (Denmark, Germany and the Czech Republic), presumably involving both breeding birds and others overwintering there from the north. Cormorant abundance increased with water surface area on a pan-European scale for stillwater lakes, freshwater aquaculture ponds and coasts and water surface area explained 56% of the variation in maximum Cormorant numbers across these habitats. There was no such relationship on rivers based on the information available for this synthesis. Such apparent differences require further investigation, particularly as information suggests that average Cormorant density on rivers is significantly higher than that in other habitats.

0.7 Conflicts: fish

Throughout Europe, there were strong associations between particular fish groups reported in conflict cases and particular habitat and fishery types. A wide variety of fish species were reported in relation to coastal conflicts. Cyprinids and salmonids were the main groups of fish recorded by stakeholders in relation to Cormorant conflicts on rivers. Similarly cyprinids, especially Carp, plus some salmonids, Perch and Pike were involved in conflicts at freshwater aquaculture ponds. Many conflicts were reported at Carp ponds throughout Europe and these sites are considered highly attractive to Cormorants in places such as the Czech Republic, Bavaria, southern Germany, and France. A small group of fishes including mullets, sea basses and sea breams were involved in conflicts at coastal, often extensive lagoon, aquaculture sites of southern Europe.

0.8 Conflicts: finance

Financial information was provided by fishery-related stakeholders for 105 conflict cases, approximately 45% of those recorded in the present synthesis. Nature conservation stakeholders did not provide any financial information in relation to any of the conflict cases they recorded. Fishery stakeholders provided information on the annual financial turnover in their fishery system and the turnover loss due to Cormorants as 'actual' figures or as 'estimates'(derived by unknown means), thus care must be taken when interpreting the financial information collected in this synthesis. Nevertheless, the 105 conflict cases gave a cumulative total for annual turnover of about 154 million euro and associated losses to Cormorants were given at about 17 million euro, an overall loss of 11%. There were significant differences in the scale of financial losses reported by the relevant stakeholders for different habitats and fishery types. All three fishery stakeholder groups independently were consistent in their views on relatively low financial losses due to Cormorants, recording average values of 9-12% of annual turnover. Around 2% of aquaculturist, 13% of commercial freshwater fishermen and 31% of commercial coastal fishermen recorded losses greater then 50% of the annual financial turnover in their fishery. In contrast, recreational anglers recorded considerably higher financial losses due to Cormorants, averaging 57% of annual turnover. Furthermore, in 43% of cases, anglers recorded financial losses greater then 50% of the annual turnover in their fishery. Although the disparity between commercial and recreational stakeholders' perceptions of financial losses due to Cormorants was clear from the information provided, the explanation for it was not and requires further investigation.

0.9 Conflict issues

Nine specific conflict issues were most commonly cited as being major ones for stakeholders. For both aquaculturists and commercial fishermen, the issue of **reduced catches** was most important whilst for both recreational anglers and nature conservationists the most important issue was **reduced fish stock through lowered production**. Recreational stakeholders also most frequently reported conflicts over reduced catches and **effects on fish population dynamics and community structure**, an issue that was also important to nature conservationists. Both aquaculturists and commercial fishermen were concerned over **loss of earnings from the fishery**, the former stakeholders cited conflicts over **loss of stocked fish** and the latter ones cited conflicts over reduced stock through lowered production. Finally, nature conservationists also frequently recorded concerns over **loss of juvenile fish and lowered recruitment**, **scaring/shooting disturbance**, **drowning of Cormorants**

in fishing gear and **damage to vegetation and landscape**. Thus, although stakeholder groups frequently shared concerns over specific major conflict issues, some concerns were specific to particular groups. Most importantly, nature conservationists cited broader 'environmental' issues more frequently than did the three fishery-related stakeholder groups. The conflict synthesis showed considerable, and consistent, similarities between the opinions of both income-producing stakeholder groups involved in fisheries. Although recreational anglers shared many of the concerns of these other fishery-related stakeholder groups, they also recorded some different major conflict issues. However, the biggest differences were between fishery-related stakeholders and nature conservationists. Nature conservationists, in general, were most concerned with wider (i.e. 'environmental') conflict issues.

0.10 Information sources

Stakeholders provided over 3, 500 records of the type of information they used to inform themselves about Cormorant conflict issues. Although most records were categorised as 'popular', this category included a range of diverse sources. Overall, only 15% of information sources used by stakeholders were assigned to the scientific literature. For all stakeholder groups, scientific literature was the least frequently recorded information source. The importance of 'popular' sources of information to all four stakeholder groups contributing to this synthesis was thus clear. For several specific conflict issues, different stakeholder groups claimed to be informed by scientific literature yet considered the magnitude of such conflicts to be very different. It is clear that there is a need for better dissemination of scientific information and for better understanding of the limitations and implications of scientific research.

0.11 Cormorant ecology: factors leading to conflicts

Any successful resolution, or management, of the conflicts between Cormorants and fisheries interests on a pan-European scale must include careful consideration of the best available biological information on Cormorant populations throughout the region. REDCAFE thus synthesised aspects of Cormorant ecology that lead conflicts. Relevant factors were categorised into four main themes: (1) general ecology and habitat features, (2) migration and the annual cycle, (3) fish communities and Cormorant diet, and (4) Cormorant ecology and impact at fisheries.

0.12 Ecology synthesis in relation to Cormorants

Cormorant ecology has been well studied. With respect to numbers, distribution, migratory movements, foraging behaviour and diet it is one of the best known wild bird in Europe. It is clear that Cormorants are opportunistic generalist fish predators. As a result of their broad ecological requirements, they do have the potential for considerable conflicts at specific fisheries. This is because, as well as flexibility in feeding site choice, generalist predators like the Cormorant could have considerable impact on their preferred prey species because their numbers are buffered to some extent against declines in these prey by their ability to switch to other types. The opportunistic nature of its foraging behaviour and its great adaptability to a variety of habitats, both freshwater and marine, makes the Cormorant an exceptionally successful species which is currently probably more abundant in western Europe than ever before and still expanding numerically in eastern Europe. This expansion in numbers and area is the result of European wide protective measures, eutrophication, the reduction of pesticides in the environment and alterations of water systems such as dams, sluices which facilitate foraging.

0.13 Ecology synthesis in relation to fish

Fish species eaten by Cormorants are, for the most part, common, widespread species. The heavy fishery pressure exerted by people in many water systems in Europe has resulted in a shift in size distribution towards the smaller classes, which enhances Cormorant foraging conditions. Fewer large predatory fish are now present in many European waters because of over-fishing. This enables populations of smaller fish species to increase, which in turn favours the Cormorant. Eutrophication of water bodies has altered fish community - (and size -) structure again increasing the possibilities for Cormorants to exploit larger densities of small prey fishes.

0.14 Ecology synthesis in relation to damage at fisheries

Fish species eaten by Cormorants are, for the most part, common, widespread species. The heavy fishery pressure exerted in many water systems in Europe has resulted in a shift in size distribution towards the smaller classes, which enhances Cormorant foraging conditions. Reduction of eutrophication will decrease Cormorant numbers through reduction in the carrying capacity of fishing waters. Restoration of waterways, aiming at a greater connectivity, will favour fish populations and reduce predation risk. In fish farming areas, specific knowledge on prey detection underwater may help to reduce predation of small fish. Enlarging stocked fish above the range commonly eaten by Cormorants (i.e.>500 g) may act to reduce the damage caused by birds. Periods of large-scale Cormorant movements through Europe (e.g. March and October) require extra management attention to avoid the establishment of any tradition to visit stocked water bodies or fish farm areas. A combination of ecological, demographic, climatological and geographical data into a GIS based Decision Support System may help to predict future Cormorant 'problems' and reduce current ones through integrated management.

0.15 Potential Cormorant management tools

Potential Cormorant management tools were assessed on two spatial/temporal scales: long-term control of European Cormorants at the population level and shorter-term site-specific control measures. The synthesis aimed to provide a comprehensive overview of potential Cormorant management tools. It provides a review of population modelling and a synthesis of site-specific techniques and actions used against Cormorants. The synthesis also includes semi-quantitative information on the 'usefulness' of techniques in relation to their effectiveness (i.e. how long a technique works for), practicability (i.e how easy the technique is to use), acceptability (i.e. how the technique is viewed by both stakeholders and the general public) and costs. REDCAFE participants provided information for this synthesis, often after discussions with local stakeholders over their experiences.

0.16 Cormorant population modelling

The most well-supported Cormorant population model scenarios using current information indicated three important things. First, that the effect of culls at the 1998-9 level (i.e. 17, 000 birds shot) was limited. Second, that increasing the annual cull to 30, 000 birds would have limited effect at the population level. Third, that shooting 50, 000 birds per year was predicted to lead to population extinction in 20-40 years. The modelling approach also demonstrated that increasing the number of culled Cormorants was risky because once the compensatory power of the population is overcome, it will inevitably decline towards extinction if the cull is unchecked. One general inference was that culls should be planned so that they become the most powerful density-dependent mechanism affecting the target population. This strategy would require a well parameterised population model and should also be accompanied by monitoring programmes. Even though Cormorant population control through culling is feasible it may not be the most efficient, economical or ethical way of limiting Cormorant damage to fisheries, and other interests, across Europe. Research suggests several limitations to culling and these are discussed.

0.17 Relatively large-scale Cormorant control

The synthesis of general information on actions against Cormorants included information from all 25 countries covered by the REDCAFE project. Some form of national or regional Cormorant management plan was in effect in 11 of these countries. A further four countries had a legal regulation in effect that allowed Cormorant culling. Overall, such a regulation was in effect in 14 counties. In a further 6 countries licences could be obtained for the limited killing of Cormorants at particular sites as a aid to scaring. In most countries (84%), there was either no killing of Cormorants or it was uncoordinated. Few countries (16%) had a co-ordinated culling programme. Few countries (or regions therein) provided either financial compensation for fish losses caused by Cormorants or financial aid for Cormorant exclosures or scaring programmes (16% and 24%, respectively). Of the 25 countries, ten recorded the destruction or disturbance of Cormorant colonies in recent (i.e. 1990-2002) years, with 102 colonies reported to be affected annually. As a result a minimum of 5,194 Cormorant nests were reported to be destroyed annually in five countries. Between 600-650 Cormorant nestlings were also reported to be killed in three countries. Numbers of both nests and nestlings destroyed were known to be under-recorded. Around 10, 000 adult Cormorants (of the 'Atlantic' *carbo* race) are hunted legally as game in Norway outside the breeding season. During this time of year, a further 18 countries reported killing Cormorants (mostly the 'Continental' *sinensis* race) as a control measure. Here, between 41-43, 000 adult birds (including young birds in their first winter) were reported to be killed annually. However, given the unprecedented number of Cormorants killed in France in 2001/02, and the fact that many of the birds killed were juveniles in their first winter, it is more appropriate to say that between 41-43, 000 fully grown birds were killed in 2001/02. A further 4,598 Cormorants were reported to be killed annually during the breeding season in six countries. However, this was known to be an underestimate. Over 248 night roosts were reported to be destroyed or damaged annually in nine countries. This figure was a considerable underestimate because roosts were also known to have been destroyed or disturbed in three other countries.

0.18 Site-specific actions: non aquaculture habitats

A total of 33 site-specific techniques used regularly to reduce the effects of Cormorants at feeding sites were recorded for 16 countries. However, only three techniques were used regularly at all five feeding habitats (small rivers, large rivers, small stillwaters, very large waterbodies, aquaculture): the use of live ammunition to scare birds, shooting birds to reinforce other forms of scaring, and shooting birds to reduce their numbers at specific sites. Eleven techniques were recorded in regular use on small and large rivers. Only two of these appeared to be effective in the long-term (i.e. years), although both of them (improving fish habitat quality and submerged fish refuges) were primarily related to the management of fishes rather than to that of Cormorants. Several other techniques appeared to be effective on rivers for months.

Eight techniques were recorded in regular use on small lakes. All appeared to be effective only for days, the exceptions being the use of two audio techniques (pyrotechnics/fireworks and live ammunition) and two lethal techniques (shooting to scare or to kill limited numbers of birds). Ten techniques were recorded in regular use on very large water bodies (lakes and coasts). Three audio techniques and three lethal Cormorant control techniques appeared effective over the time-scale of weeks to months. Other techniques appeared effective for only days.

0.19 Site-specific actions: aquaculture habitats

Twenty eight techniques were recorded in regular use at aquaculture facilities. Eight bird-proof barrier techniques appeared to be effective for up to years, although in some cases the same techniques were reported only to be effective for days. Alterations to fish stocking at aquaculture facilities appeared to be effective for up to months, as did the use of two audio techniques (pyrotechnics/fireworks and live ammunition) and three forms of lethal Cormorant control.

0.20 Cormorant management tools: conclusions

Very few techniques were, according to the experience in 16 countries covered by the synthesis, considered to be effective in the long-term (i.e. years). These long-term techniques appear to fall into two broad categories. First, those involving the alteration of fish habitat at some ‘natural’ rivers and lakes. Second, those involving the erection of various bird proof barriers (e.g. narrow mesh enclosures, wires, submerged anti-predator nets) at aquaculture facilities (both ponds and net pens/cages). Many other techniques used regularly can be effective for up to months at some sites. However, the same techniques were reported to be effective for only days, or not at all, at other sites. Overall, the practicability, acceptability and costs of all techniques used regularly were highly variable. The most likely explanation for such variation is that it is related to site-specific features. These are likely to be two-fold. First, the physical location of the site, its size, the type of fishery, the number of Cormorants involved etc. Second, the scale of the Cormorant ‘problem’ in financial terms.

0.21 Cormorant-fishery conflict resolution: a case study

REDCAFE analysed a specific Cormorant-fishery conflict case study, in the form of a three-day Workshop designed to give project participants and local stakeholders the opportunity to share their knowledge and experience. This case study also formed the basis for evaluating REDCAFE progress and the applicability of the ‘REDCAFE experience’ to the real world. Furthermore, it allowed participants to explore whether the project’s concept of equitable stakeholder involvement was a useful framework for future Cormorant-fisheries conflict resolution elsewhere in Europe. An opportunity arose to link the project to a ‘live’ conflict case study - that of Cormorants and recreational fisheries in the Lea Valley, Hertfordshire, south-east England. Importantly, selecting the Lea Valley Cormorant-fishery issue also allowed REDCAFE to link with Fisheries Action Plans, and the government agency-led process being developed to address and prioritise issues affecting inland fisheries at a catchment scale. The REDCAFE case study was placed in perspective through reviews and discussions of values and dialogue in conflict resolution and management, Fisheries Action Plans in the UK, and the Lea Valley case study area.

0.22 Lea Valley Workshop

Workshop delegates comprised 36 REDCAFE participants, representing 20 countries, and 16 stakeholders, representing 11 institutions or organisations. Successful conflict management depends on conflicting parties opening communication channels and developing networks of trust for effective collaboration and dialogue. REDCAFE thus worked closely during the Workshop with a facilitator skilled in environmental conflict management. The Workshop began the process of approaching the numerous environmental conflicts apparently affecting the Lea Valley. Although time was short, many important issues were addressed and developed, including conflict management experiences from both continental Europe and the Lea Valley itself. Several key issues arose from discussions with local stakeholders. First, many believe that the main problem facing the Lea Valley is an economic one. Economic measures of angling 'effort' (i.e. day and season ticket sales and angling club membership) have all fallen considerably in the last decade. This has had a knock-on effect on the local economy. Second, several lines of evidence suggest that many fish stocks and/or catches there have declined dramatically. The perception is that most small fish – both small individuals and small species - have declined, whilst there are still some fisheries containing large individuals (i.e. 'specimen' fish). There is also some evidence that the distribution of fish has changed within the Lea Valley. Third, the lack of fish, and the related economic decline, has local conservation implications, social implications, and planning and policy implications. These are all discussed.

0.23 Workshop progress

Key local issues were summarised in an initial 'problem statement' for the Lea Valley. Substantial progress was made in identifying critical scientific and social issues in cormorant/fisheries conflicts. Cormorant-fishery conflicts play a part in the mix of issues facing the Lea Valley but one important outcome of the Workshop was to situate these conflicts in a broader social, economic and ecological context. Local stakeholders made considerable progress where escalating conflicts had become significant obstacles in the Lea Valley. REDCAFE participants had the opportunity to explore part of a conflict management process that related directly to many Cormorant-fishery conflicts across Europe. The Workshop process enabled significant progress to be made in several areas: (a) linking scientific processes and data to real-world social issues, (b) agreeing initial problem statements, stakeholders and needs, (c) identifying relevant agencies, people and pathways for action planning, and (d) identifying research priorities and dissemination actions that link the need for strong, evidence-based scientific knowledge with social and strategic planning needs.

0.24 Workshop evaluations

A specific element of the REDCAFE project was to evaluate the conflict resolution Workshop in terms of determining whether the project's concept of equitable stakeholder involvement was a useful framework for future Cormorant-fisheries conflict resolution elsewhere in Europe. To this end, the Facilitator organised an anonymous questionnaire survey of delegates immediately after the Workshop. Twenty-six responses (50% of Workshop delegates) were received and almost all agreed that the case study was useful and enjoyable and that REDCAFE had helped them relate conflict management methods to Cormorant-fisheries conflicts elsewhere. A series of questions were also asked of delegates and those responding to the questionnaire provided over 200 responses which are synthesised in the report.

0.25 The REDCAFE process: main strengths

The most commonly cited strength of the case study Workshop, and of the REDCAFE process in general, was the development of trust between project participants and other stakeholders, and effective dialogue between scientists and others. Next followed the pan-European involvement and collaboration produced by the project and the opportunity it has provided to bring international perspectives to bear on local case studies. Another important strength identified was the project's attempts to reach consensus on Cormorant-fisheries conflicts through collaboration with social scientists.

0.26 The REDCAFE process: main weaknesses

In relation to the case study Workshop, the commonest weaknesses identified were lack of time and the involvement of too few local stakeholders. It was recognised that these constraints probably limited, to some degree, discussions on potential site-specific management tools. More generally, policy makers should have been included as REDCAFE participants and the continued need for effective dialogue between all interested parties was highlighted.

0.27 The REDCAFE process: main lessons learned

Several lessons for the REDCAFE project were recorded. The most frequent involved the vital importance of participation and dialogue. Almost all stakeholders stated that conflicts can only be resolved through relationships and trust: people must work together, ideally in face-to-face discussions, to develop solutions. All those involved in dialogue must consider the language they use and be aware that different participants (individuals or groups) will have different levels of confidence and enthusiasm. Respondents also noted that it takes time to understand conflict and decide how best to manage it. There may be no ultimate solutions but effective dialogue will invariably help to resolve conflicts. Another important lesson was that large-scale culling of Cormorants will almost certainly be ineffective. Cormorants are now an established element of many aquatic ecosystems and people need to learn to live with them. Scientific information is necessary to inform debate and potential mitigation policies, and REDCAFE has demonstrated that clear communication of scientific information can influence other stakeholders' perceptions and understanding and *vice versa*. Other important REDCAFE lessons were cited and these are discussed in detail in the report.

0.28 Looking forward: overview

REDCAFE has attempted to synthesise, for the first time, key stakeholder groups' views and perceptions on Cormorant conflicts with fisheries (and, to a lesser extent, with the wider environment) in a standardised way across Europe. Despite methodological limitations, many clear pictures emerged and these are discussed. Just as importantly, collecting and collating information for this synthesis has allowed REDCAFE participants (primarily natural scientists or those working closely with them) to forge links with local stakeholders experiencing conflict issues at first hand. REDCAFE offered the first opportunity to apply recognised conflict management techniques to Cormorant-fisheries interactions at the pan-European level. Through discussions with stakeholders it was clear that conflicts with Cormorants are not the only ones facing many fisheries and environmental stakeholders. To better understand the nature of Cormorant-fishery conflicts it is useful to consider other internal and external issues leading to conflicts over fisheries resources. These issues, both environmental and social, are often complex and closely linked. Environmental conflicts over resources, including those involving fisheries, usually involve numerous issues. This appeared true across Europe: many of the stakeholders who provided specific information on Cormorant conflict issues for the present synthesis also described other issues, fears and concerns affecting their businesses or recreation. Many stakeholders also recorded concerns over the creation of sustainable fisheries and the development and implementation of effective, 'holistic' fisheries management programmes. Some of the other wider concerns affecting fishermen contributing to the present synthesis related to ownership and property rights and to changes in market economies. These issues are discussed in the report. The evaluation process confirmed that the REDCAFE philosophy of developing interdisciplinary links within and between the fields of natural and social science was very useful. Moreover, the project clearly demonstrates the necessity, and value, of dialogue and participation between all stakeholders (or their legitimate representatives) involved in Cormorant-fishery conflicts. Evaluations also showed that REDCAFE's approach to a specific Cormorant-fishery conflict case study provides a useful framework for similar activities elsewhere. There is acknowledgement that the process of conflict management will take time and require appropriate resources, including funds.

0.29 Looking forward: case studies, individuals and stakeholder groups

At the local level, by far the most commonly anticipated next step was to consider potential site-specific management techniques based on lessons learned from the REDCAFE synthesis. There is a strong desire to put theories into practice and to try mitigation measures that have been shown to work elsewhere. For many, next steps should include exploring the possibilities of developing and implementing local fishery management, or action, plans for specific case studies and/or the building of partnerships at the national level between fishery and conservation organisations such as the Moran Committee in the UK. REDCAFE emphasised the importance of making concerted efforts to create participation, dialogue and consensus building between local stakeholders involved in Cormorant-fisheries conflicts across Europe. This will require effective dissemination of relevant information at local, regional, national and international levels. Politicians and policy makers should also be included in such dissemination activities.

0.30 Looking forward: the scientific community

While social issues now feature strongly in the minds of the natural scientists involved in the REDCAFE project, many in that community expressed clear needs to further improve understanding of ecological issues. Scientists also realise the need to forge better links with others. Although scientific independence and rigour remain crucial, there is a need for scientists to apply their research results to real life cases. Scientists also need to collaborate with other stakeholders and local people, for example in the development of local management plans. Such collaboration will require scientists to communicate practical information to others in a clear manner and to maintain dialogue with all interested parties. Natural and social scientists also need to forge closer links because Cormorant-fisheries conflicts are situated in social and political contexts.

0.31 Looking forward: Fisheries co-management

While REDCAFE focused on Cormorant-fishery conflicts, other tensions were recognised by the project as influencing them. Addressing such broad fisheries conflict issues is not trivial and will take time and require trust between stakeholders. Furthermore, in order to avoid inadequate fisheries policies and management systems, that tend to treat the symptoms rather than address underlying problems, broader environmental and institutional factors should be taken into account and fundamental socio-cultural conditions must also be given high consideration. Participatory co-management in fisheries, where managers and local fishermen co-operate in drafting policy, may facilitate successful management while also offering the possibility of reducing public costs. If natural resource management is to be sustainable in the long term, an understanding of human behaviour is vital and this multidisciplinary approach was recognised by REDCAFE. The fundamental challenge for fisheries management in this context is to find ways of expanding technical expertise whilst increasing collaboration in decision-making processes. In the past there has been much co-operation between fishermen and scientists at the individual level but a more organised management structure is required to bring these, and other, groups together. REDCAFE's work established an area of co-operation between natural scientists, local environmental stakeholders (fishermen and conservationists) and policy makers which should form the basis of future dialogue and collaboration.

0.32 Looking forward: future research

A major challenge for natural scientists will be to make their work more relevant and useful to stakeholders. It is clear that different stakeholders involved in Cormorant-fisheries conflicts have different values and perceptions over these issues. It is also clear that other stakeholders view scientists as having different values and perceptions. Thus, scientists should be considered as another stakeholder group involved in the issue of Cormorants and fisheries. Given the recognition that there is no single value or perception (i.e. 'reality') for all the different stakeholders groups within this conflict, it is unrealistic to expect a single method of collecting, analysing and interpreting useful scientific information. The development of a rigorous scientific research programme to address Cormorant conflict issues will have to maintain high scientific standards but will also have to be both relevant to and influential in the decision-making process. There is a need for a practical pan-European Cormorant-fishery research programme that includes ecological study, collaboration between natural and social scientists and a strong conflict management element. Similarly, there is a need for long-term studies to quantify the effectiveness of various measures to mitigate against Cormorant problems at fisheries. Stakeholders have a long list of possible management actions against Cormorants but relatively little guidance on their likely effectiveness, practicability, acceptability or costs at a specific site. Clearly, considerably more work is required to trial the use of techniques to reduce Cormorant impact at feeding sites. Whatever framework future scientific research into Cormorant conflicts takes, it is clear that all stakeholders are concerned over the common issues of quality, health and status of biological resources in wetland systems. Dialogue with stakeholders highlighted several areas where major conflicts were currently poorly served by scientific literature and these are discussed. However, it must be stressed that such research should be undertaken with participation from stakeholders at all stages where possible. Ultimately, this should increase the useful knowledge of both scientists and other stakeholder groups whilst also increasing collaboration between all parties, but particularly local people, in the decision-making process with regard to Cormorant conflict issues across Europe.

0.33 Looking forward: concluding remarks

Full information from REDCAFE should be disseminated as widely as possible so that the lessons learned from the project can be applied elsewhere. The establishment of a pan-European information exchange network would greatly facilitate the conflict resolution process and allow stakeholders to view their own particular situations in the broader continental context. Information must be exchanged at several levels: within and between disciplines of natural and social science, between scientists and other stakeholders, and between all interested parties and politicians, policy makers and the general public. The most important next step after dissemination is to build on the findings of REDCAFE so that local stakeholders can begin to develop effective site-specific strategies for resolving local conflicts. The formation of an information exchange network would be a very useful tool to facilitate the rapid transfer of ideas, experiences, management techniques, their implementation and subsequent outcomes. It could also offer stakeholders opportunities for discussion and could provide them with clear information on the actual costs (both invested and saved) of specific techniques. Although the REDCAFE project is the most comprehensive attempt to address Cormorant-fishery conflicts at the pan-European scale, it is clear that the project is merely the first step. Opportunities must now be explored to further develop the foundation framework that REDCAFE has developed in linking science with society and advancing processes of conflict management across a range of European contexts.

The REDCAFE Cormorant-conflict synthesis demonstrated clearly that such conflicts are complex, in terms of both biology and equally important social and economic issues. This synthesis is an important first stage towards developing trust and collaborations between all those affected by Cormorant conflicts. These issues are as much a matter of human interests as they are of biology. It is hoped that this element of REDCAFE's work will indeed be the start of a management process for Cormorant-fisheries conflict issues and, by implication, for wider environmental issues affecting fisheries and aquatic conservation across Europe. A formal approach to applying REDCAFE philosophy to the thousands of other case studies across Europe is needed. Moreover, the onus is currently on biologists to solve what are essentially people-people conflicts, professionals in other disciplines should be increasingly involved in these conflict management issues.

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1 Introduction: background and aims of the project

1.1 Pan-European Great Cormorant populations

Two subspecies of Great Cormorant (hereafter 'Cormorant') occur in Europe: the 'Atlantic' subspecies *Phalacrocorax carbo carbo* and the 'Continental subspecies *P. c. sinensis*. Latest (1995) breeding estimates for *carbo* are of 40,000 pairs, mostly on the coasts of Norway, UK, Ireland and northern France, representing over 80% of the world population of the nominate race (Debout *et al*. 1995). Although there are no estimates for *sinensis* populations during the 19th century or the first half of the 20th, it is likely that numbers in the remainder of Europe had declined to an unprecedented level of around 800 breeding pairs in the Netherlands in the early 1960s. Thereafter, numbers increased dramatically to over 150,000 pairs throughout the region in 1995 (van Eerden & Gregersen 1995) and it is likely that the species is now more numerous than ever before.

The geographical range of these populations has also expanded with Cormorants returning to some areas after a long absence whilst also moving into areas previously never occupied. Recent DNA studies have shown one consequence of such population increases and associated range expansion. *Sinensis* birds are breeding in inland colonies in the UK, living sympatrically, and probably hybridising, with *carbo* populations there (Goostrey *et al*. 1998).

The reasons for such expansion are unclear but possible causal factors include a "non-limiting food supply" (i.e. populations are not limited by a lack of food), protection of breeding sites and reduction in persecution throughout Europe (van Eerden & Gregersen 1995, Bregnballe & Gregersen 1997). The expansion of the European Cormorant population must be considered in the context of unprecedented landscape and social changes during the late 20th century. For instance, industrial activity in western Europe created many wetland habitats as a result of such things as gravel extraction and the construction of reservoirs. On the other hand, the recent decline in heavy industry in east/central Europe has led to reductions in aquatic pollution and an associated recovery of fish populations. Furthermore, the aquaculture industry has expanded across the whole continent, leading to areas of intensive freshwater fish production and enhanced stocks through the release of hatchery-reared fish.

Undoubtedly, protective legislation, particularly EEC Directive 79/409 on the Conservation of Wild Birds, has also been an extremely important factor in the increase of Cormorant populations throughout the region (van Eerden *et al*. 1995). Other important protective legislation in the EU includes the Bern Convention on the Conservation of European Wildlife and Natural Habitats and the Bonn Convention on the Conservation of Migratory Species of Wild Animals and, in the EU and elsewhere, the Ramsar Convention on Wetlands of International Importance especially as waterfowl habitat.

1.2 Basic conflicts between Cormorants and fisheries

Cormorants are generalist fish-eating predators taking a wide variety of species in shallow coastal seas, freshwater fisheries (natural and stocked artificially) in lakes and rivers, and both traditional/extensive and intensive aquaculture systems (Cramp & Simmons 1977). In almost all countries where Cormorants occur, their increasing numbers and geographical spread has led to a growing number of conflicts with commercial fisheries and recreational angling interests (e.g. Bildsøe *et al*. 1998 and Suter 1995, respectively).

These conflicts arise either through direct consumption of commercial or rare fish species or through fears of indirect effects such as injury to fish and the spread of diseases and/or parasites that increase fish mortality and reduce their market value. There are clear cases of Cormorant damage to fishing gear and ensnared fish, as well as documented cases of considerable impact at fish farms and small water bodies (see van Dam & Asbirk 1997). Demonstrating the impact of Cormorants in large rivers and other water bodies is difficult because of ecological complexities. Nevertheless, annual losses as a result of Cormorant predation have been variously estimated at over 4 million ECU for European fishery yields in 1992 (Adamek *et al.* 1997) and at 163.7 million ECU for losses of commercial fish during the winter in relation to recreational angling, a sport for at least 23 million EU citizens (EAA, 1998).

1.3 International legislation, conservation and management plans

Given these conflicts, where a species causes "*serious damage*" to specified interests such as fisheries and where other satisfactory solutions are lacking, several European Member States have derogated from their protective provisions with regard to the Cormorant under Article 9 of the EU Bird Directive. Although Article 9 derogations, or a national equivalent, have been applied on a local scale, the calls for further measures to reduce the population size of Cormorants made by some fisheries interests, particularly those in regions where Cormorants over-winter, increased during the 1990s. In particular, the governments of Denmark and the Netherlands - the countries where ca. 36% of the European Cormorants breed - were urged to address this issue. Thereafter, discussions were aimed at placing Cormorant management in the international legal framework of the Bonn Convention (Conservation of Migratory Species of Wild Animals). The underlying ethos was that the Cormorant, although not currently at risk, might be threatened again by illegal killings, if not properly managed. Moreover, there was also a need to protect two endangered cormorant species in the region, the Pygmy cormorant *P. pygmaeus* and the Socotra cormorant *P. nigrogularis*. These discussions resulted in a draft recommendation on the management of cormorants in the African-Eurasian region being presented to, and adopted by, the Conference of Parties at the fourth meeting of the Bonn Convention in 1994 (see van Dam & Asbirk 1997).

In 1996, the European Parliament adopted a 'resolution on the cormorant problem in European fisheries' (see van Dam & Asbirk 1997) considering it appropriate to take special temporary measures by means of scientific projects approved by the European Commission. These measures should aim at reducing the Cormorant's impact on the environment by, for example, preventative action to restrict the reproduction of Cormorants and by the temporary exclusion of *P. c. sinensis* from Annex 1 of the Bird Directive. This resolution also called on the Council to take effective action to restore depleted fish stocks and ensure that the Common Fisheries Policy maintains fish at levels that can support both human fisheries and natural predators.

Under the auspices of the Bonn Convention, there followed a workshop '*Towards an International Conservation and Management Plan for the Great*

Cormorant' (Lelystad, the Netherlands, October 1996). An international meeting of experts to complete an Action Plan for the Management of the Great Cormorant in the African-Eurasian Region (Copenhagen, Denmark, September 1997) was held in the following year. This Action Plan aimed to minimise the conflict between fisheries interests and the Cormorant 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 stated that Range States should try to achieve this, in the following order of preference, through (a) appropriate site-specific management, (b) local management and control of Cormorants, and (c) co-ordinated management and control of Cormorants between Range States.

The *Action Plan for the Management of the Great Cormorant in the African-Eurasian Region* was sent to all European Range States with a request to implement the recommendations included therein. Any response to the action Plan was left to the discretion of individual Range States. Individual Range States appeared to largely ignore the Action Plan and continued with their own regional or national cormorant mitigation policies based on national and international legislation. There was little evidence that advice was being made available to Range States on the implementation of the Action Plan, nor was there facilitation to co-ordinate its implementation at the international level. Thus, in practice, and certainly for many affected by the 'cormorant problem', the Action Plan appeared to be ineffectual.

1.4 Aims of the project

The REDCAFE project was designed to complement and develop the previous work described above. It also addresses several of the main uncertainties highlighted during the development of the Action Plan (see van Dam & Asbirk 1997). For example, (a) the total size, long-term trends and movements/dispersal of the European Cormorant population, (b) the lack of reliable estimates of the social/economic aspects of Cormorant conflicts with commercial and recreational fisheries, and (c) the lack of reliable estimates of the efficacy and cost-effectiveness of methods of Cormorant control. Project aims were realised through synthesising available Cormorant/fisheries information, through identifying methods of reducing the current Europe-wide conflict between Cormorants and fisheries interests, and through collating expert evaluations of their practical use. The project took a novel approach to delivering solutions to these problems by, for the first time, bringing together avian, fisheries and social scientists and many relevant 'stakeholders'[1] to discuss and report on these issues in a rigorous, co-ordinated and equitable manner.

1.5 Project set up

During the years 1995 through 1999, it became increasingly apparent to many 'Cormorant researchers' that further progress towards Cormorant-fisheries conflict resolution required three important elements: first, a genuine pan-European approach to the problem; second, better integration of avian and fisheries science; third, a link

[1] The word 'stakeholders' is a difficult one: it means different things to different people and it is not easily translated into some languages. In the context of this report, the term 'stakeholders' is taken to mean (a) people who are affected (either positively or negatively) by a particular problem or activity or (b) people who can influence (either positively or negatively) the outcome or end result of a particular process. For further details see (Ramírez 1999).

between biological and social scientists and constructive dialogue between these groups and other stakeholders. Realising this, an initiative was taken by a group of natural scientists to propose an international network in order to synthesise relevant knowledge and to further progress pan-European Cormorant-fisheries conflict resolution.

This proposal was for a Concerted Action under the EU's 'Quality of Life and management of Living Resources' Fifth Framework Programme. Concerted Actions are "*Designed to encourage collaboration between teams of interested researchers and other actors, combining their accumulated expertise in a research network, to find solutions to problems common to all European Member States, but with better chances of solution through European collaboration.*" and " *… can be considered when pooling of data would facilitate common interpretation of facts and contribute to the development of harmonised standards, procedures and methodologies…*"

The European Commission agreed to award a financial contribution of 100% of the costs for this proposal ('REDCAFE'), paying for co-ordination staff time and the costs of four international Workshops. REDCAFE ran for 24 months (01.12.00 - 30.1.02) and in the first phase of this project, available information on Cormorant conflicts with fisheries was synthesised. In the second phase, available information on Cormorant ecology, focussing on those factors leading to conflicts with fisheries, was synthesised. In the third phase, a set of potential management tools, from continental to site-specific, was compiled. In each of these phases, as well as synthesising available knowledge, critical deficiencies and uncertainties were also highlighted. In the fourth phase a specific Cormorant-fishery case study was selected as a model for conflict resolution and to determine whether a useful framework could be established for future conflict resolution elsewhere. Finally, the report was compiled, including detailed findings from each of the four phases of the project and relevant national and international overviews.

This report contains two volumes. Volume 1 (this volume) provides the REDCAFE framework, a regional, national and international synthesis of Cormorant-fisheries conflicts (Chapter 3), a synthesis of relevant Cormorant ecology (Chapter 4) and a synthesis of potential management tools in all, or most, countries (Chapter 5). It also provides background, description, analysis and evaluation of a 'real world' case study exercise involving conflicts between Cormorants and recreational angling interests in a catchment in south-east England (Chapter 6). Volume 2 includes a Chapter for each participating country, in which the local situation is described in as much detail as possible. Each of the volumes, and each individual country text, can be read as stand alone texts.

Major contributions to this report were drafted by individual participants of this Concerted Action, namely: David Carss (all Chapters), Erik Petersson (Chapter 3), Mariella Marzano (Chapters 3, 6, 7), Mennobart van Eerden (Chapter 4), Stef van Rijn (Chapter 4), (Harold Claassen Chapter 4), Thomas Keller (Chapter 5), Morten Frederiksen (Chapter 5) and Scott Jones (Chapter 6, 7) and Participants contributing information to the country reports in Volume 2 are indicated at the beginning of each report in that Volume. To all colleagues and friends participating in this project, the Editor extends grateful and heartfelt thanks for their enthusiasm and hard work. Additionally the Editor would like to thank the following people for their input to

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2 Introduction: the REDCAFE project

The purpose of the REDCAFE project (December 2000 – November 2002) is to synthesise current Cormorant/fisheries information and to identify, describe and evaluate methods of reducing the current Europe-wide conflict between conservationists and fisheries interests. Each REDCAFE participant was invited to contribute as much as possible to the synthesis process and, through collaboration, to develop an effective working partnership between groups, some of whom are, or have been in the recent past, sceptical of each other. The project also includes analysis of a specific Cormorant-fishery conflict case study, giving project participants the opportunity to share their extensive knowledge and experience with local stakeholders and *vice versa*. With these aims in mind, a pan-European network of project participants was established comprising 49 participants representing 43 organisations from 25 countries (Figure 2.1) and included seven main stakeholder groups: commercial fishermen, recreational fishermen, aquaculturists, avian/wetland conservationists, fisheries scientists, avian ecologists and social scientists.

Figure 2.1 The 25 countries participating in the REDCAFE project 2000-2002.

Like most conflicts surrounding natural resource management, Cormorant/fishery conflicts are very often conflicts between people wishing to conserve natural resources and people wanting to make a living from them. However, there is common ground: a healthy environment is vital for all. Scientists, policy makers and users, beneficiaries and the public, all 'stakeholders' (see footnote #1) in the environment, need to work together to ensure its sustainability. Only by developing such partnerships can research provide solutions. The success of the REDCAFE project depended on dialogue between all interested parties, as part of a stepwise process of conflict resolution/management (Figure 2.2). This model is just one of many tools available for developing collaborations in natural resource management (Buckles & Rusnak 1999). However, it was considered appropriate to this project because REDCAFE's aims were to synthesise current Cormorant-fisheries knowledge, create dialogue between scientists and stakeholders, and to identify current gaps in understanding, rather than to embark on new areas of relevant research.

Steps to resolving conflicts

Conflict Resolution = "harmonisation of the incompatible"

0. Stakeholder perceptions
   The conflict created
   ⇩
1. Stakeholder - scientist dialogue
   Identify the problem
   ⇩
2. Scientists provide relevant information
   Improve understanding
   ⇩⇧
3. Scientist - stakeholder dialogue
   Information exchange
   ⇩⇧
4. Effective partnerships
   Implement & monitor conflict resolution measures and / or policies
   ⇩

RESOLUTION, SOLUTIONS AND STRONG PARTNERSHIPS

Figure 2.2 The REDCAFE concept: steps to resolving ecological conflicts.

It should be recognised that, regardless of the nature of any available scientific 'evidence', the views or perceptions of some stakeholders (e.g. that predators compete with humans for commercial resources) often create and/or fuel natural resource conflicts. There are then four steps to resolving these conflicts. The first is for scientists and other stakeholders to work together to identify the problem. From this comes step two, for the researchers to provide data to improve understanding of the conflict. Thirdly, scientists and other stakeholders can evaluate the research together. This can lead to effective partnerships between all parties and, perhaps to additional research. The final step is to implement and monitor resolution measures or policies. Crucially, at every step, stakeholders must be aware that conflict resolution is well described as 'harmonisation of the incompatible'.

It was also recognised that although some individuals and institutions had already progressed through several steps of this, or a similar, process, none had done so at more than a national level. Moreover, it was clear, in some countries at least, that many important stakeholder groups had lost confidence in natural scientists to deliver a solution to the 'cormorant problem'. Finally, given the continued heated debates across Europe about this problem, it was apparent that there were still dialogue difficulties, poor information exchange and few effective partnerships between scientists and stakeholders. This has resulted in little progress toward conflict resolution at the pan-European level. Against this background and following the process outlined above, REDCAFE sought to bring as many relevant people together as possible to discuss Cormorant-fisheries conflicts in an equitable manner. This last point was important, as the project would only succeed if all stakeholders had a voice and the opportunity to state their case. Through such active participation, all REDCAFE participants - even those who may have felt disenfranchised at first - were able to begin the critical process of building trust and rapport that underpins successful natural resource conflict management.

The REDCAFE project addressed four main topics. In order to offer participants common ownership of the work of the project, each topic was discussed initially at an international meeting. Here, participants shared their expertise and experiences and agreed on the most appropriate methodology for each piece of work.

The four main REDCAFE topics were:

(1) **A Conflict Workshop** to: (1) synthesise available information on Cormorant conflicts with fisheries, in relation to (a) specific fishery types, (b) geographical and temporal trends, and (c) the commercial fish species involved, and (2) quantify, with uncertainties, the economic losses to fisheries as a result of Cormorant activity.

(2) **A Cormorant Ecology Working Group** meeting to synthesise available information on Cormorant ecology, focussing on those factors that lead to conflicts with fisheries.

(3) **A Management Tools Working Group** meeting to (1) identify and evaluate existing Cormorant population models with particular emphasis on (a) predicting the ultimate size and geographical distribution of the European Cormorant population and (b) determining the levels of control that would be necessary to reduce the overall

population size, (2) identify and evaluate potential site-specific management techniques, incorporating current information on their efficacy and cost-effectiveness.

(4) **A Conflict Resolution Workshop** to focus on a specific Cormorant-fishery conflict involving recreational angling in the Lea Valley, Hertfordshire, south-east England. Here, REDCAFE participants met with a number of local stakeholders and both groups shared expertise and knowledge. This case study formed the basis for evaluating REDCAFE progress and the ability of the REDCAFE experience to be applied to the real world. Furthermore, it allowed participants to explore whether the project's concept of equitable stakeholder involvement was a useful framework for future Cormorant-fisheries conflict resolution elsewhere in Europe.

3 Cormorant conflicts with fisheries

3.1 Introduction

This Work Package was an attempt to synthesise Cormorant conflicts[2] on a pan-European scale. Various stakeholder groups often hold different values and consequently have different preferences for the use of limited natural resources. Conflict in natural resource management is thus often inevitable. In addition to addressing environmental conflicts from a biological perspective, the social and cultural dimensions of human society that influence conflicts with wildlife also demand equal attention.

By taking such a pluralistic approach, many people:wildlife conflicts can be understood as people:people or people: state conflicts. For example, in many societies around the world, fishing rights are controlled. Acheson (1981) believes such rights-based systems operate to reduce uncertainty: "if fishermen cannot control the fish, at least they can control who will be allowed to fish for them and how they will do so". Seen in this context, fisheries stakeholders may view Cormorants as another 'fisherman' in the system, albeit one whose access to the fishery they have little, or no, control over. Moreover, many fishermen feel that Cormorants are given unduly high conservation status or legal protection, and that current legislation works against them (see discussion in Marquiss & Carss 1997). As a consequence, they may often think that other stakeholders (e.g. nature conservationists, biologists, policy-makers) have too much control over rights of access to their fisheries and over the fisheries management decision-making process. Furthermore, a common source of Cormorant-fisheries conflict stems from feelings of exclusion among local people. For example, local experts often believe that scientists and policy makers ignore their knowledge and experiences.

Successful conflict management depends on conflicting parties opening communication channels and developing networks of trust for effective participation[3], dialogue and collaboration. The themes mentioned above are explored in more detail for a specific Cormorant-fishery conflict case study in Chapter 6 whilst this Chapter describes the broad conflict synthesis process REDCAFE used on a much broader scale. The REDCAFE pan-European synthesis was an attempt (a) to develop dialogue, both within and between the project participants and a wide network of other stakeholders and (b) to know and understand Cormorant-related conflicts at the continental level.

Wherever possible, information for the present synthesis was provided by stakeholders affected directly by Cormorant conflicts. This information is therefore

[2] Throughout this report, terms such as 'Cormorant conflicts' and 'conflicts with Cormorants' are used to mean both conflicts that cause problems for people and those that cause problems for Cormorants. Furthermore, as detailed in this Chapter, such conflicts are not restricted to fisheries issues but also include broader environmental ones.

[3] There are numerous definitions and interpretations for 'participation' (e.g. see Chambers 1998; Nelson & Wright 1995) in relation to helping local people ensure that local cultural values are respected and orientating projects towards people's felt needs. However, in the context of REDCAFE work, 'participation' means the involvement of local people as partners (rather than as passive spectators) in the process of collecting local knowledge and experiences. Future participatory work in relation to the management of Cormorant conflicts would aim for the increased involvement of local people in the decision-making process.

presented as an indication of stakeholders' perceptions of Cormorant-fishery conflicts. These perceptions are very important as they are informed by stakeholders' 'values'[4]. In the case of Cormorant-fishery conflicts, these values may, at first, appear to be related solely to environmental issues. Partially as a consequence, environmental scientists have often been asked to deliver solutions to such conflicts. These scientists have often worked in relative isolation, both between academic disciplines (e.g. avian ecology and fisheries biology) and between scientists and the wider community.

One of REDCAFE's aims was thus to break down some of the isolation associated with academic scientific research and, through dialogue with other stakeholders involved in Cormorant-fishery conflicts, better understand their values and opinions. The provision and collation of information for the present conflict synthesis formed the basis for REDCAFE's dialogue with these stakeholders. Through this process it became clear that, as with many other environmental issues, the 'environmental values' of stakeholders involved in Cormorant conflicts are a "thorny nest of intellectual and political problems. (They) delineate a complex field whose ideas and visions, rights and responsibilities encounter traditions and interests, institutions and technologies, all of which are essentially contested at the level of experience." (O'Brien & Guerrier 1995). Thus, REDCAFE's work to synthesise Cormorant conflicts on a pan-European scale was an attempt to record and understand the experience of a diverse range of stakeholders (individuals, groups and organisations) affected by these issues. Furthermore, this process highlighted the difficulties involved in creating and managing dialogue between stakeholders from many countries and diverse backgrounds.

The following sections discuss the general synthesis of Cormorant conflicts as follows. First, the methods used are described (section 3.2) and then the findings of the information collection and collation exercise are presented (section 3.3). methodological difficulties and limitations are discussed (section 3.4) before a general synthesis and discussion of the information presented (in 3.3) is presented (section 3.5). Finally, Cormorant –fisheries conflicts in a wider context (section 3.6) and ways to take work forward (section 3.7) are discussed.

3.2 Methods

Given time and logistical constraints and the need for a relatively high level of standardisation in data collection, a spreadsheet was devised to incorporate all the information thought relevant to Cormorant conflicts (Figure 3.1). This spreadsheet was designed so that, through a collaborative process involving REDCAFE participants working in partnership with other stakeholders, information could be recorded separately for each of four stakeholder groups: recreational fishermen ('anglers'), commercial fishermen, aquaculturists and nature conservationists.

Six categories of information were provided by stakeholders. First a basic **site description** covering geographical location, type of and characteristics of the waterbody. Second, information on **fish and birds**, including the species of cormorant involved in the conflict (or, in the case of Great Cormorants, the race), the numbers of birds and species of fish involved, and the months over which conflicts occurred. Third, **financial information**, either 'actual' or estimated', on both the annual

[4] For further discussion on 'values' and resulting actions, see section 6.2

turnover in the system and the turnover loss due to cormorants. Fourth, specific details of **conflict issues** arising at the site. These were placed in three categories relating to Fisheries, Fish Stocks and Other issues on the spreadsheet (see Figure 3.1). However, given the nature of the seven issues in this latter category, they are better termed 'Environmental' issues and this term is therefore used throughout the rest of this Chapter. Stakeholders recorded (see Figure 3.1) the magnitude of each relevant conflict issue (a score of 0-3), any references to literature used to inform themselves about the conflict, and the status of these references (coded *p*, *g*, or *s*, see Figure 3.1 for explanation). This allowed a semi-quantitative analysis of both the scale of perceived conflicts but also the type of information used by various stakeholders in relation to particular conflict issues. Finally, space was provided for stakeholders to give additional comments and also further details of the literature references cited. These literature references are provided in a bibliography in Volume 2 of this report.

In the first instance, the information described above was requested on specific conflict cases. Secondary to this, case study information was also collated under generic headings relating to rivers, stillwaters and coasts, and these were further collated to provide a national profile for each country. This information was later incorporated into some aspects of the pan-European analysis (see 3.3.2) but the bulk of this Chapter deals with the specific case study information.

Again, given time constraints, REDCAFE participants from each country completed spreadsheets initially for as many case studies as they could. These were then passed to relevant stakeholders, identified by REDCAFE participants after regional or national consultation, who both refined the information for these cases and also provided further information for other cases (full lists of the stakeholders involved are given in Volume 2 of this report). Although every effort was made to ensure that the information included in this synthesis was derived from the stakeholders themselves, in a few cases the only information available was that provided by REDCAFE participants (see 3.3.1).

After completion, spreadsheets were returned to REDCAFE participants and then collated on a national basis. Resulting data was analysed in two ways. First a pan-European overview was generated through a redundancy analysis (ter Braak & Šmilauer, 1998; Jongman *et al.*, 1995; Šidák, 1967). Essentially, this analysis distils all the information into simple interpretative diagrams that show the strongest relationships between factors recorded on the original spreadsheets. In these diagrams, each arrow points in the direction of steepest increase of values for the corresponding factor. Arrows thus show the relative importance of this factor: the longer the arrow, the more important its corresponding factor in explaining variation within the overall dataset. The angles between arrows can be used to indicate correlations (or covariance) that is, the 'degree of relatedness' between factors. In the second analysis, specific factors relating to each of the pieces of information provided in case study spreadsheets were analysed separately using appropriate statistical tests. It was therefore possible to investigate relationships between factors at a more fine-scale level than was possible in the 'global' redundancy analysis described above.

NAME OF RESPONDENT AND YOUR AFFILIATION: ______________________

(1) SITE DESCRIPTION

CASE STUDY SITE	Name: ________		Geographical coordinates: Long ____	Lat ____		
COUNTRY	________		Region/province/etc. ________			
river location	upper	middle	lower			
river width	<10 m ____	10-50 m ____	50-100 m ____	100+m ____		
altitude	< 100 m ____	100 - 500 m ____	500 + m ____			
Water body type and size	Running waters ____	ha drainage	Still waters	ha surface ____	Coastal waters	ha surface ____
trophic status	oligotrophic ____	mesotrophic ____	eutrophic ____			
Anthropogenic influences	natural ____	semi-natural ____	artificial ____			

(2) FISH AND BIRDS

CORMORANT species/sub sp	Ph.c.c. ____	Ph.c.s. ____	Ph.pygmeus ____	
No. CORMORANTS involved	Birds: min= ____	max= ____	(Min and max over the year)	
	Breeding pairs ____			
FISH SPECIES (in conflict)	________			
Months of conflicts (Jan=1)	first: ____	last: ____		

(3) FINANCE

(a) Annual turnover in the system	____ euro	actual/estimate ____	Source of information ________
(b) Turnover loss due to cormorants	____ euro	actual/estimate ____	Source of information ________

Notes: (a) this figure is the revenue of fisheries/aquaculture or value to local economy of recreational fisheries
(a) and (b) please provide actual values and source of information if available, if unavailable please give best estimate

(4) CONFLICT ISSUES

		STAKEHOLDERS											
		Commercial fisheries			Recreational fisheries			Aquaculture			Nature conservation		
	organisation:												
	respondent name:												
		magnit	reference	status	magnit	reference	status	magnit	reference	status	magnit	reference	status
FISHERIES	reduced catch												
	loss of stocked fish												
	reduced value of catch (damage)												
	removal of fish from nets												
	damage to fishing gear												
	reduced catchability (stress/behav)												
	loss of earnings from the fishery												
	reduced capital values of fisheries												
	reduced fishing tackle sales												
	*increased recurrent costs												
	loss of employment												
STOCKS	reduced stock - lowered production												
	effects on popn dynamics/comm structure												
	threats to endangered fishes												
	vectors of diseases/parasites												
	loss of juvenile fish - lowered recruitment												
	loss of spawners												
	loss of aquaculture stock												
OTHERS	eutrophication												
	interactions with other birds												
	scaring/shooting disturbance												
	lead comtamination (birds,environment)												
	landscape alteration												
	drowning in fishing gear												
	damage to vegetation / landscape												

*NB "increased recurrent costs" include things like increased workload and provision of anti-predator measures

Magnitude coding
- **0** not claimed / not applicable
- **1** no impact
- **2** minor effect (~ 10 %)
- **3** major effect (~ 50 %)

Status coding
- **p** Popular literature, magazines, oral communication
- **g** Gray literature, official reports, etc
- **s** Scientific publication, refereed journal

(5) ADDITIONAL COMMENTS

(6) LITERATURE REFERENCES

code author, year, title, source, any other useful information
1
2
3
etc

Figure 3.1 Spreadsheet template completed by stakeholders to provide information for REDCAFE pan-European Cormorant conflict synthesis.

3.3 Cormorant conflicts at the pan-European scale

3.3.1 Coverage

Work Package I sampled Cormorant conflicts in 24 countries, all those detailed in Figure 2.1 with the exception of Switzerland. Overall REDCAFE collated information on 235 conflict cases (Table 3.1)[5]. The majority of information provided (79% of countries and 91% of cases) was based on some degree of stakeholder input (see 3.2). Only for Belgium, Finland, Israel and Romania was information provided solely by REDCAFE participants.

Five distinct habitats were identified in relation to Cormorant conflicts. The highest proportion of conflicts detailed was on rivers, followed by lakes, freshwater aquaculture ponds and coasts, with fewest at coastal aquaculture sites (Table 3.1)

COUNTRY	RIVERS	LAKES	AQUA-CULTURE PONDS	COASTS	COASTAL AQUA-CULTURE	TOTAL NO.
Austria	30	1	-	-	-	31
Belgium	2	1	1	-	-	4
Bulgaria	-	1	-	-	-	1
Cz. Republic	2	-	3	-	-	5
Denmark	-	-	-	5	-	5
Estonia	-	-	-	3	-	3
Finland	-	-	-	9	-	9
France	-	5	-	1	-	6
Germany	7	9	4	-	-	20
Greece	-	2	-	2	-	4
Ireland	No specific cases cited					
Israel	-	-	1	-	-	1
Italy	3	2	1	4	8	18
Latvia	-	1	1	-	-	2
Lithuania	-	-	15	-	-	15
Netherlands	-	3	-	-	-	3
Norway	-	-	-	1	-	1
Poland	-	14	22	2	-	38
Portugal	-	-	-	-	12	12
Romania	Danube Delta case cited – both lake and coastal					
Slovenia	19	2	1	-	-	22
Spain	5	2	-	8	2	17
Sweden	-	2	-	7	-	9
UK *	2	7	-	-	-	9
Total no.	**70**	**52**	**49**	**42**	**22**	**235**
% of total	**29.8**	**22.1**	**20.8**	**17.9**	**9.4**	**(=100%)**

Table 3.1 Distribution of Cormorant conflict case studies collated by REDCAFE in relation to country and the 5 main habitat types identified.
Here, UK refers to England & Wales and Scotland. The number of cases was not distributed evenly amongst habitat types (X^2_4 = 14.154, P = 0.007).

[5] For France, at least, it was clear that the case studies reported were not representative of the full national picture. This point is discussed further in section 3.4.

3.3.2 Pan-European overview

Stakeholders, habitats, conflict issues, and sources of information

Redundancy analysis, based on 23 countries (Ireland was excluded due to the fact that no specific cases were cited), was based on a descriptive dataset containing 24 factors and a response dataset containing 28 factors (Figure 3.2).

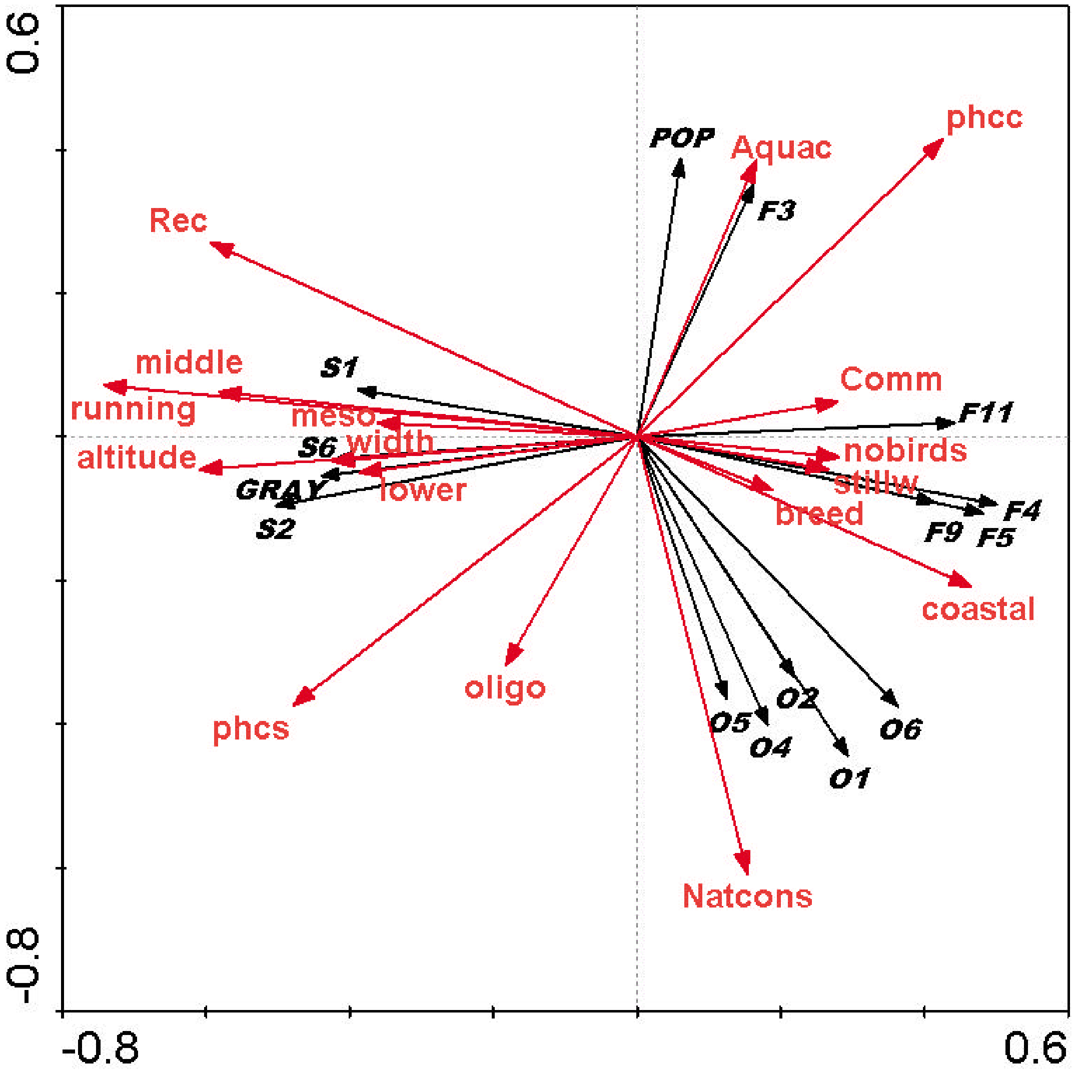

Figure 3.2 Pan-European overview of Cormorant conflicts: stakeholders, habitats, conflict issues, and sources of information. Red arrows indicate descriptive factors, black arrows indicate response factors. For interpretation, see text. In this figure descriptive variables having a t-value below 3.7 have been excluded, which means that 15 variables remain. Response variables having a fit range lower than 14% have been excluded, which resulted in 15 remaining variables. Test for first canonical axis: F=18.29, p<0.01, test for significance of all canonical axis: F=3.24, p<0.01 (Sidak correction performed).

The following points emerge from this analysis.

1. Of the four stakeholder groups, aquaculturists (Aqua) and commercial fishermen (Comm) were most similar with their arrows in the top right. The arrow representing Recreational fishermen (Rec) was also towards the top of the figure but points to the left. This was in sharp contrast to the arrow representing nature conservationists (Natcons) which points to the bottom right.

2. Several factors were associated with recreational stakeholders. These related clearly to river habitats: running waters, middle and lower reaches of rivers, river width, mesotrophic status, and altitude.

3. Several factors were associated with commercial fisheries. These related to two habitat types, stillwaters and coasts, and to both Cormorant numbers in general and to numbers of breeding birds.

4. There were significant differences between the two races of Cormorant, Atlantic birds (phcc) and Continental ones (phcs) as their associated arrows point in almost opposite directions.

5. One ‘Fisheries’ conflict issue in particular (F3: reduced value of catch [damage]) was closely associated with aquaculture.

6. Four ‘Fisheries’ conflict issues (F4, 5, 9, 11) were closely related to commercial fishing: removal of fish from nets, damage to fishing gear, reduced fishing tackle sales and loss of employment.

7. Three fish ‘Stock’ conflict issues (S1, 2, 6) were closely related to recreational fishing: reduced stock through lowered production, effects on population dynamics and community structure, and loss of spawners.

8. Five ‘Environmental’ conflict issues (O1, 2, 4, 5, 6) were closely related to nature conservation: eutrophication, interactions with other birds, lead contamination (birds, environment), landscape alteration, and drowning in fishing gear.

9. Two sources of information appeared important to stakeholders: popular literature, discussions (Pop) and grey literature, official reports etc. (Gray).

Fish species and conflict issues

Redundancy analysis, based on 23 countries (Ireland was again excluded due to the fact that no specific cases were cited), was based on a descriptive dataset containing 68 factors (i.e. fish species) and a response dataset containing 25 conflict issues (Figure 3.3).

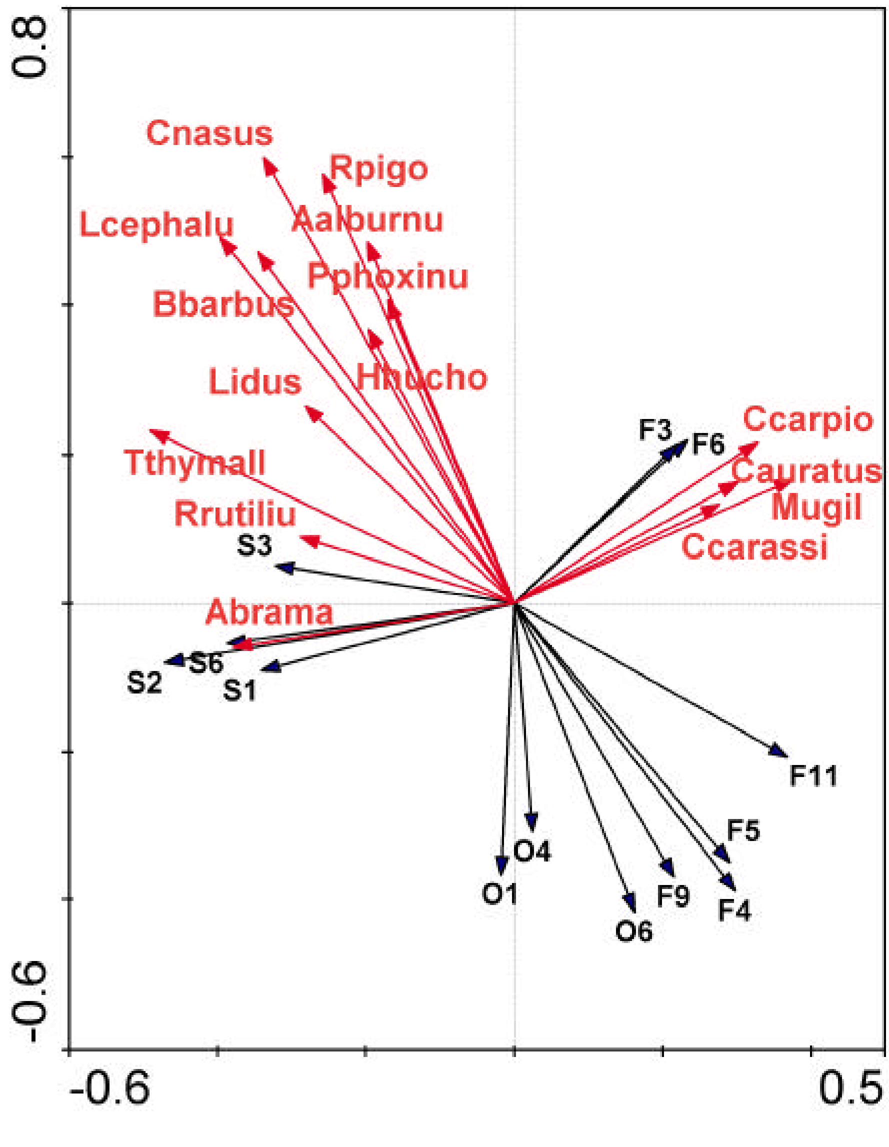

Figure 3.3 Pan-European overview of Cormorant conflicts: fish species and conflict issues. Red arrows indicate descriptive factors, black arrows indicate response factors. For interpretation, see text.

In this figure descriptive variables having a correlation range within –0.19 and 0.19 have been excluded, which means that 15 variables remain. Response variables having a fit range lower than 9% have been excluded, which resulted in 15 remaining variables. Test for first canonical axis: $F=22.01$, $p<0.01$, test for significance of all canonical axis: $F=2.34$, $p<0.01$ (Sidak correction performed).

The following points emerge from this analysis.

1. The fish species highlighted by the analysis fall into two distinct groups. The first includes four species common in aquaculture systems: Carp (see Table 3.4 for scientific names), Crucian carp and goldfish in freshwaters and mullets in coastal lagoons.

2. The second, larger, group of fish is dominated by nine species of cyprinids (Carp family, see Table 3.4) but also includes Huchen and Grayling.

3. Two 'Fisheries' conflict issues (F3, 6) were closely related to the aquaculture fish species group: reduced value of catch (damage) and reduced catchability through stress/behaviour. The former issue was also closely related to aquaculture stakeholders in Figure 3.2.

4. Three fish 'Stock' conflict issues (S1, 2, 6) were closely related to the cyprinid-dominated fish group: reduced stock through lowered production, effects on population dynamics and community structure, and loss of spawners. These three issues were also closely related to recreational fishery stakeholders in Figure 3.2. A fourth fish 'Stock' conflict issues (S3) was also highlighted in association with the cyprinid-dominated fish group: threats to endangered species.

5. A third group of conflicts was highlighted, covering both 'Fisheries' (F4, 5, 9, 11) and 'Environmental' (O1, 4, 6) issues (and closely related with commercial and nature conservationist stakeholders, respectively, in Figure 3.2). These seven conflict issues were removal of fish from nets, damage to fishing gear, reduced fishing tackle sales, and loss of employment (Fisheries) and eutrophication, lead contamination (birds, environment), and drowning in fishing gear (Environmental). It is clear from these issues that they are not necessarily related directly to fish species and this lack of association is clear from the direction of the arrows in Figure 3.3.

Seasonality of conflicts

Redundancy analysis, based on 23 countries (Ireland was again excluded due to the fact that no specific cases were cited), was based on a descriptive dataset containing 23 factors (i.e. countries) and a response dataset containing 12 months (Figure 3.4).

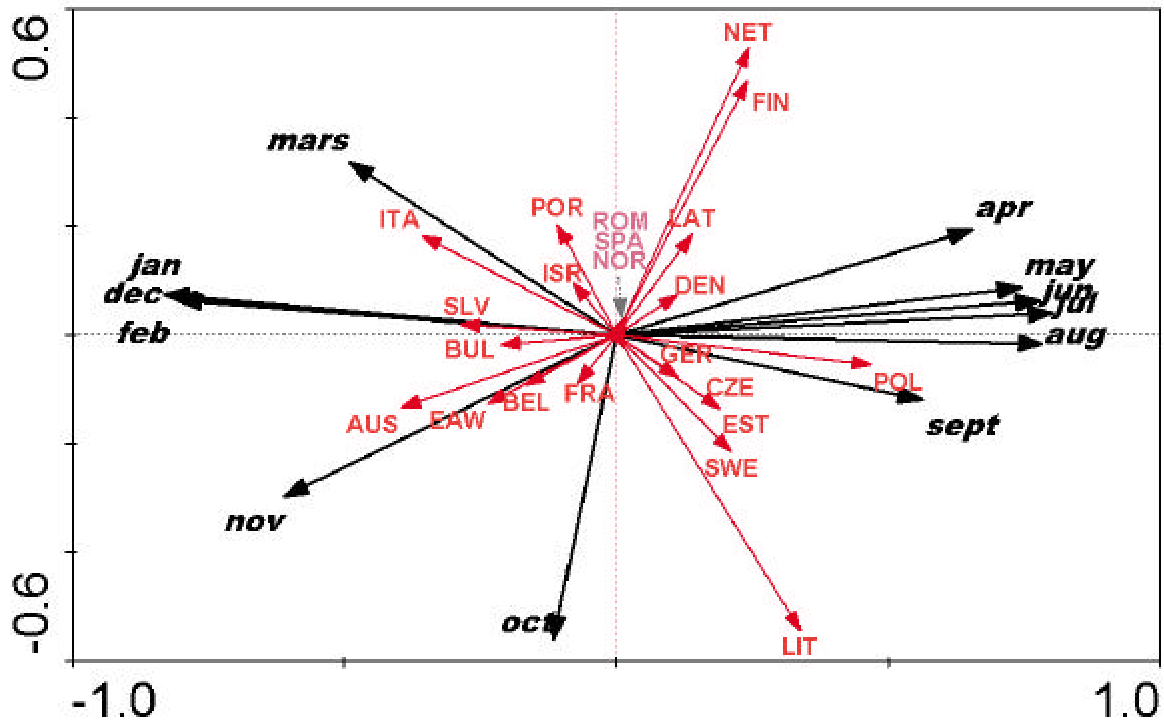

Figure 3.4 Pan-European overview of Cormorant conflicts: timing of conflict by country. Red arrows indicate descriptive factors, black arrows indicate response factors. For interpretation, see text.
In this figure all variables have been included. Test for first canonical axis: $F=269.55$, $p<0.004$, test for significance of all canonical axis: $F=19.21$, $p<0.004$ (Sidak correction performed).

This analysis shows that (1) although countries differ in relation to the months during which Cormorant conflicts are reported, there are two major groups which (2) are associated with conflicts in two time periods: 'winter' October-March and 'summer' April-September. This, and the other pan-European overviews in this section, are explored in further detail in the following sections.

3.3.3 Conflict site descriptions

National overview

Cormorant conflicts on rivers were reported in 8 countries, on lakes (14 countries), aquaculture ponds (9), coasts, (10) and coastal aquaculture (3). However, in relation to habitat type, only a relatively few countries (i.e. 2-4) hold most (i.e. > 10%) of these conflict cases (Figure 3.5). Thus there are thirteen 'main' countries reporting Cormorant conflicts (Table 3.2).

Habitat type	**Country holding > 10% of reported Cormorant conflict cases**
Rivers	Austria, **Germany**, Slovenia
Lakes	France, **Germany**, **Poland**, UK (England & Wales, Scotland)
Aquaculture ponds	**Germany**, Lithuania, **Poland**
Coasts	Denmark, Finland, Spain, Sweden
Coastal aquaculture	Italy, Portugal

Table 3.2 Thirteen 'main' countries reporting Cormorant conflicts (those in bold have conflicts in more than one habitat type).

Habitat overview

Within rivers, the reported Cormorant conflicts were not distributed randomly in relation to location within river (i.e. reach), its width or altitude. Most reported conflicts were on the 'middle' or 'lower' reaches of rivers, at widths of 10-100m and at altitudes of less than 500 m. Such lowland features were also clear for conflicts on lakes where most records were from sites at less than 500m altitude (Table 3.3).

The majority of Cormorant conflict cases were reported to be on nutrient-rich (i.e. eutrophic) waters. However water quality differed between the five habitat types, tending towards nutrient-poor conditions for rivers and nutrient-rich conditions for lakes and especially freshwater aquaculture ponds. In terms of anthropogenic influences, similar proportions of conflict cases were recorded overall on natural, semi-natural and artificial sites. Again there were differences between the five habitat types with most rivers and coasts being natural and most freshwater aquaculture ponds being artificial (Table 3.3).

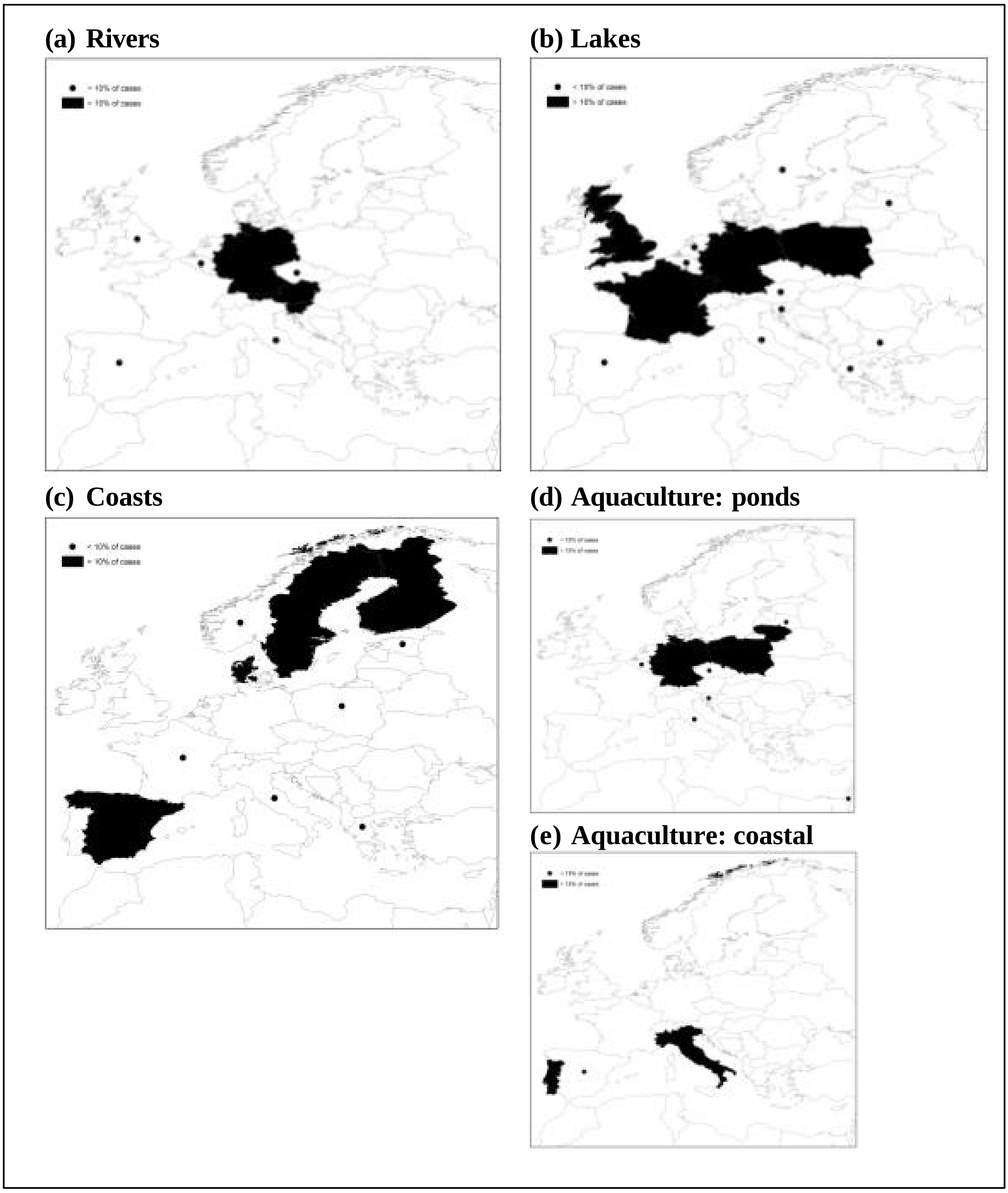

Figure 3.5 Geographic distribution of habitat types affected by conflicts with Cormorants. Shaded countries have over 10% of recorded conflict cases, those indicated by dots have less than 10%.

Habitat	Feature	Category			
	Reach	**Upper**	**Middle**	**Lower**	
Rivers	N = 66 cases[1]	7	**43**	16	
	Width (m)	**< 10m**	**10-50m**	**50-100m**	**100+m**
Rivers	N = 66 cases[2]	10	**37**	11	8
	Altitude (m)	**< 100m**	**100-500m**	**500+m**	
Rivers	N = 62 cases[3]	11	**47**	4	
Lakes	N = 70 cases[4,5]	**38**	28	4	
	Trophic status[6]	**Oligotrophic**	**Mesotrophic**	**Eutrophic**	
Rivers	N = 68 cases	**32**	28	8	
Lakes	N = 49 cases	4	14	**31**	
Aquaculture ponds	N = 50 cases	0	2	**48**	
Coasts	N = 29 cases	10	3	**16**	
Coastal aquaculture	N = 22 cases	**9**	4	**9**	
	Anthropogenic Influence[7]	**Natural**	**Semi-natural**	**Artificial**	
Rivers	N = 67 cases	**40**	27	0	
Lakes	N = 51 cases	**22**	14	15	
Aquaculture ponds	N = 49 cases	0	9	**40**	
Coasts	N = 33 cases	**24**	9	0	
Coastal aquaculture	N = 22 cases	3	**15**	2	

Table 3.3 The number of Cormorant conflict cases reported in relation to habitat (river, lake) and habitat features. Within each habitat/feature category, the highest proportions are highlighted in red.

[1]Most river conflicts were recorded on 'middle' reaches (X^2_2 = 15.491, P < 0.001), [2]on rivers of 10-50m width (X^2_2 = 13.721, P = 0.003), and [3]at 100-500m altitudes (X^2_2 = 24.620, P < 0.001). [4]Most lake conflicts were at < 100m altitude (X^2_2 = 17.543, P < 0.001) [5]in contrast to those on rivers (X^2_2 = 19.277, P = 0.0001). [6]Overall, trophic status differed between habitats, especially in relation to low numbers of eutrophic river cases and high numbers of eutrophic freshwater aquaculture pond cases (X^2_8 = 96.447, P < 0.001). [7]Overall, anthropogenic influences differed between habitats, especially in relation to high numbers of artificial freshwater aquaculture ponds (X^2_8 = 135.175, P < 0.001).

3.3.4 Birds and fish

Across Europe, three species/races of cormorant were involved in conflicts: both the Atlantic (*Phalacrocorax carbo carbo*) and Continental (*P. c. sinensis*) races of the Great Cormorant and the Pygmy Cormorant (*P. pygmeus*). Only the Atlantic race of the Great Cormorant was recorded in Norway, Scotland and the Republic of Ireland, both races were recorded in England, Wales, France, Spain and Portugal, whilst the only Continental race was recorded in all other countries. In Bulgaria, Greece and Israel, the Pygmy Cormorant was also recorded alongside Continental Great Cormorants (Figure 3.6).

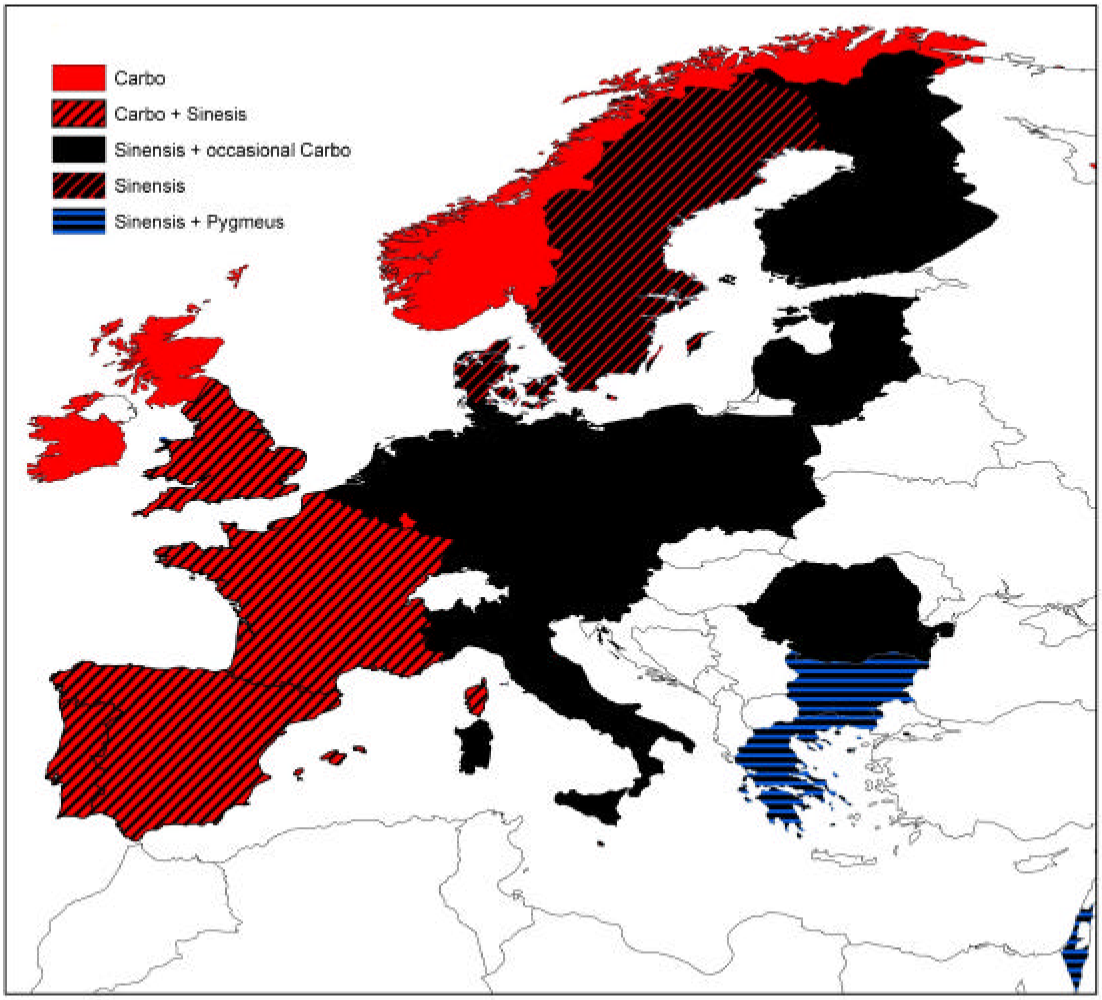

Figure 3.6 Geographic distribution of Cormorant races/species involved in conflicts across Europe.

Information on maximum Cormorant numbers and area of water involved was available for 147 conflict cases: involving 43 lakes, 42 rivers, 42 freshwater aquaculture ponds, and 20 coastal cases. Overall, there were significant differences in the mean density of Cormorants (i.e. maximum number/area) between habitat types (Table 3. 4) with the highest Cormorant densities recorded on rivers. However, there are some problems with the definition of 'area of water' in relation to these conflict cases, particularly for rivers where cases (and hence, associated densities) range from short study sections to the catchment area of the River Danube (see discussion in 3.4).

Nevertheless, statistical analysis showed that the maximum number of Cormorants recorded for each case was influenced by both 'area of water' and 'habitat type' (i.e. lake, river, pond and coast) and also by an interaction between these two factors. Further analysis showed that this interaction was due to the 'rivers' habitat category where maximum Cormorant numbers appeared little affected by the area of water (Figure 3.7). Excluding river cases showed that for lakes, ponds and coasts, area of water was the main factor influencing Cormorant numbers at specific conflict case sites (Figure 3.7).

Habitat	No. cases	Cormorant density (maximum no. ha^{-1})			
		Mean	**SE**	**Minimum**	**Maximum**
Lakes	43	1.9	0.68	0.05	25.00
Rivers	42	4.3	0.89	3.0×10^{-5}	31.25
Aq ponds	42	1.6	0.60	0.06	21.25
Coasts	20	0.5	0.14	0.005	2.67

Table 3.4 Cormorant density (mean, standard error [SE], minimum and maximum) in relation to 4 habitat types. Densities differed between habitats, being highest on rivers, lowest on coasts and intermediate on stillwaters (lakes and aquaculture ponds) ($F_{3,143}$ = 4.54, P = 0.004).

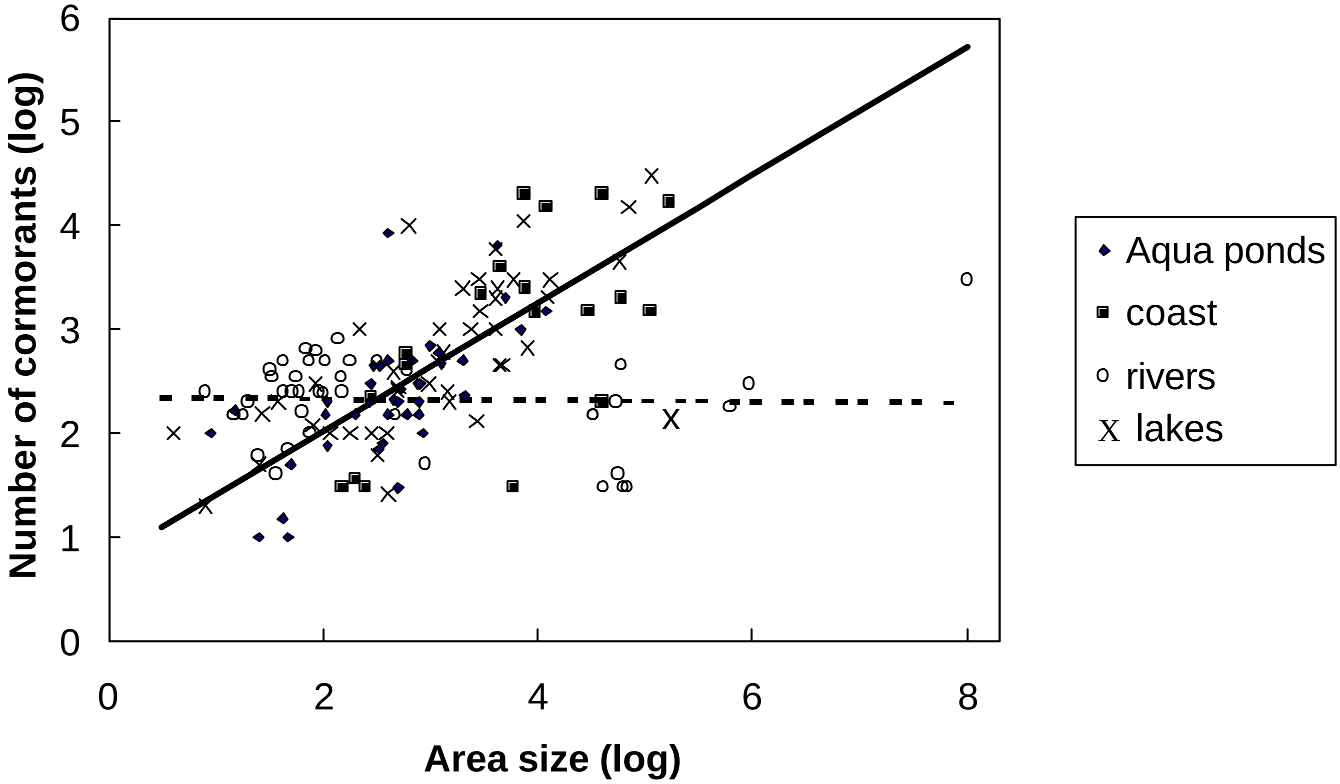

Figure 3.7 Relationship between maximum Cormorant numbers and area of water for conflict cases at four main habitat types. Each point represents one case.

Within lake, pond and coastal habitats, the relationship between maximum Cormorant numbers and area of water was best described by the following equation where water area explains 56% of the variation found in maximum Cormorant numbers:

$$\text{Log}_{10}\text{ (maximum number of Cormorants)} = 0.6179 \times (\text{Log}_{10}[\text{area of water}]) + 0.77798$$

Information on the fish species that are involved in Cormorant conflicts was available for 212 conflict cases: involving 43 lakes, 66 rivers, 48 freshwater aquaculture ponds, 22 coastal aquaculture sites and 33 coastal ones. Overall, 68 species were recorded from 24 Families (Table 3.5).

Fish species were assigned to one of eight categories: (1) Cyprinids; (2) Salmonids; (3) Perch/Pike; (4) Eel and other freshwater species; (5) flatfishes; (6) Cod fishes; (7) Mullet/Sea Bream/Bass; (8) other marine fishes (see Table 3.4). Overall, the highest proportion of fish species recorded in conflicts involving Cormorants were Cyprinids, followed by Salmonids, Perch/Pike and a number of fishes associated with coastal aquaculture. However, different fish groups were identified when conflicts were assigned to one of five habitat types (Table 3.6).

	Habitat type					
Fish group	**River**	**Lake**	**Aquaculture ponds**	**Coast**	**Coastal aquaculture**	**% of records**
Cyprinids	**120**	**41**	**54**	7	0	33.7
Salmonids	109	20	10	**26**	0	25.0
Perch/pike	20	**46**	15	19	0	15.2
Mullet etc.	0	0	0	11	**48**	8.9
Eel + others	6	24	3	15	10	8.8
Flatfishes	0	0	0	15	9	3.6
Marine	0	0	0	**22**	0	3.3
Cod fishes	0	0	0	9	0	1.4
Total number of records = 659						**= 100%**

Table 3.6 The number of records of fishes involved in conflicts with Cormorants in relation to five habitat types. Figures are the number of records for species included in each of eight fish groups, those highlighted in red indicate the most commonly recorded groups in each habitat type.

ANGUILLIDAE[4] - Eels
Eel *Anguilla anguilla*

CLUPEIDAE[6] – Herrings
Herring *Clupea harengus*

COREGONIDAE[2] - Whitefishes
Powan *Coregonus lavaretus*
Vendace *C. albula*
Northern whitefish *C. peled*

SALMONIDAE[2] - Salmonids
Atlantic salmon *Salmo salar*
Brown trout *S. trutta*
Marbled trout *S. marmoratus*
Rainbow trout *Oncorhynchus mykiss*
Arctic char *Salvelinus alpinus*
Brook char/trout *S. fontinalis*
Huchen *Hucho hucho*

THYMALLIDAE[2] - Graylings
Grayling *Thymallus thymallus*

ESOCIDAE[3] – Pikes
Northern pike *Esox lucius*

CYPRINIDAE[1] – Carps
Carp *Cyprinus carpio*
Crucian carp *Carassius carassius*
Goldfish *Carassius auratus*
Gibel carp *Carassius auratus gibelio*
Tench *Tinca tinca*
Bream *Abramis brama*
Zährte *Vimba vimba*
Silver bream *Blicca bjoerkna*
Schneider *Alburnoides bipunctatus*
Bleak *Alburnus alburnus*
Barbel *Barbus barbus*
Italian barbel *B. barbus plebejus*
Nase *Chondrostoma nasus*
Savetta *Chondrostoma soetta*
South European nase *Chondrostoma genei*
Dace *Leuciscus leuciscus*
Ide/Orfe *L. idus*
Chub *L. cephalus*
Soufie *L. souffia*
Silver carp *Hypophthalmichthys molitrix*
Big head carp *Aristichthys nobilis*
Minnow *Phoxinus phoxinus*
Roach *Rutilus rutilus*
Danubian roach *Rutilus pigus*
Rudd *Scardinius erythropthalmus*

SILURIDAE/ICTALURIDAE[4] - Catfishes
Wels *Silurus glanis*
Black bullhead *Ictalurus melas*
Channel catfish *I. punctatus*

GADIDAE[6] – Cod fishes
Cod *Gadus morhua*
Saithe *Pollachius virens*
Burbot *Lota lota*

ZOARCIDAE[8] – Eelpouts
Viviparous blenny/Eelpout *Zoarces viviparus*

BELONIDAE[8] – Garfishes
Garfish *Belone belone*

ATHERINIDAE[7] – Sand-smelts
Big-scale sand-smelt *Atherina boyeri*

COTTIDAE[8] – Sculpins/Bullheads
Fourhorn sculpin *Myoxocephalus quadricornis*
Bull-rout *M. scorpius*

PERCICHTHYIDAE[7] – Sea basses
Bass *Dicentrarchus labrax*

PERCIDAE[3] – Perches
Perch *Perca fluviatilis*
Ruffe *Gymnocephalus cernuus*
Pikeperch/Zander *Sander lucioperca*

SPARIDAE[7] – Sea breams
Gilthead *Sparus auratus*
Striped sea bream *Lithognathus mormyrus*

MUGILIDAE[7] – Grey mullets
Thin-lipped grey mullet *Liza ramada*
Leaping mullet *L. saliens*

SCOMBRIDAE[8] – Mackerels
Mackerel *Scomber scombrus*

SCOPHTHALMIDAE[5] – Left-eyed flatfishes
Turbot *Scophthalmus maximus*

PLEURONECTIDAE[5]– Right-eyed flatfishes
Plaice *Pleuronectes platessa*
Flounder *Platichthys flesus*
Dab *Limanda limanda*

SOLIDAE[5] – Soles
Sole *Solea solea*
Senegal sole – *Solea senegalensis*

VALLENCIIDAE[8] – Killifishes
Valencia toothcarp *Valencia hispanica*

CYPRINODONTIDAE[8] – Pupfishes
Spanish toothcarp *Aphanius iberus*

CICHLIDAE[4] – Cichlids/Tilapia
Mango tilapia *Sarotherodon galileus galileus*

Table 3.5 Fish species recorded in relation to conflicts with Cormorants across Europe. Numbers refer to species categories discussed in the text.

Information on the seasonality of Cormorant conflicts was available for 186 conflict cases. For each, the months during which conflicts occurred were identified. Conflict cases could be split, on a national basis, into four distinct seasonal groups (Figure 3.8). Moreover, these four seasonal groups corresponded to four distinct geographical regions: Western Europe (winter conflicts), Baltic and Netherlands (summer conflicts), Central Europe (conflicts throughout year) and South-eastern Europe (winter conflicts) (Figure 3.9). In Germany, most conflicts in summer were reported in the northern regions where the main breeding colonies are located (i.e Baltic Sea coast), while most winter conflicts were reported from the central or southern (i.e. inland) regions.

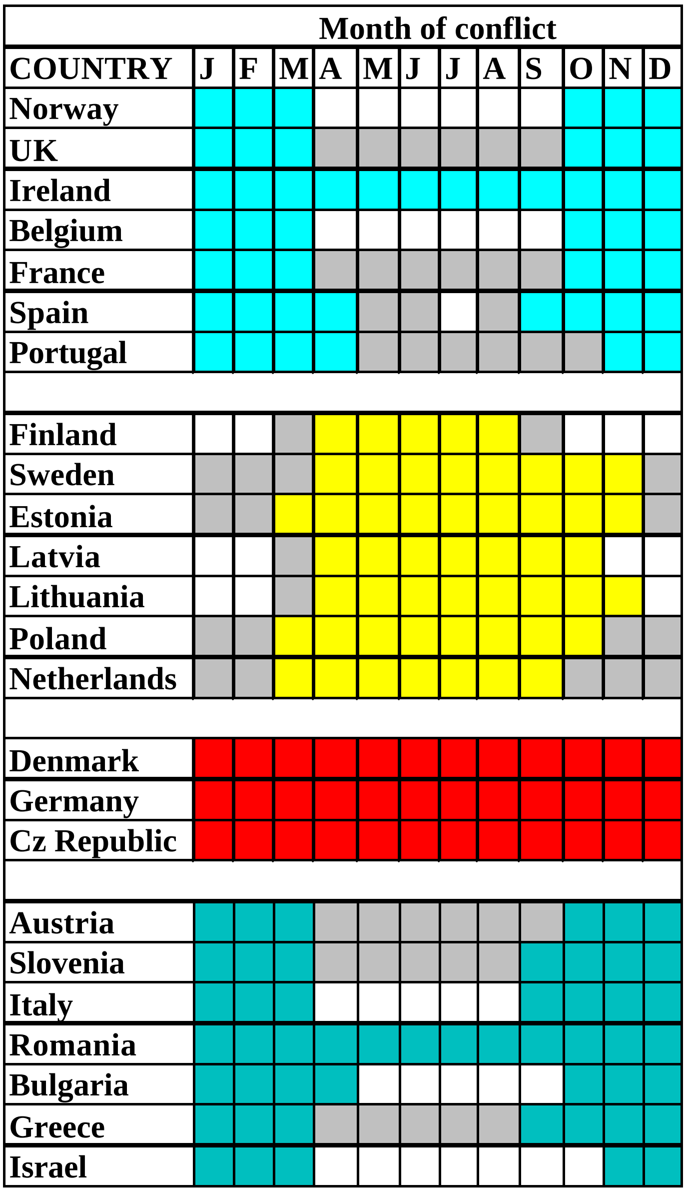

Figure 3.8 The months for which Cormorant conflicts were recorded by country. Coloured boxes indicate the months during which conflicts were recorded in the majority of case studies (blue = winter conflicts in north/west, blue hatch = winter conflicts in south/east, yellow = summer, red = all year). Grey boxes indicate months when few conflict cases were reported and white boxes indicate months with no reported conflicts.

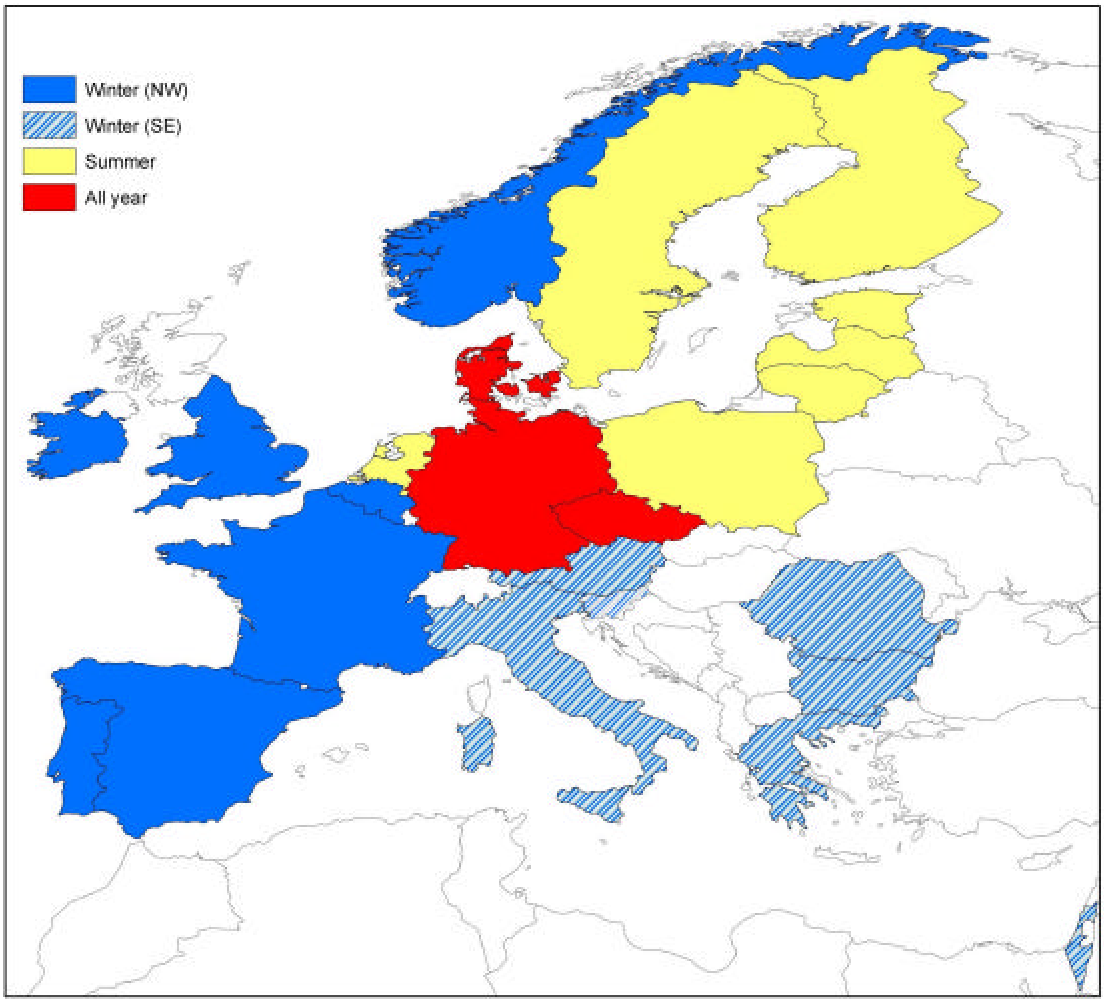

Figure 3.9 Geographical distribution of Cormorant conflicts in relation to country and season (blue = winter conflicts in north/west, blue hatch = winter conflicts in south/east, yellow = summer, red = all year).

3.3.5 Finance

Financial information on the 'costs' of Cormorant predation was recorded for 105 cases. Two pieces of financial information were provided: (a) the annual financial turnover in the system and (b) the turnover loss thought to be due to Cormorants. In one case, this information was derived from a socio-economics model, for the remaining cases, such information came from a variety of different sources (Table 3.7).

Information source	**% of cases**
(a) TURNOVER	
Provided by relevant stakeholder	33.6
Based on fish prices/catch statistics	15.4
Licence payments	1.9
Estimated by REDCAFE participant	32.7
Not stated	16.3
Total number of cases	**104 (= 100%)**
(b) LOSS	
Provided by relevant stakeholder	42.3
Calculated (Cormorant nos, diet, Daily Food Intake, energetic requirements etc)	16.3
Restocking value of lost fish	1
Estimated by REDCAFE participant	20.2
Not Stated	20.2
Total number of cases	**104 (= 100%)**

Table 3.7 Sources of financial information provided for 104 Cormorant conflict case studies. Note: in one other case, both turnover and loss were derived from a socio-economics model.

In an attempt to quantify the 'quality' of the financial information provided, it was requested that the values provided be categorised as either 'actual' or 'estimated'. However, this information was not provided for around 20% of the values recorded for both turnover and loss. Just less than half of the values recorded for turnover were estimates while one-third were categorised as 'actual' amounts (e.g. based on stakeholder accounts). This contrasted ($X^2_2 = 25.212$, $P < 0.001$) with the values for losses, three quarters of which were estimates and only 7% were considered to be actual values.

Financial information provided for the 105 conflict cases gave a cumulative total for annual turnover at these sites of 154,002,380 euro. Associated losses due to Cormorants were given at 16,994,801 euro, an overall loss of 11%.

For each case, loss claimed due to Cormorants was calculated as a percentage of the annual turnover value provided. Resulting 'percentage financial loss' figures were then examined in relation to four main types of stakeholder groups providing information: recreational anglers on rivers (n = 23 cases), aquaculturists on freshwater ponds (41), Commercial fishermen on lakes (23) and on coasts (13). For each stakeholder group, most of the calculated values for percentage financial loss were clustered around values of less than 50% but there were some exceptionally large values. Thus, the most appropriate measure of the central tendency for this information is median reported percentage financial loss (Table 3.8).

STAKEHOLDER/HABITAT	No. CASES	MEDIAN REPORTED FINANCIAL LOSS	% OF CASES WHERE REPOTED LOSS > 50%
Recreational anglers – rivers	23	57%	43.5
Aquaculture – freshwater ponds	41	9%	2.4
Commercial - lakes	23	12%	13.0
Commercial - coasts	13	10%	30.8

Table 3.8 Median financial loss due to Cormorants reported by stakeholders (values are loss as percentage of annual turnover). Proportions of cases where reported financial loss was greater than 50% of annual turnover are also given.
Based on $\log_{10}$ transformed data, recorded financial losses were highest for recreational anglers, lowest for aquaculturists and intermediate for commercial fishermen on lakes and coasts ($F_{3,95} = 9.92$, $P < 0.001$).

Information provided showed that the estimated median financial losses due to Cormorants were similar, at around 10% of annual turnover, for aquaculturists at freshwater ponds and commercial fisheries on both lakes and coasts. However, for coastal commercial fishermen a higher proportion of financial losses was relatively high. These records contrasted sharply with those provided by recreational anglers on rivers. This stakeholder group claimed generally higher financial loss than did the others, median losses claimed were around six times higher for these stakeholders. Similarly, a greater proportion of financial losses reported by recreational anglers on rivers exceeded 50% of annual turnover.

3.3.6 Conflict issues: magnitude of conflict

Original REDCAFE discussions identified 25 potential Cormorant conflict issues (see Figure 3.1). Although stakeholders were free to add other issues, none did. Thus analyses were based on the original 25 issues identified, which were categorised as being related to ‘fisheries’ or ‘fish stocks’ or ‘environmental’ (i.e. more general issues relating to the wider environment). This section examines these conflict issues in relation to their magnitude (see 3.2 for details) as reported by stakeholders.

Analyses including all magnitude codes (not presented) showed very similar patterns to those for magnitude 3 scores only. Thus, for simplicity, analyses of conflict issues were restricted to those given a magnitude coding of 3 which categorised the conflict issue as having a ‘major effect’ for stakeholders. Stakeholders gave magnitude 3 ratings (hereafter referred to as ‘major conflict issues’) on 771 occasions (Table 3.8).

Two things were clear from the overall dataset in Table 3.9. First, that stakeholders recorded major conflict issues differently: nature conservationists seldom recorded major conflict issues (4.0% of all records) whilst recreational anglers did frequently (48.5% of all records). Second, stakeholders recorded major conflict issues in different categories. Specifically, the majority of major conflicts identified by recreational anglers related to fish stock issues, by commercial fishermen and aquaculturists related to fisheries issues and by nature conservationists related to environmental issues.

Category of conflict issue	Stakeholder Group			
	Recreational	**Commercial**	**Aquaculture**	**Nature conservation**
Fisheries	43.6%	55.4%	55.5%	6.4%
Fish Stocks	55.3%	36.4%	35.6%	29.0%
Environmental	1.1%	8.2%	8.9%	64.5%
Total no. records (= 100%)	**374**	**220**	**146**	**31**

Table 3.9 Categorisation of major (i.e. magnitude 3) conflict issues by stakeholders. Figures are percentages of the total number of records provided by each stakeholder group, highest values are shown in red.
Stakeholders recorded major conflict issues differently (X^2_3 = 183.221, P < 0.001) and recorded major conflict issues in different categories (X^2_6 = 197.456, P < 0.001).

Examining all 25 conflict issues separately also highlighted significant differences between stakeholders in terms of the number of times major issues were recorded (Figure 3.10). All three 'fishery related' stakeholders most frequently highlighted either fisheries or fish stock conflict issues. In contrast, fisheries issues were scarcely recorded by nature conservationists, although this stakeholder group did cite concerns over many fish stock issues.

Commercial and aquaculture stakeholders both recorded very similar major conflict issues, the most regularly cited issue being reduced catches. These two stakeholder groups were also both concerned about Cormorants causing a loss of fishery earnings. Perhaps not surprisingly, aquaculturists were also concerned with losses of aquaculture stock and commercial fishery stakeholders were concerned about reduced fish stocks in relation to lowered production. This latter issue was the most regularly cited conflict issue by recreational angling stakeholders, followed equally by effects on fish population dynamics/community structure and reduced fish catches.

Nature conservation stakeholders differed from the three 'fishery related' stakeholders in that nine out of the eleven 'Fisheries' conflicts were unrecorded as major issues. Furthermore, several major conflict issues were cited with the same frequency, thus six issues were included in the top three recorded. Three of these issues were related to fish stocks: reduced fish stocks in relation to lowered production, effects on fish population dynamics/community structure and loss of juvenile fish – lowered recruitment. However, the remaining three (scaring/shooting disturbance, drowning in fishing gear, damage to vegetation/landscape) were categorised as 'Environmental' issues and were only infrequently recorded by other stakeholders. The exception was scaring/shooting disturbance, an issue also in the top ten recorded by aquaculturists.

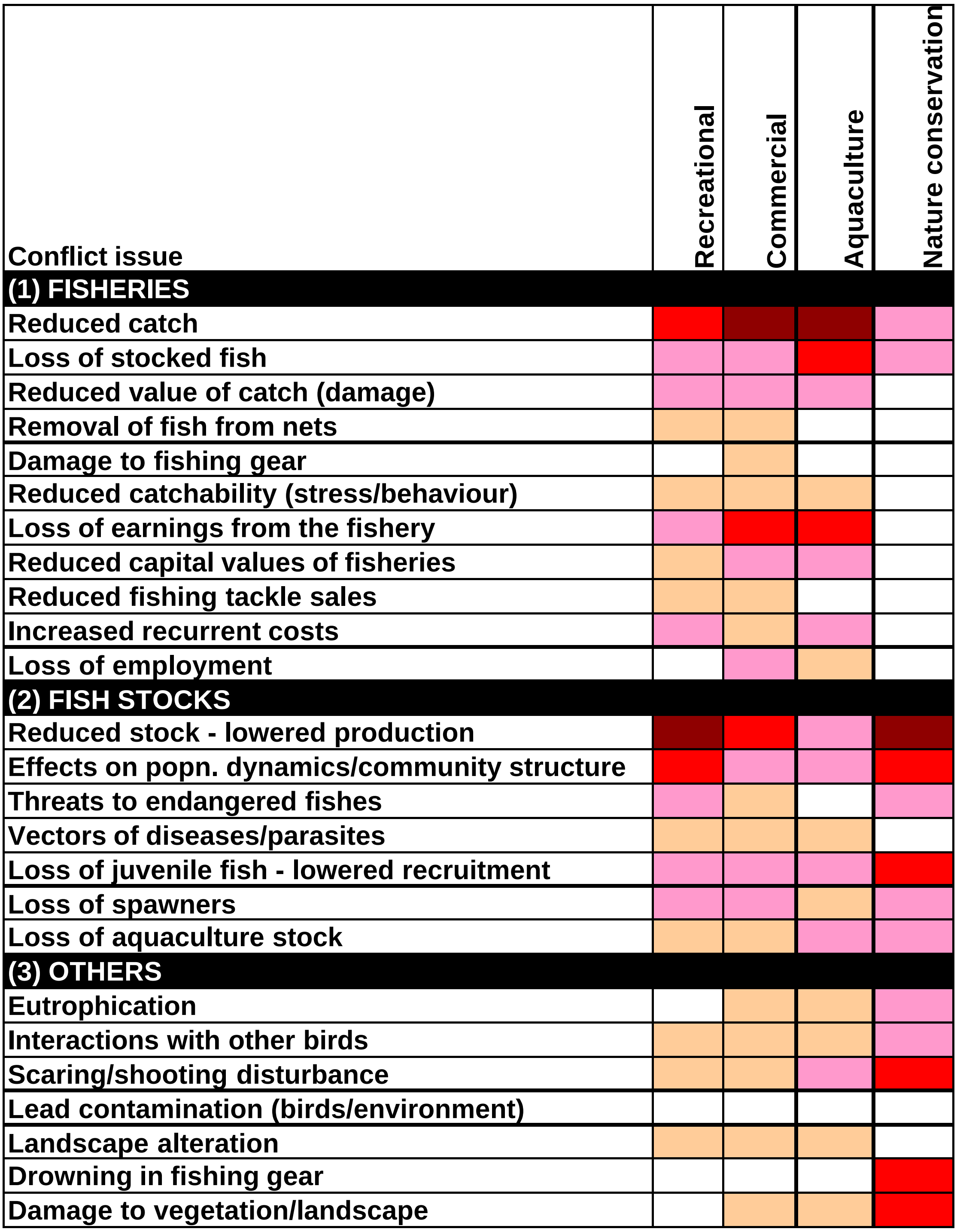

Figure 3.10 Major Cormorant conflict issues as recorded by four different stakeholder groups. Red indicates the top three conflict issues for each stakeholder (note that the top issue for each stakeholder group is hatched and that several issues are shared amongst the top three for nature conservationists), pink indicates other issues in the top ten for each group. Orange indicates major conflict issues recorded less frequently and blank boxes indicate issues not considered by stakeholders to be major ones. The number of major conflict records for each issue was closely correlated ($P < 0.001$) for commercial and aquaculture stakeholders (correlation coefficient, $r = 0.81$), for commercial and recreational stakeholders ($r = 0.79$) and for recreational and aquaculture stakeholders ($r = 0.65$). However, there was no correlation for records from nature conservationists and any of the three other stakeholders.

3.3.7 Conflict issues: status of information used by stakeholders

As well as recording the magnitudes of various conflict issues, stakeholders also provided details of the status of information they used to inform their opinions on them. Such information was categorised broadly as being (a) popular literature/discussions, (b) official reports and unpublished 'grey' literature, and (c) refereed, scientific publications. Stakeholders listed the literature references for categories (b) and (c), and this information is given in Volume 2 of this report. In some cases, stakeholders provided further details on information sources in the 'popular' category (a) and these are discussed later in this section.

Overall, stakeholders provided 3,870 records for the status of the information they used to inform themselves about Cormorant conflict issues. Most records (50.7%) were in the 'popular' category, followed by 'grey literature' (33.9%) and 'scientific literature (15.3%).

Across all 25 conflict issues there were significant differences between stakeholders in terms of their use of different sources of information. (Table 3. 10).

Status of information	**Stakeholder group**			
	Recreational	**Commercial**	**Aquaculture**	**Nature conservation**
Popular	45.9%	52.3%	54.6%	53.2%
Grey literature	39.5%	40.3%	25.8%	23.1%
Scientific literature	14.5%	7.4%	19.6%	23.7%
Total no. records (= 100%)	**1356**	**1000**	**907**	**607**

Table 3.10 Categorisation of the status of information used by stakeholders to inform themselves about Cormorant conflict issues.
Stakeholders recorded the status of information differently ($X^2_6 = 153.701$, $p < 0.001$).

Commercial stakeholders recorded the smallest proportion of scientific literature and nature conservationists the largest whilst nature conservationists and aquaculturists used less grey literature than did commercial and recreational stakeholders. For all four stakeholder groups, 'popular literature' was the most frequently recorded source of information informing them about conflict issues. From information provided by stakeholders, this category included a wide-range of individual sources (Table 3.11).

The most common sources of 'popular' information were provided by stakeholders themselves and could be categorised as local expert knowledge. Apart from records of general discussions and communications between stakeholders, the next most regularly cited source of information was the media, a category that included many different forms of communication. Although all records came from the 'popular' category, 16% of them were clearly identified as having a scientific basis.

Source of ‘popular’ information	**No. of records**	**Frequency of records**
(A) Local expert knowledge		
Stakeholders: direct observations	240	
Stakeholders: data/information	130	
Stakeholders: opinion	38	
“Local knowledge”	63	**35.6%**
(B) Media		
Newspapers, magazines, TV, radio, WWW/internet, letters of compliant to authorities and associated discussions	295	**22.3%**
(C) Other discussions		
Various discussions/personal communications	306	**23.1%**
(D) Administrative sources		
Regional administrative documents/management plans	9	
Local meeting/workshop discussions	31	**3.0%**
(E) Scientific information		
Discussions on the implications of scientific studies	138	
Unpublished scientific information	40	
Popular science articles	34	**16.0%**
Total no. records (= 100%)	**1324**	

Table 3.11 The number (and % frequency) of records for different sources of ‘popular’ information used by stakeholders to inform themselves on Cormorant conflict issues.

It was possible to examine the relationship between the number of records for each ‘major conflict issue’ (see Figure 3.1) and the associated number of records for the use of ‘scientific literature’ (Figure 3.11). Although nature conservation stakeholders do not record many ‘major’ conflicts, they use a relatively large amount of scientific literature. Both aquaculture and commercial stakeholders record more major conflicts than do nature conservationists but are informed by scientific literature less frequently than are conservationists. Nevertheless, aquaculturists make consistently more use of scientific literature than do commercial fisheries stakeholders. Recreational angling stakeholders record major conflicts more frequently than did any other stakeholders and, for the most commonly cited conflicts at least, appear to be informed by the scientific literature.

It is possible to determine the major conflict issues for which the four stakeholder groups are using scientific literature (Figure 3.12). For recreational stakeholders these were reduced catch, loss of stocked fish, reduced fish stocks in relation to lowered production, effects on fish population dynamics/community structure, and loss of juvenile fish through lowered recruitment. For commercial stakeholders, these were reduced catch and effects on fish population dynamics/community structure. For aquaculturists, these were reduced catch, loss of stocked fish, reduced fish stocks in relation to lowered production and loss of aquaculture stock.

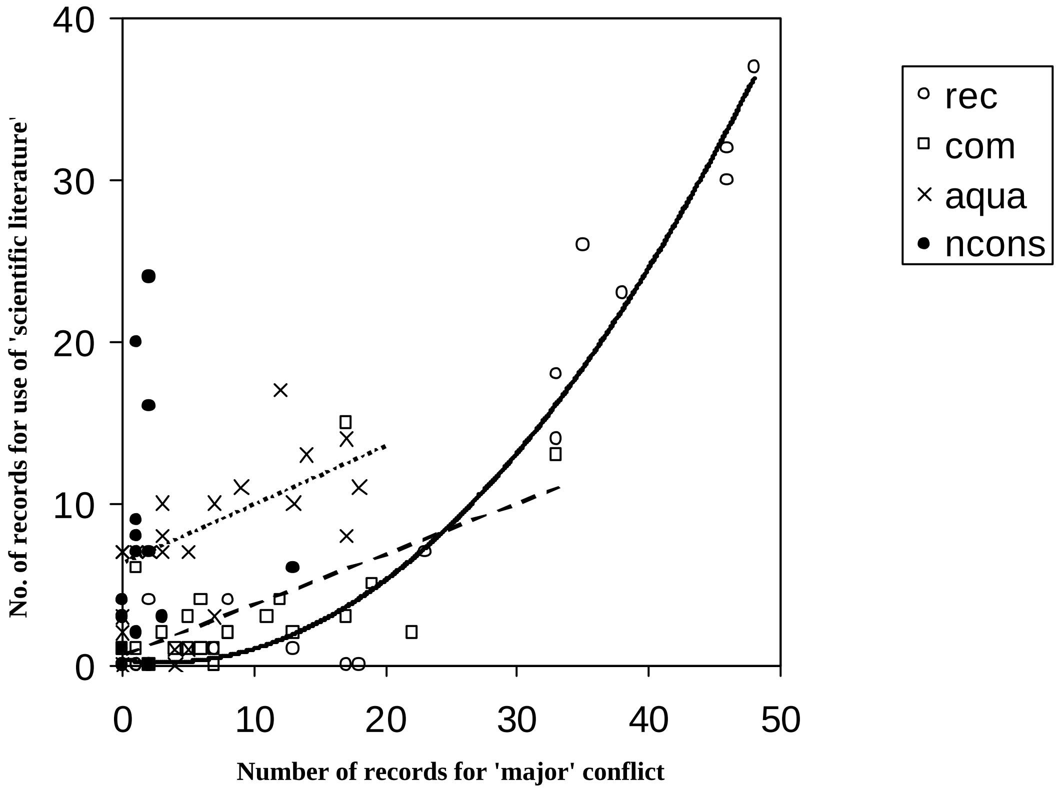

Figure 3.11 Relationship between the number of records for 'major' conflict and for the use of 'scientific literature' as a source of information for four stakeholder groups. Each point represents one conflict issue.

Although conservationists recorded high use of science for three conflict issues, reduced catch, reduced fish stocks in relation to lowered production and effects on fish population dynamics/community structure, they seldom recorded these issues as having a major effect. This is a distinctly different pattern to those of the three 'fishery' stakeholders described above who also used scientific literature to inform themselves on these issues and recorded them very frequently as major conflicts.

3.3.8 Gaps in knowledge

The 'major conflict/science' dataset shown in Figure 3.12 can also be used to identify conflict issues for which there were few, or no, records of the use of 'scientific literature' (Figure 3.13). This process can be used to give a broad picture of possible gaps in current scientific knowledge in relation to the four stakeholder groups.

There were nine major conflict issues for which there were few, or no, records of the use of scientific literature, six of these in the 'Fisheries' category, two relating to 'Fish Stocks' and one 'Environmental' conflict issue. Four of the issues were shared between two or more stakeholders whilst the remaining five were particular to one stakeholder group.

The issue of loss of earnings from the fishery was common to all three 'fishery' stakeholders but appeared to be poorly served by the scientific literature. Similarly, concerns over the issues of reduced value of catch and loss of aquaculture stock were shared between recreational and commercial stakeholders but with little associated scientific literature. The same was true for reduced fish catchability, reduced capital value of fisheries and of increased recurrent costs for recreational stakeholders and for the issues of loss of stocked fish and reduced stock through lowered production for commercial fishermen. Concerns over the disturbance effects of Cormorant scaring and shooting were shared by both commercial and nature conservation stakeholders but, again, there appeared to be little supporting scientific literature (see section 3.7.3).

Conflict issue	Recreational		Commercial		Aquaculture		Nature conservation	
	conflict	science	conflict	science	conflict	science	conflict	science
(1) FISHERIES								
Reduced catch	46	30	33	13	18	11	1	20
Loss of stocked fish	35	26	12	4	17	14	1	9
Reduced value of catch (damage)	23	7	11	3	7	3	0	4
Removal of fish from nets	2	0	6	4	0	2	0	3
Damage to fishing gear	0	0	6	1	0	3	0	3
Reduced catchability (stress/behaviour)	8	4	7	1	4	1	0	1
Loss of earnings from the fishery	17	0	22	2	17	8	0	4
Reduced capital values of fisheries	13	1	8	2	9	11	0	1
Reduced fishing tackle sales	1	0	4	1	0	0	0	0
Increased recurrent costs	18	0	5	3	5	1	0	1
Loss of employment	0	0	8	2	4	0	0	0
(2) FISH STOCKS								
Reduced stock - lowered production	48	37	19	5	14	13	2	24
Effects on popn. dynamics/community structure	46	32	17	15	7	10	2	16
Threats to endangered fishes	33	14	6	1	0	7	1	8
Vectors of diseases/parasites	2	4	1	6	3	10	0	4
Loss of juvenile fish - lowered recruitment	38	23	17	3	13	10	2	7
Loss of spawners	33	18	13	2	3	8	1	7
Loss of aquaculture stock	7	1	7	0	12	17	1	2
(3) OTHERS								
Eutrophication	0	0	1	1	2	7	1	7
Interactions with other birds	1	0	3	2	3	7	1	8
Scaring/shooting disturbance	2	0	5	1	5	7	13	6
Lead contamination (birds/environment)	0	0	0	1	0	7	0	3
Landscape alteration	1	0	2	0	1	7	0	3
Drowning in fishing gear	0	0	0	1	0	7	2	0
Damage to vegetation/landscape	0	0	7	0	2	7	3	3

Figure 3.12 The number of records for 'major' conflicts and for the use of 'scientific literature' for 25 Cormorant conflict issues in relation to four stakeholder groups. For each stakeholder group, issues with frequent records of both major conflicts and use of scientific literature are highlighted.

Conflict issue	Recreational conflict	Recreational science	Commercial conflict	Commercial science	Aquaculture conflict	Aquaculture science	Nature conservation conflict	Nature conservation science
(1) FISHERIES								
Reduced catch	46	30	33	13	18	11	1	20
Loss of stocked fish	35	26	12	4	17	14	1	9
Reduced value of catch (damage)	23	7	11	3	7	3	0	4
Removal of fish from nets	2	0	6	4	0	2	0	3
Damage to fishing gear	0	0	6	1	0	3	0	3
Reduced catchability (stress/behaviour)	8	4	7	1	4	1	0	1
Loss of earnings from the fishery	17	0	22	2	17	8	0	4
Reduced capital values of fisheries	13	1	8	2	9	11	0	1
Reduced fishing tackle sales	1	0	4	1	0	0	0	0
Increased recurrent costs	18	0	5	3	5	1	0	1
Loss of employment	0	0	8	2	4	0	0	0
(2) FISH STOCKS								
Reduced stock - lowered production	48	37	19	5	14	13	2	24
Effects on popn. dynamics/community structure	46	32	17	15	7	10	2	16
Threats to endangered fishes	33	14	6	1	0	7	1	8
Vectors of diseases/parasites	2	4	1	6	3	10	0	4
Loss of juvenile fish - lowered recruitment	38	23	17	3	13	10	2	7
Loss of spawners	33	18	13	2	3	8	1	7
Loss of aquaculture stock	7	1	7	0	12	17	1	2
(3) OTHERS								
Eutrophication	0	0	1	1	2	7	1	7
Interactions with other birds	1	0	3	2	3	7	1	8
Scaring/shooting disturbance	2	0	5	1	5	7	13	6
Lead contamination (birds/environment)	0	0	0	1	0	7	0	3
Landscape alteration	1	0	2	0	1	7	0	3
Drowning in fishing gear	0	0	0	1	0	7	2	0
Damage to vegetation/landscape	0	0	7	0	2	7	3	3

Figure 3.13 The number of records for 'major' conflicts and for the use of 'scientific literature' for 25 Cormorant conflict issues in relation to four stakeholder groups. For each stakeholder group, issues with frequent records of major conflicts and infrequent records for the use of scientific literature are highlighted.

3.4 Methodological limitations and difficulties

REDCAFE participants experienced several difficulties in producing this synthesis of Cormorant conflict issues. Understanding these difficulties is important for two reasons. First, they highlighted the difficulties involved in creating and managing dialogue between stakeholders from many countries and diverse backgrounds. Second, they highlighted several of the 'non-biological' issues at the heart of many people-wildlife conflicts and attempts to resolve and/or manage them. The major difficulties and limitations faced during this synthesis process are described below.

First, at a national level, the case studies provided may not be fully representative. This was almost certainly the case for France, a country with an important wintering population of Cormorants and widespread recreational and aquaculture interests. It is clear that the six case studies reported for France did not represent the complete situation here. Although the available conflict case studies refer to lakes and coasts, the majority of conflicts are thought to occur on rivers (with angling interests) and fish ponds (with aqauculture). This disparity was thought to be due to the interpretation of the term 'case studies'. In France, case studies were considered to be those that had been the subject of scientific investigation and these, as reported in this Chapter, were on lakes or coasts. However, the 'true picture' for France would involve most conflicts occurring at fish ponds followed by rivers, with relatively few conflicts on lakes and practically none on the coasts.

Second, perceptions of conflict may depend on the 'organisational level' of stakeholders, thus an institutional view may not reflect that of people affected by conflicts at first hand. The difficulty was therefore to determine at what 'level' contact should be made with local stakeholders. Given time constraints, selection of the most appropriate stakeholders to provide information for this synthesis was made on a national basis by REDCAFE participants on the basis their own knowledge and experience. However, in this task, REDCAFE participants also benefited greatly from invaluable discussions with stakeholders themselves.

Third, there were general difficulties in language. The information spreadsheet (Figure 3.1) was originally devised and written in English but was translated if necessary. There were also misunderstandings over the nature of the form. Provision of information thus often involved close dialogue between REDCAFE participants and stakeholders. As one REDCAFE participant stated: "for me it has been difficult to get the feedback (from stakeholders) wanted. Nobody outside our little group seem to understand the (spreadsheet) schemes, and the only way to obtain answers was to contact organisations and individuals directly…"

Fourth, many REDCAFE participants experienced considerable difficulties in getting responses back from stakeholders. Participants were asking stakeholders to provide information, and to spend time doing so, with no guarantee of confidentiality or of how the information would be used. This raised issues of trust. However, through close dialogue with stakeholders, REDCAFE participants often partly guided them through the spreadsheet and partly interviewed them. Although this was time consuming, it has built a degree of trust between many REDCAFE participants and stakeholders and will allow them to work more closely together on Cormorant-fisheries management issues in the future. It was thus clear from this experience that future work should include more appropriate social science methodology both to improve information and knowledge transfer and to promote the interdisciplinarity essential for addressing Cormorant-related conflicts across Europe.

Fifth, the conflict synthesis spreadsheet (Figure 3.1) was subsequently considered by REDCAFE participants to be a rather simplistic device for obtaining information from stakeholders. Nevertheless, this was the first attempt to allow stakeholders to articulate their knowledge and understanding on Cormorant conflict issues across so much of Europe. However, the extent to which fishermen's knowledge can be articulated has implications for how other stakeholders understand these issues (an important aspect of co-management, see 3.7). This is particularly true in relation to organising this knowledge into a format that can be used for management purposes and to make sure that fishermen retain equitable control over the knowledge base (Wilson 2000). Wilson differentiates between 'discursive' knowledge (i.e. that which is shared and expressed) and 'tacit' knowledge (i.e. that which is not easily expressed) and asks: "To what degree is the knowledge that various stakeholder groups have about the resource tacit or discursive knowledge?". Discussions are complicated further when we consider the important role that tacit knowledge plays in fishing. Wilson (citing Pálsson, 1995; 2000) argues that fishermen's knowledge is inextricably linked to the skills they have in fishing and their immersion in the everyday fishing world. Thus, fishermen may find it hard to explain what they know, and why they know it, because the knowledge associated with their skills is often innate and thus not easily expressed. Thus, while information provided by stakeholders for this synthesis was based largely on discursive knowledge, time and logistical constraints meant it was probably not possible to record much, if any, tacit knowledge. However, knowledge of this type was experienced and recorded during more lengthy discussions with stakeholders in relation to the specific case study of recreational angling described in Chapter 6.

Sixth, quantifying Cormorant conflicts in this synthesis was relatively crude, involving a small number of broad 'magnitude' codes (Figure 3.1). In many ways this was an inevitable consequence of the project's relatively short time scale, the language and communication difficulties described above, and the simple, standardised method for REDCAFE's necessarily broad-brush approach. However, the broad magnitude codes were, to some extent at least, open to interpretation and none of the records provided could be checked.

Seventh, the status coding for literature references (Figure 3.1) was similarly not always easily interpreted by stakeholders. For example, Stakeholders experienced some difficulties in categorising particular sources of information as 'scientific literature', a term open to interpretation. Although in many countries a scientific publication is synonymous with one that has been externally refereed, this was not always the case for every country. Obviously, although such national differences in interpretation are interesting and should be borne in mind, no attempt was made to alter in any way the records provided by stakeholders for this, or any other aspect, of the conflict synthesis spreadsheet.

One further issue requires discussion. At this stage it would be tempting for REDCAFE participants (i.e. stakeholders with training, or familiarity with western science) to say things like "there was no guarantee that other stakeholders were providing accurate information or even being truthful and none of the information provided for this synthesis was tested by independent means." However, we have to be careful: accuracy and truth are subjective terms and are also open to interpretation. In social terms, testing whether somebody is telling the truth (based on your own values and beliefs) is in danger of being ethnocentric and not necessarily useful. It was very clear that stakeholders were willing to spend time contributing to this synthesis and that they appeared genuinely interested in the process and in REDCAFE in general. Thus the information included in this synthesis was considered to give a good impression of stakeholders' perceptions of Cormorant conflicts on a pan-European scale. Furthermore, the present synthesis was more comprehensive than any previous one.

3.5 *General synthesis of Cormorant conflicts*

3.5.1 Overview

This synthesis was based on information provided for 235 conflict cases across 24 European countries. It was an attempt to report the concerns of numerous stakeholders and allowed REDCAFE to consider Cormorant conflicts (see footnote #2) in terms of human interests:

"A list of cormorant-fisheries conflict situations will, of course, reflect the perceived problems of the person making the list. Thereby I hope to state that any list may to some extent be subjective. I think of cormorant-fisheries matters as a conflict between human interest groups. The birds and the fish they hunt are the subjects of the conflict, not a part of it. I would list the conflict situations based on the human stakeholders. Realising that the conflict is a matter of human interests may turn out to be the most productive way when attempting to come up with solutions."
(Christian Dieperink, Danish REDCAFE participant)

Cormorant conflicts were reported from a wide variety of habitats and fishery types (Table 3.1). About 30% of case studies included in this synthesis related to rivers, around 20% each to lakes, freshwater aquaculture ponds and coasts and around 10% to coastal aquaculture sites. Although it was not possible to determine whether this spatial distribution reflected the true 'availability' of these habitat types across Europe, it demonstrated the widespread geographical distribution of conflicts. Furthermore, conflicts were reported by four different stakeholder groups representing recreational, commercial and nature conservation interests and covered a wide variety of fishery types, suggesting that the nature of conflicts will also differ on a geographic scale.

Although Cormorant conflicts were reported from all 24 countries surveyed, they appeared to be most prevalent in 13 'main' countries (Table 3.2). Again this picture could have been influenced by the intensity of reporting in different countries and this was not investigated (though see 3.4 for France). Nevertheless, it was clear that stakeholders from Sweden and Finland in the north, to Spain, Portugal and Italy in the south, and from the United Kingdom in the west, to Poland and Lithuania in the east, reported numerous conflicts with Cormorants.

3.5.2 Waterbodies

Cormorant conflicts were reported mostly from lower altitudes (< 500m, Table 3.3). Most, if not all, Cormorant colonies are at altitudes of < 500m and all the major ones are very close to sea level. It is thus perhaps not surprising that summer conflicts were reported at these lower altitudes. Conflicts also occurred during the winter months (i.e. October-March, see below), and at this time birds often forage on freshwaters that do not normally freeze (Marion *et al*., in Hagemeijer & Blair 1997a). Thus, although foraging-site choice will depend ultimately on prey abundance and availability, the relationship with altitude was presumably due, in part at least, to minimum winter temperatures and the risk of ice conditions on foraging grounds (e.g. Van Eerden & Munsterman 1995) particularly those at higher altitudes.

Within river systems, Cormorant conflicts on a pan-European scale, showed similar distribution patterns to those documented for birds on individual river systems (e.g. France: Marion 1995; Scotland: Richner 1995; England: Davies & Feltham 1997). Cormorant conflicts were very much restricted to the lower and middle reaches, and hence relatively wide (i.e. 10-50m) stretches, of rivers (Table 3.3). Similar, restricted distribution patterns were clear for conflict cases on the coast. The ten countries reporting conflicts with Cormorants in coastal habitats (Figure 3.5c) were all those that had access to shallow (< 50m deep) inshore coastal water (see Figure 1B in van Eerden *et al*., 1995).

Overall, most conflict cases were reported on nutrient-rich (i.e. eutrophic) waters, particularly freshwater aquaculture ponds, lakes and coasts (Table 3.3). Across European waters, there was a general increase in nutrient levels (phosphates and nitrates) during the last century (de Nie 1995). It was not possible to determine whether the spatial distribution of the conflicts reported here reflected the true 'availability' of these eutrophic waters across Europe. However, the information supported the idea that Cormorant distribution is, in part at least, determined by the nutrient status of these waters. For example Cormorant density on Swedish lakes is closely correlated to the total phosphorous levels there (Engström 2001) and similar patterns are evident for Swiss lakes (Suter 1995). In Sweden, lake productivity (as measured by total phosphorous) were also be considered a surrogate measurement for fishery yield (Engström 2001), supporting the idea of a relationship between nutrient status and fish populations. On a wider scale, there is a general pattern amongst fish populations to increasing eutrophication (de Nie 1995). This trend is towards unstable fish populations dominated by small, shoaling, short-lived, early-maturing fish species such as Perch (see Table 3.5 for scientific names), Ruffe, Smelt *Osmerus eperlanus* and/or cyprinids, mainly Roach and Bream (de Nie 1995). Such species are commonly recorded in the diet of Cormorants across Europe (see below) and, at the landscape scale, this is associated with a preference for eutrophic lakes that support high densities of such fish species (Suter 1997). In France, larger concentrations of Cormorants occur on artificial and eutrophic lakes established on rivers for electricity production and water resource management (Marion 1994). Even at the pan-European scale, information provided by stakeholders suggested that Cormorant conflicts are often associated with eutrophic waters, particularly lakes, freshwater aquaculture ponds and on coasts.

3.5.3 Cormorant distribution, seasonality and abundance

Two species of cormorant were recorded in conflicts (Figure 3.6), the Great Cormorant (*Phalacrocorax carbo* – both the Atlantic *P.c. carbo* and continental *P. c. sinensis* races) and the Pygmy Cormorant (*P. Pygmeus*). The geographical distributions of both species, as recorded in conflicts, followed closely their known breeding and/or wintering distributions. It was clear from the information provided that stakeholders were aware of the presence of both races of Great Cormorant in many countries, providing more detailed records than are available in many published accounts (cf. Marion *et al*. in Hagemeijer & Blair 1997a). Indeed, both *carbo* and *sinensis* races were recorded in conflicts in England, Wales, France, Spain and Portugal and *sinensis* plus occasional *carbo* were recorded in Sweden and Denmark. Similarly, Pygmy Cormorants were recorded mainly in Bulgaria and Greece but also in Israel (though in association with *sinensis* birds), countries within their known distribution (Michev & Weber in Hagemeijer & Blair 1997b).

With a population of around 13,000 pairs, Pygmy Cormorant is classified as Vulnerable in Europe (Species of European Concern category 2), as its global population is concentrated in Europe and this is in decline (Tucker & Heath 1994). Drainage and hydrological disruption of large wetlands, disturbance and shooting are considered the main threats, and it is the subject of a European Species Action Plan, adopted by the European Union and the Council of Europe (http://europa.eu.int/comm/environment/nature/directive/birdactionplan/phalacrocoraxpygmeus.htm). This promotes protection from hunting and positive management of wetlands as critical to the species' recovery. The conservation status of the Great Cormorant is considered to be Secure (Tucker & Heath 1994), now that populations have recovered sufficiently from earlier declines. This recovery resulted in the removal of the *sinensis* race from Annex I of the EU Birds Directive (79/409) during the early 1990s.

The Pygmy Cormorant is listed on Annex I of the EU Birds Directive, requiring Member States to protect wetlands and ensure the survival and reproduction of the species, particularly (though not exclusively) through the designation of Special Protection Areas. Member States are also required to take similar measures for Great Cormorants (as one of an assemblage of migratory species) across its breeding, wintering and moulting areas and migration stopover points.

In assessing conflicts with fisheries, the synthesis has not differentiated those involving Great Cormorants from those involving Pygmy Cormorants. Clearly, given the different population trends and conservation priority afforded to each species, management approaches will differ, with the range of options for conflicts with Pygmy Cormorants likely to be less than for Great Cormorant. Shooting Pygmy Cormorants is illegal in all range states.

Information on the seasonality of Cormorant conflicts was also available (Figures 3.8 and 3.9). Again, these patterns fitted closely with the known seasonal movements of birds across Europe that are roughly along a north-south axis (Reymond & Zuchuat 1995). Most continental *sinensis* Cormorant populations, breeding in northwest Europe and the southern Baltic, are completely migratory. Wintering quarters occur all over the Mediterranean basin, along the Atlantic shore and also inland. Lower numbers also winter along the southern North Sea close to breeding grounds. Birds from the Netherlands mainly winter in France and the western Mediterranean while many Danish birds winter from the Swiss lakes south through Italy and beyond (van Eerden *et al*., 1995). Traditionally, Atlantic *carbo* Cormorants are less migratory but birds may travel as far south as the French Atlantic coast or the west coast of the Iberian Peninsula (van Eerden *et al*., 1995). As a consequence, the broad pan-European picture of Cormorant conflicts has three elements. First, winter (October-March) conflicts in those countries where birds overwinter, either towards the north west or south east. Second, summer (April-September) conflicts, presumably involving breeding birds, in the Netherlands and almost all countries bounding the Baltic. Third, conflicts throughout the year in the 'centre' of Europe (Denmark, Germany and the Czech Republic), presumably involving both breeding birds and others overwintering there from the north. In Germany, most conflicts in summer were reported in the northern regions where the main breeding colonies are located (i.e Baltic Sea coast), while most winter conflicts were reported from the central or southern (i.e. inland) regions.

At a local scale, Cormorant abundance increases with water surface area as shown for birds using Czech Carp ponds over 10ha in area (Musil & Janda 1997). Conflict case records showed a similar pattern on a pan-European scale for stillwater lakes, freshwater aquaculture ponds and coasts (Figure 3.7). Indeed, water surface area explained 56% of the variation in maximum Cormorant numbers across these habitats. It was clear from the information provided, that there was no relationship between water surface area and Cormorant numbers on rivers. Although there may be a biological explanation for this finding, it may also be due to differences experienced in estimating water surface area. Estimating area for standing waters and coasts is relatively straightforward, however stakeholders estimated the area of rivers in different ways: some were calculated for study sections (i.e. length x average width = water surface area), others were measurements of total catchment area. Nevertheless, even when these catchment areas were excluded from analysis, the relationship between Cormorant numbers and surface area of rivers appeared to be different to that for other habitats. Clearly, such apparent differences require further investigation, particularly as information collected to date suggests that average Cormorant density on rivers is significantly higher than that in other habitats (Table 3.4). Furthermore, particularly in small streams, Cormorants are sometimes considered to exert disproportionately high predation pressure on populations of threatened fish species (e.g. Grayling, Nase, Marbled Trout, see Table 3.5 for scientific names). For example, some Slovenian angling clubs are considering giving back to the Government their management rights for rivers under high predation pressure from fish-eating birds. This is because they have become frustrated by regularly stocking streams with costly juvenile indigenous fishes (which is mandatory) just to apparently feed Cormorants and Grey Herons (*Ardea cinerea*).

3.5.4 Fish species involved in conflicts

There have been a large number of Cormorant dietary studies across Europe. For example Marquiss *et al.* (1998) summarised the results of 37 European studies conducted in a variety of freshwater and marine habitats. Although these studies recorded at least 77 species of fish as Cormorant prey, only about a third of these species were reported regularly. However, within habitats, different studies have shown similar prey spectra despite different diet assessment methods (see Carss *et al.* 1997 for methodological review). In the sea, Cormorants mainly feed on bottom-dwelling fishes, wrasses (Labridae) and cods (Gadidae) over rocky and weed-covered substrates and flatfish (e.g. Pleuronectidae) over soft substrates, and Eel (see Table 3.5 for scientific names) and Eelpout in a variety of areas. Sometimes small, shoaling, midwater fishes such as herrings (Clupeidae) are taken. In estuaries, Flounder, Brown Trout, Eel and Saithe are most frequent prey and Sand-smelt, Mullets (Mugilidae) and Sea Bass are important in southern Europe. On rivers, diet varies according to stream characteristics. Salmonids are the main prey in fast-flowing streams, cyprinids in slower, deeper ones and flatfish in the lowest reaches. On lakes by far the commonest recorded prey are Roach, Perch and Eel. Other cyprinid prey in nutrient-rich lakes include Bream, Rudd and Tench, other percids, notably Ruffe and Pikeperch. Finally, Cormorants frequently use waters stocked artificially for recreational angling (Brown and Rainbow Trout) as well as Carp aquaculture ponds.

These dietary patterns were also evident in the information provided by stakeholders in the present synthesis (Table 3.6). A wide variety of species were recorded in relation to coastal conflicts, these included many of the fishes mentioned above but also a high proportion of salmonids, perch and pike. Although not considered truly marine species, these fishes also occur in brackish waters such as the Baltic Sea and many of the coastal conflicts recorded in this synthesis were from the surrounding countries, Finland and Sweden but also Estonia and Poland (Figure 3.5c). As expected from the dietary summary of Marquiss *et al.* (1998), cyprinids and salmonids were the main groups of fish recorded by stakeholders in relation to Cormorant conflicts on rivers. Similarly cyprinids, especially Carp, plus some salmonids, Perch and Pike were involved in conflicts at freshwater aquaculture ponds. Many conflicts were reported at Carp ponds throughout Europe and these sites are considered highly attractive to Cormorants in places such as the Czech Republic (Musil *et al.* 1995), Bavaria, southern Germany (Keller *et al.* 1997), and France (Marion 1997). Indeed such farms are thought to have played an extremely important role in the increase of Cormorant numbers across much of Europe, particularly in the east (e.g. Belarus: Samusenko & Kozulin 1997 Bologna p75). A small group of fishes including mullets, sea basses and sea breams were involved in conflicts at coastal, often extensive lagoon, aquaculture sites of southern Europe (Figure 3.5e).

These striking similarities between previous dietary studies and records of fish species involved in conflicts as documented by stakeholders in the present synthesis, are perhaps not surprising. This is because many, probably the vast majority, of Cormorant dietary studies have been instigated as a response to concerns over the birds' potential damaging effects at fisheries (Marquiss *et al*. 1998). Nevertheless, there were strong associations between particular fish groups recorded in conflict cases and particular habitat and fishery types. Many of the fish species involved in conflicts have high commercial value, particularly those farmed at aquaculture sites or those targeted of coastal fishery exploitation. However, the list of recreational angling quarry species was lengthy (Table 3.5) and it is more difficult to put monetary value on them. Nevertheless, angling quarry species do have commercial value, albeit not in the same sense as do those harvested by aquaculturists and commercial fishermen (see 3.5.5).

3.5.5 Financial information

REDCAFE participants experienced several problems in relation to the disclosure by stakeholders of economic information in relation to conflicts. These are discussed in detail in section 6.5.4 (Box 6.7). Nevertheless, financial information was provided by fishery-related stakeholders for 105 conflict cases, approximately 45% of those recorded in the present synthesis. It is interesting, but perhaps not surprising, that nature conservation stakeholders did not provide any financial information in relation to any of the conflict cases they recorded.

Fishery stakeholders provided information on the annual financial turnover in their fishery system and the turnover loss due to Cormorants (Table 3.7). In around 30% of cases, stakeholders categorised their turnover values as 'actual' (e.g. based on licence payments, fish prices or catch statistics), in contrast only 7% of their loss values were recorded as 'actual'. This disparity presumably highlights the difficulties in quantifying financial losses to Cormorants. Most values for loss (either provided by stakeholders or by REDCAFE participants) were thus estimates, of unknown accuracy, sometimes based on crude calculations of Cormorant numbers, diet, daily food intake and residence time at the fishery. As a consequence, care must be taken when interpreting the financial information collected in this synthesis.

Nevertheless, the 105 conflict cases gave a cumulative total for annual turnover of about 154 million euro and associated losses to Cormorants were given at about 17 million euro, an overall loss of 11%. However, there were significant differences in the scale of financial losses reported by the relevant stakeholders for different habitats and fishery types: recreational anglers predominantly on rivers, freshwater pond aquaculturists and commercial fishermen on lakes and coasts (Table 3.8). Truly commercial (i.e. 'income-producing') stakeholders (aquaculturists and both types of commercial fishermen) might be expected to provide the most accurate financial values because of the commercial nature of their businesses. However, perhaps against expectations, all three groups independently were remarkably consistent in their views on relatively low financial losses due to Cormorants, recording average values of 9-12% of annual turnover. This is not to say that all financial losses recorded by these stakeholder groups were small: around 2% of aquaculturist, 13% of commercial freshwater fishermen and 31% of commercial coastal fishermen recorded losses greater then 50% of the annual financial turnover in their fishery.

In contrast to commercial stakeholders, recreational anglers recorded considerably higher financial losses due to Cormorants (Table 3.8), averaging 57% of annual turnover. Furthermore, in 43% of cases, anglers recorded financial losses greater then 50% of the annual turnover in their fishery. Although the disparity between commercial and recreational stakeholders' perceptions of financial losses due to Cormorants was clear from the information provided, the explanation for it was not. We do not know how recreational anglers calculated/estimated their financial losses to Cormorants and thus can not draw too much by way of conclusion from this. It could be that because anglers pay to catch fish from their own disposable income, as opposed to commercial fishermen to whom such costs would be a financial investment in an income-producing venture, they may value the cost of their quarry more highly. For example, the cost of angling includes the purchase of equipment, supplies, meals, lodgings, transport and the right to fish in certain locations as well as expenditures in time (Conover 2002). Alternatively, the disparity may have less to do with variations in the value of fish and could be a true reflection of higher levels of Cormorant predation at the fisheries (predominantly rivers) exploited by recreational anglers providing information for this synthesis. A third alternative is that anglers were doing crude calculations of financial losses based on the number of Cormorants, their Daily Food Intake and the cost of restocking (or some other factor).

From the information recorded in this synthesis, it is clear that the highest perceived financial losses due to Cormorants are related to recreational activities rather than to commercial ones. This may have important implications in terms of quantifying rigorously the losses due to Cormorants and any possible conflict- and/or fisheries-management actions taken. However, it is important to recognise that although financial losses to commercial stakeholders appear considerably smaller than those for recreational ones, this does not mean that their conflicts with Cormorants are any less 'important'. Commercial stakeholders are trying to produce income and long-term financial security from their fisheries, these are often traditional and have high local and national cultural value, and recorded financial losses in some cases represent a high proportion of the annual turnover of the fishery. Whatever the reasons for the higher recorded financial losses at recreational fisheries, the apparent disparity with commercial ones certainly deserves further study. Finally, in relation to economic losses due to Cormorants, any estimates made may be influenced by perceptions of the problem. Conover (2002) believes that such 'wildlife damage' can alter people's perceptions about wildlife, particularly when the damage has exceeded stakeholders' tolerance. However, he questions the accuracy of many local perceptions about wildlife damage, particularly as the "consciousness" of a species can influence these perceptions: highly visible species often taking most of the blame for damage. This fact is particularly true for Cormorants (e.g Bezzel 1997).

3.5.6 Cormorant conflicts: issues and their magnitude

Stakeholders provided information on specific conflict issues in relation to each case study reported. Data sheets listed 25 potential conflict issues based on initial discussions between REDCAFE participants. Although stakeholders were free to add new conflict issues to this list, none did. Thus, the conflicts included in this synthesis apparently covered all the issues concerning stakeholders taking part. Conflict issues fell into three broad categories, being related to 'fisheries' or fish stocks' or more general 'environmental' issues (Figure 3.1). Independently, both commercial and aquaculture stakeholders categorised the conflict issues important to them in a very similar manner (Table 3.9): the majority was related to fisheries, about 36% to fish stocks and less than 10% to environmental issues. Recreational stakeholders categorised conflict issues differently, though not significantly so: the majority was related to fish stocks, over 40% to fisheries but only 1% to environmental issues. However, nature conservationist stakeholders categoried conflict issues very differently to the three other, fishery-related, stakeholder groups: the majority of recorded conflicts were related to environmental issues, around 30% to fish stocks and around 6% to fisheries issues.

In relation to specific conflict issues, nine were most commonly cited as being major conflicts for stakeholders (Figure 3.10). For both aquaculturists and commercial fishermen the issue of **reduced catches** was most important whilst for both recreational anglers and nature conservationists the most important issue was **reduced fish stock through lowered production**. Recreational stakeholders also most frequently reported conflicts over reduced catches and **effects on fish population dynamics and community structure**, an issue that was also important to nature conservationists. Both aquaculturists and commercial fishermen were concerned over **loss of earnings from the fishery**, the former stakeholders cited conflicts over **loss of stocked fish** and the latter ones cited conflicts over reduced stock through lowered production. Finally, nature conservationists also frequently recorded concerns over **loss of juvenile fish and lowered recruitment**, **scaring/shooting disturbance**, **drowning of Cormorants in fishing gear** and **damage to vegetation and landscape**. Thus, although stakeholder groups frequently shared concerns over specific major conflict issues, some concerns were specific to particular groups. Most importantly, nature conservationists cited broader 'environmental' issues more frequently than did the three fishery-related stakeholder groups.

All three fishery-related stakeholder groups recorded most of the remaining 25 conflict issues as being 'major' ones for some cases (Figure 3.10), although not as frequently as those issues discussed above. In contrast, nature conservation stakeholders seldom recorded fisheries issues as being major conflict issues, the exceptions being reduced catches and loss of stocked fish.

Overall, this synthesis has shown considerable, and consistent, similarities between the opinions of both income-producing stakeholder groups involved in fisheries: commercial fishermen and aquaculturists. Although recreational anglers shared many of the concerns of these other fishery-related stakeholder groups, they also recorded some different major conflict issues. However, the biggest differences were between fishery-related stakeholders and nature conservationists. Nature conservationists, in general, were most concerned with wider conflict issues. They recorded concerns over fish stocks at the 'ecosystem level' (e.g. those relating to reduced stocks, productivity and recruitment, and to population dynamics and community structure) and broader 'environmental' issues such as disturbance, damage to vegetation and landscape, and the drowning of Cormorants in fishing gear.

3.5.7 Cormorant conflicts: information sources used by stakeholders

Stakeholders provided over 3, 500 records of the type of information they used to inform themselves about Cormorant conflict issues (Table 3.10). Although most records were categorised as 'popular', this category included a whole range of diverse sources (Table 3.10). From a purely scientific perspective, 'popular' is sometimes viewed as a derogatory term by scientists to whom the most 'useful' knowledge is that published in the peer-reviewed scientific literature. Overall, only 15% of information sources used by stakeholders were assigned to the scientific literature. For all stakeholder groups, scientific literature was the least frequently recorded information source[6]. However, analysis showed that a further 16% of the 'popular' literature references was obviously science-based (Table 3.11). Nevertheless, the importance of 'popular' sources of information to all four stakeholder groups contributing to this synthesis was clear (Table 3.10). All groups consistently used this source more frequently than they did any other.

For natural scientists, many of whom have been required to deliver solutions for environmental problems such as those involving Cormorant and fisheries, the findings of the

[6] Though see nature conservationists' sources of information in Table 3.9

present synthesis represent a challenge. Perhaps most important is the challenge to their traditional hierarchy of 'useful' knowledge (i.e. scientific literature > grey literature/reports > popular articles). It was clear that this hierarchy is inappropriate to Cormorant-conflict issues, at least, because scientific literature was the least frequently cited source of information for all stakeholder groups. However, it is interesting to note that most, if not all, Cormorant-related management and conservation policies are 'science-based' and so science will continue to be an essential element of future efforts to resolve and manage Cormorant-fisheries conflicts.

Nevertheless, for several specific conflict issues, different stakeholder groups claimed to be informed by scientific literature yet considered the magnitude of such conflicts to be very different. It would be interesting to compare the science used by recreational and nature conservation stakeholder groups and who come to such different views on the magnitude of conflicts (Figure 3.11). Do these groups interpret the same science differently based on their own knowledge and experience or do they have access to different pieces of scientific information? It is clear that there is a need for better dissemination of scientific information and for better understanding of the limitations of science.

3.5.8 Concluding remarks

REDCAFE has attempted to synthesise, for the first time, key stakeholder groups' views and perceptions on Cormorant conflicts with fisheries (and, to a lesser extent, with the wider environment) in a standardised way across Europe. Despite methodological limitations (see 3.2, 3.4), many clear pictures emerged and these have been discussed above. Many of the patterns emerging from this synthesis are intimately linked to the ecology of Cormorants and these important links are examined in Chapter 4 of this report. Just as importantly, collecting and collating information for this synthesis has allowed REDCAFE participants (primarily natural scientists or those working closely with them) to forge links with local stakeholders experiencing conflict issues at first hand. Through these discussions it was clear that conflicts with Cormorants are not the only ones facing many fisheries and environmental stakeholders. The following section (3.6) therefore provides wider context to the Cormorant –fisheries conflicts discussed above.

3.6 Cormorant-fisheries conflicts in a wider context

To better understand the nature of Cormorant-fishery conflicts it is useful to consider other internal and external issues leading to conflicts over fisheries resources. These issues, both environmental and social, are often complex and closely linked. Environmental conflicts over resources, including those involving fisheries, usually involve numerous issues (Daniels & Walker 2001). This appeared true across Europe: many of the stakeholders who provided specific information on Cormorant conflict issues for the present synthesis also described other issues, fears and concerns affecting their businesses or recreation. Many stakeholders also recorded concerns over the creation of sustainable[7] fisheries and the development and implementation of effective, 'holistic' fisheries management programmes. Some of the other wider concerns affecting fishermen contributing to the present synthesis related to ownership and property rights and to changes in market economies.

Until recently, academic contributions to fisheries management have usually been dominated by those from biologists and economists whose understanding are influenced by their own discipline (Couper & Smith 1997). However, policy makers are now also paying

[7] There is often no common understanding among stakeholders of what is meant by 'sustainable'. Some stakeholders use 'sustainable' purely as an economic term, some as a term to describe the process by which resources are not over-harvested, others use it in relation to 'sustainable development'.

attention to the human element in fisheries management by including an appreciation of fishermen's perceptions (see 3.7) and territorial rights. Often, these are long-held: "Many fishermen have deeply embedded beliefs in a right to fish, a strong sense of territory, and a view which, in Europe for example, goes back to the seventeenth century when the common property nature of fish stocks was enshrined in the early stages of development of the modern law of the sea. At that time stocks were plentiful and belonged to no one until caught" (Couper & Smith 1997).

One overlying issue affecting all fisheries stakeholders, and others, is the long-held concern over increasing pressure on limited aquatic resources. Symes (1996) notes that overfishing has been acknowledged by fishermen, administrators and scientists for over a hundred years and that by the mid-1990s the Food and Agriculture Organisation had estimated that some 70% of the world's fish stocks were overfished. Fishing takes places in uncertain and diverse environments, including both the biological and the social setting in which these activities are undertaken (Acheson 1981). This not only relates to commercial fisheries but also to aquaculture, another income producing fisheries activity, (see Noakes *et al*. 2003) and to recreational angling (where social settings seem particularly important, see Chapter 6). Thus, attempts to create sustainable fisheries must extend to all aspects of the fishery system, from the fish stocks and ecological considerations to the social, cultural and economic structure of fishing groups and management institutions (Symes 1996; Charles 2001). Current Cormorant-fishery conflicts must therefore be viewed as but one of many diverse issues within the complex context of sustainable fisheries.

In order to incorporate these diverse issues, future fisheries policies will probably be set within the wider context of environmental management (Symes 2001). However, fisheries management must also take into account the "uncertainty factor" resulting from the behaviour of fishermen (individually and collectively through organisations) which is increasingly influenced by socio-economic and political marginalisation and increasingly insecure livelihoods (Symes 2001)[8].

Finland provides an example of the inherent conflicts between policy makers and local people over access rights and decision-making within fisheries (Box 3.1). In some cases, fisheries are also affected by decisions taken by others over which they have no control. One such case identified frequently to REDCAFE participants involved changes to market economies. The fishery sectors of many post-communist countries have encountered serious problems, particularly in relation to privatisation and changes in policy (Vetemaa *et al*. 2000) as the example from Estonia shows (Box 3.2).

Other post-socialist countries have also experienced similar tensions in relation to fishing. Bell *et al*. (2001) note that privatisation of the marketing system in Romania and Lithuania has led to the expansion of black market trading and to overfishing of certain species. There are also considerable conflicts between fishermen and Cormorants in these countries and in others covered by REDCAFE, including Poland and the Czech Republic. Stakeholders' perceptions of Cormorant conflicts in these post-socialist countries thus often appear to be linked to the consequences of major international changes in market economies operating on their fisheries.

Dialogue between REDCAFE participants and stakeholders over Cormorant conflict issues highlighted a range of other environmental and social concerns. These concerns will

[8] In this context, the fisheries co-management concept is discussed further in section 3.7.

have to be acknowledged and incorporated into future attempts to best manage Cormorant-fisheries conflicts. The present synthesis should thus be seen as only the first stage of a process of dialogue, participation and collaboration between natural scientists and local stakeholders. For this process to continue successfully, natural scientists need to better understand the views of stakeholders and devise new ways of working with them. These issues are discussed below in section 3.7.2.

In Finland, fisheries management operates in a hierarchical way on multiple levels, where responsibility is shared between the Government Fishing Authorities (nationally), Fisheries Regions (regionally) and Statutory Fisheries Associations at the local level (Salmi *et al*. 2000). Like land ownership, most inland and coastal water areas are privately owned, typically by a collective (a shareholders' association) represented by the Statutory Fishing Association that embodies the interests of individual shareholders (Vihervuvori 1992 in Salmi & Muje 2001). At the national level, the Ministry of Agriculture and Forestry is responsible for ensuring the sustainable use of water areas for commercial and recreational fishing while the provincial Fishing Authorities implement policy at the regional level (Salmi *et al*., 2000). Fisheries Regions, although not an official branch of Government, act as a forum to encourage co-operative decision-making amongst the various stakeholders.

Local fishermen have an important role to play in the whole organisational system in Finland, particularly as they manage the Fishery Associations (Salmi & Muje 2001). However the potential for conflict exists amongst the stakeholders, particularly between local fishermen and conservationists and scientists. Salmi *et al*. (2000) describe current conflicts involving a fish-eating predator the Saimaa Ringed Seal (*Phoca hispanida saimensis*) but the potential exists for similar conflicts to occur over Cormorants, particularly as their numbers are increasing (Rusanen *et al*. 2003). Current concerns over the conservation of seals have created tensions because local fishermen, the water owners, who feel resentment against 'outsiders' (i.e. in-coming residents, conservationists, scientists). Locals feel that these groups are unable to understand their views because they do not live or work in the area. Importantly, fishermen often consider that these other stakeholder groups do not have the right to interfere. As Salmi *et al*. (2000) point out: "Although most of the commercial fishermen consider that there are no severe problems in the coexistence of the seals and the fishery, research activities and knowledge about conservation are not always appreciated. For instance, some of the fishermen stress that the number of seals is not as low as that stated by the researchers or that the research activities cause more harm to the seal population than the fishery itself…Finnish lake fisheries include strong tensions concerning, especially, the owners' power to decide about fishing and the local way of life in general, which reflect problems of cultural identification". More emphasis on co-management and encouraging dialogue would thus work towards managing fisheries conflicts (Salmi & Muje 2001), including access rights, especially if user groups and other stakeholders such as nature conservationists are given similar and sufficient representation in the decision-making process.

Box 3.1 Finnish case study: access rights and decision-making within fisheries.

In Estonia, there have been considerable changes in the fishing industry since the 1990s (Eschbaum *et al*. 2003). These changes began in the late 1980s with the transition to a market economy following the breakdown of the Soviet economic system and the declaration of independence in 1991 (Vetemaa *et al*. 2000). Following independence, people employed in agriculture and other rural sectors encountered considerable difficulties, as traditional markets (particularly in the former USSR) were lost. In addition, subsidies at the heart of the centrally planned economy, were discontinued leaving the agricultural industry and other linked enterprises unprofitable and often unable to continue. However, at the same time, the fishery sector provided a new area of employment and income generation, particularly as trade liberalisation allowed coastal fisheries to expand their markets (Vetemaa *et al*. 2000).

Vetemaa *et al*. (2000) detail how, during the Soviet period, all water bodies were state owned and commercial fishing was carried out by collectives with produce oriented towards the markets of socialist countries. A number of changes occurred following independence. First, there was a high demand for fish and a rapid increase in exports so that 'first buyer' prices for fish rose dramatically. Second, most fishermen formally connected to collectives were given the chance to privatise fishing boats and gear at low cost. In addition, the oppressive border regime was abandoned allowing fishermen free access to the sea.

The increase in fishermen and fishing activity along Estonia's coast resulted in unsustainable pressure on fish stocks. This pressure has been difficult to control because fishing is now such an important livelihood strategy (Vetemaa *et al*. 2000). Nevertheless, while revenue in the fishing industry was high during the early 1990s, profitability has declined in recent years, exacerbated by increasing costs and declining stocks. Within the troubled fishing industry, the debate over Cormorant predation has highlighted potential conflict, particularly in certain regions such as Väinameri where many commercial fishermen believe that Cormorants are to blame for declining catches (Eschbaum *et al*., 2003).

Box 3.2 Estonian case study: changes to market economies.

3.7 The way forward

3.7.1 From people:wildlife conflict to people:people conflicts

One of the main findings of the present synthesis was the disparity in opinion between nature conservationist stakeholders and those stakeholder groups involved with fishing. Fishing is always potentially in conflict with conservation. Bell *et al*. (2001) believe that inevitable tensions arise from the juxtaposition of the aims of fishing with those of conservation: "In ecological terms humans who fish are predators, albeit ones who respond to and reflect upon their role as predators (whilst) conservation is a set of ideas and measures intended to ensure the maintenance, and possible enhancement, of populations of fauna and flora within their natural habitats". In the Romanian Danube Delta, for example, Bell *et al*. (2001) highlighted how local villagers feel that their needs as local fishermen have taken second place to conservation efforts to preserve wildlife. Part of the problem, they say, is one of values, especially those placed on fish-eating species such as Cormorants. Indeed, Cormorants are commonly held in contempt by fishermen across Europe but are valued by ecologists (Bell *et al*. 2001) as top predators in many aquatic systems.

Goodwin (1998) examined disputes between local people and conservation stakeholders (often with some scientific training). He highlighted how conservation agencies have responded to calls for more equitable involvement in environmental decision-making by promoting local participation[9]. Goodwin (1998) argued that participation can be seen as a desirable process if it shifts the decision-making towards those people who have to live with the consequences of these decisions. By forging links with local people, it is hoped that conservation is made more relevant to local interests and will foster better understanding of environmental issues. Moreover, participation encourages greater dialogue between local people and others involved in environmental management and conservation. Cormorant-fishery conflicts, and others discussed above, are emerging as real conflicts surrounding natural resources management at the pan-European level.

3.7.2 Fisheries co-management

While REDCAFE focused on Cormorant-fishery conflicts, other tensions were recognised by the project as influencing them, and many of these have also been highlighted elsewhere. For example, Pinkerton (1989) discussed several major fisheries conflict issues that also emerged through REDCAFE's dialogue with stakeholders. First, there is often a lack of faith in the ability of governments to solve management problems. Second, fishermen want a voice in the decision-making process to ensure more appropriate and equitable management[10]. Third, there is an evident lack of trust: fishermen feel that governments (or the scientists they commission) have inadequate data and accuse them of interfering while governments can see fishermen as "unrelenting predators". The problem is complicated further when local people feel they cannot trust the reliability of scientific data but nevertheless feel they need to use it in order to be recognised as legitimate stakeholders when dealing with governments and policy-makers. Fourth, there may be conflicts over distribution. For example Pinkerton (1989) notes that fisheries organisations are often factionalised and that "there may be more grounds for conflict than for co-operation among fishermen or fishing groups" Thus, governments and policy-makers may follow the path of least resistance and allocate resources disproportionately to the most powerful lobby group. As well as being an uncertain enterprise, fishing, particularly as a commercial business, is also a competitive one which is aggravated further by the free access nature of many fisheries (Acheson 1981). Thus, many fisheries conflicts are also inherently mixed-motive situations where there is often both motivation to compete and some incentive to co-operate (Daniels & Walker 2001).

Addressing such broad fisheries conflict issues is not trivial and will take time and require trust between stakeholders. Furthermore, in order to avoid inadequate fisheries policies and management systems, that tend to treat the symptoms rather than address underlying problems, broader environmental and institutional factors should be taken into account and fundamental socio-cultural conditions must also be given high consideration (Symes 1996). Rettig *et al*. (1989) suggest that participatory co-management in fisheries, where fishermen and managers co-operate in drafting policy, may facilitate successful management while also offering the possibility of reducing public costs. They suggest that developing fishery regulations, collecting and analysing biological information, the planning process and administration and enforcement are all costly, especially if fishermen suspect that administrators do not understand or take heed of their views. One particular benefit of co-management relates specifically to the formation of relationships (see Pinkerton 1989). She

[9] Details of REDCAFE's conflict case study workshop involving local participation towards the development of Fisheries Action Plans are given in Chapter 6.

[10] For example there are often problems associated with the government allocation of individual fishing quotas. The government perceives these quotas as 'transferable commodities', which will flow freely. However, fishermen do not consider quotas to be a saleable commodity, particularly as the 'right to fish' is intricately linked to culture and community. Many fishermen have difficulty envisaging themselves as a "mobile labour force" that can pull up roots and move away from their communities (Pinkerton 1989).

states: "Once the relationship among actors is changed by establishing an area of co-operation, enlarging co-operation to other management functions becomes easier. This is because co-management is not only about new institutions, but more fundamentally about the new relationships resulting from them. Institutions and legal arrangements can only permit, support, and create incentives for new relationships: it is the new relationships which generate the communication, trust, and willingness to risk innovation which the benefits of co-management actually materialise".

However, the involvement of local people in fisheries planning and decision-making can however be fraught with difficulties. Hampshire *et al.* (in review) state that there is rarely a single "public discourse" and that, in the majority of situations, there is likely to be a range of contested views and values in relation to natural resources. Indeed, the present synthesis has shown a range of contested views and values specifically in relation to Cormorant-fishery conflicts, just one are of concern for fisheries management. It should be noted that this synthesis process has dealt mostly with 'discursive' knowledge and may well have excluded other types of knowledge (e.g. 'tacit', see 3.4). Thus, understanding stakeholders' behaviour (i.e. what people think, what they want, and why they do what they do) is complex because people often say one thing and do another (Hampshire *et al*. in review). If natural resource management is to be sustainable in the long term, an understanding of human behaviour is vital (Hampshire *et al*. in review). The need for collaborative links between natural and social scientists was indeed recognised by REDCAFE participants (see Chapter 6). Furthermore, work for the present conflict synthesis also established an area of co-operation between natural scientists, local environmental stakeholders (fishermen and conservationists) and policy makers.

3.7.3 Future research

A major challenge for natural scientists will be to make their work more relevant and useful to stakeholders. It is clear, from the information provided and discussed throughout this Volume, that there is a high degree of uncertainty surrounding much of the scientific information available on Cormorant-fisheries conflicts. Furthermore, it is clear, from the information presented and discussed in this Chapter, that the 'decision stakes' concerning Cormorant conflicts are high. Decision stakes refer to the 'costs, benefits, and commitments of any kind by the parties involved' (Funtowicz & Ravetz 1991). Under these conditions, traditional academic (so-called 'normal') science (which is often curiosity-driven and orientated to problem-solving), could be augmented by so-called 'post-normal' science. Funtowicz & Ravetz (1991) have "adopt(ed) the term 'post normal' to mark the passing of an age when the norm for effective scientific practice could be a process of puzzle-solving in ignorance of the wider methodological, social and ethical issues raised by the activity and its results. The scientific problems which are addressed can no longer be chosen on the basis of abstract scientific curiosity or industrial imperatives. Instead, scientists now tackle problems introduced through policy issues, where typically, facts are uncertain, values in dispute, stakes high, and decisions urgent." It is not possible to provide a thorough discussion of this topic here but see Tacconi (2000, pp23-41) for further details.

It is clear from the present synthesis that different stakeholders involved in Cormorant-fisheries conflicts have different values and perceptions over these issues. It is also clear from dialogue with other stakeholders that they also view scientists as having different values and perceptions. Thus, scientists should be considered as another stakeholder group involved in the issue of Cormorants and fisheries. Given the recognition that there is no single value or perception (i.e. 'reality') for all the different stakeholders groups within this conflict, it is unrealistic to expect a single method of collecting, analysing and interpreting useful scientific information. The development of a rigorous scientific research programme to address Cormorant conflict issues will have to maintain high scientific standards but will also have to be both relevant to and influential in the decision-making process. Such scientific research could be both academically- and action-oriented (see Tacconi 2000). Action-oriented research would acknowledge that stakeholders, other than researchers, do have considerable relevant knowledge but that their opportunity/ability to undertake research may be limited. Some form of participatory approach may even be possible within some of the academically-oriented research.

Whatever framework future scientific research into Cormorant conflicts takes, it is clear that all stakeholders are concerned over the common issues of quality, health and status of biological resources in wetland systems. Dialogue with stakeholders highlighted several areas where major conflicts were currently poorly served by scientific literature (Figure 3.13). The issue of **loss of earnings from the fishery** was common to all three 'fishery' stakeholders but appeared to be poorly served by the scientific literature. Concerns over the issues of **reduced value of catch** and **loss of aquaculture stock** were shared between recreational and commercial stakeholders but with little associated scientific literature. The same was true for the issues of **reduced fish catchability**, **reduced capital value of fisheries** and of **increased recurrent costs** for recreational stakeholders and for the issues of **loss of stocked fish** and **reduced stock through lowered production** for commercial fishermen. Concerns over the disturbance effects of Cormorant **scaring and shooting** were shared by both commercial and nature conservation stakeholders but, again, there appeared to be little supporting scientific literature. These nine conflict issues thus appeared to be ones most likely to benefit from further scientific investigation. Though, given the points discussed above, such research should be undertaken with participation from stakeholders at all stages where possible. Ultimately, this should increase the useful knowledge of both scientists and other stakeholder groups whilst also increasing collaboration between all parties, but particularly local people, in the decision-making process with regard to Cormorant conflict issues across Europe.

3.7.4 Concluding remarks

Conflicts over natural resources are often ongoing, signalling the different values and interests of the people involved. The complexity of a conflict increases "when it is driven by people's fundamental values – about right and wrong, about entitlements, about humans' role in nature, and so on" (Daniels & Walker 2001). As discussed in this Chapter, this is certainly the case for most, if not all, Cormorant-fisheries conflicts recorded in the present synthesis. The fundamental challenge for fisheries management in this context is to find ways of expanding technical expertise whilst increasing collaboration in decision-making processes. In the past there has been much co-operation between fishermen and scientists at the individual level but a more organised management structure is required to bring these, and other, groups together Couper & Smith (1997). Moreover, Daniels & Walker (2001) suggest that while it is possible for specific disputes to be *resolved*, many conflicts are complex and continuing. Thus: "Complex conflict situations may never be resolved in the sense that the parties reach an agreement that ends the core incompatibilities that give rise to the conflict. Rather many complex conflicts can be *managed* well, so that they do not become destructive."

The REDCAFE Cormorant-conflict synthesis has demonstrated clearly that such conflicts are indeed complex, in terms of both biology and equally important social and economic issues. This synthesis is an important first stage towards developing trust and collaborations between all those affected by Cormorant conflicts. As discussed above, these issues are as much a matter of human interests as they are of biology. It is hoped that this element of REDCAFE's work will indeed be the start of a management process for Cormorant-fisheries conflict issues and, by implication, for wider environmental issues affecting fisheries and aquatic conservation across Europe.

4 Cormorant ecology: factors leading to conflicts

4.1 *Introduction and methods*

Any successful resolution, or management, of the conflicts between Cormorants and fisheries interests on a pan-European scale must include careful consideration of the best available biological information on Cormorant populations throughout the region. This Work package was an attempt to synthesise aspects of Cormorant ecology that lead to the conflicts synthesised in Chapter 3. The conflict synthesis highlighted that Cormorants were widespread across Europe, that they were migratory (at least in part) and that they were highly flexible in relation to choice of foraging habitats and prey.

The aims of this Work Package were thus to (i) achieve information exchange at a European level (ii) summarise existing knowledge on Cormorant ecology (especially factors leading to conflicts), (iii) clarify certain ecological topics (focussing on feeding ecology), and (iv) synthesise common facts in a general synthesis giving a broad, pan-European overview.

Relevant ecological factors included in the synthesis were: Cormorant population status and distribution, movements and dispersal, breeding/over-winter site fidelity, foraging site selection, foraging ecology, feeding behaviour and daily energy expenditure. These factors were categorised into four main themes:

- General ecology and habitat features
- Migration and the annual cycle
- Fish communities and Cormorant diet
- Cormorant ecology and impact at fisheries

These main themes were discussed in a series of topical reviews presented by a REDCAFE participant and the main points arising from each are summarised in this Chapter (sections 4.3, 4.5, 4.6, 4.7). In addition, wherever appropriate, subsequent discussions between REDCAFE participants are also reported. Two discussion workshops were also held to discuss and synthesise broad habitat issues: the environmental requirements of Cormorants and habitat 'vulnerability' (i.e. its attractiveness) to the species. The resulting consensus on these habitat syntheses (presented in sections 4.4, 4.8) are reported here in the form of tables. A pan-European synthesis is then given (4.9) along with three sets of conclusions arising from it (4.10).

Finally, the pan-European synthesis was achieved by incorporating information from the topical reviews and discussion workshops and combining it with information on the inter-relationship between Cormorant density and distribution across Europe based on site-specific information reported by REDCAFE participants in a standard format (Table 4.1)

README: Please submit data of your country in the yellow space of the area sheets.
If you wish to contribute data on more than one area, you can use the next 10 area sheets.
Explanation of habitat type:

1. Open Sea
2. Estuaries
3. Inland sea
4. Large lakes
5. Large rivers
6. Impounded rivers
7. Streams / small rivers
8. Reservoirs / small lakes / sandpits
9. Fish ponds
10. Brackish lagoons (on request of Italy)
11. Fishing valli (on request of Italy)

* please choose option in area form

SHEET: In the Excel datasheets one more column was added to input the data. Ten of these sheets were included in the mailing to allow data input on 10 different sites. Furthermore, we asked for the name of the respondent, country and the name of the site. We asked data on the following data Blocks:

Time of study, geographical position and type of habitat data:	
Issue	Specification
HABITAT-TYPE	see README
LOCATION	Greenwich coordinates
REFERENCE(S) OF STUDY	peer / non-peer reviewed / anecdotal*
PERIOD OF STUDY (give range)	year(s)

Population data:	
Issue	Specification
SUB-SPECIES	carbo / sinensis*
NUMBER OF CORMORANTS INVOLVED	Maximum
NUMBER OF CORMORANTS INVOLVED	birddays per year
STATUS OF CORMORANTS	breeding / non-breeding*
FLOCK SIZE AT TIMES OF FISHING	average number of Cormorants
OCCURRENCE OF MASS FISHING	yes / no*
JUVENILES	% of number

Water body characteristics:	
Issue	Specification
SIZE OF FISHING WATER	Km^2
WATERBODY	natural / semi-natural / artificial*
DEPTH	M
TROPHIC STATUS	oligotrophic / mesotrophic / eutrophic*
TURBIDITY (SECCHI DEPTH)	M

Fish data:	
Issue	Specification
FISH SPECIES IN AREA	Number
FISH SPECIES / GROUP MOST ABUNDANT (rank 1)	latin name
FISH SPECIES / GROUP MOST ABUNDANT (rank 2)	latin name
FISH SPECIES / GROUP MOST ABUNDANT (rank 3)	latin name
OVERALL FISH BIOMASS	Kg/ha
DENSITY OF MOST ABUNDANT SPECIES (rank 1)	Kg/ha
DENSITY OF MOST ABUNDANT SPECIES (rank 2)	Kg/ha
DENSITY OF MOST ABUNDANT SPECIES (rank 3)	Kg/ha
FISH SPECIES IN DIET	Number
FISH SPECIES / GROUP EATEN MOST (rank 1)	latin name
FISH SPECIES / GROUP EATEN MOST (rank 2)	latin name
FISH SPECIES / GROUP EATEN MOST (rank 3)	latin name
DENSITY OF MOST EATEN SPECIES (rank 1)	Kg/ha
DENSITY OF MOST EATEN SPECIES (rank 2)	Kg/ha
DENSITY OF MOST EATEN SPECIES (rank 3)	Kg/ha
OVERALL CONSUMPTION	% taken from available (Kg/ha)

Fish data:	
Issue	Specification
(all fish species)	
CONSUMPTION OF MOST EATEN SPECIES (1-3)	% taken from available (Kg/ha)

(Inter)colony data:	
Issue	Specification
DISTANCE OF COLONY OR ROOST TO FISHING WATER	Km
DISTANCE TO NEAREST COLONY OR ROOST	Km
DISTANCE TO NEAREST ALTERNATIVE FISHING WATER(S)	Km
COLONY / ROOST EXISTENCE	number of years
COLONY / ROOST HABITAT	willow / poplar
	alder / birch
	ash / oak / beech / birch / lime
	coniferous
	ground nesting
	other
POPULATION INCREASE OR DECREASE	% average last 5 years (- = decrease, + = increase)

Table 4.1 Standardised spreadsheet used by REDCAFE participants for collation of Work Package 2 case study information on relevant aspects of Cormorant ecology.

4.2 Ecological framework

In Europe, the population of Cormorants *Phalacrocorax carbo sinensis* has shown a strong increase (Figure 4.1). For example, in 1985 in the core area of western Europe, i.e. the Netherlands, Germany, Denmark, Poland and Sweden there were 29,000 pairs, in 1990 there were 63,000 pairs and in 2000 approximately 125,000 pairs.

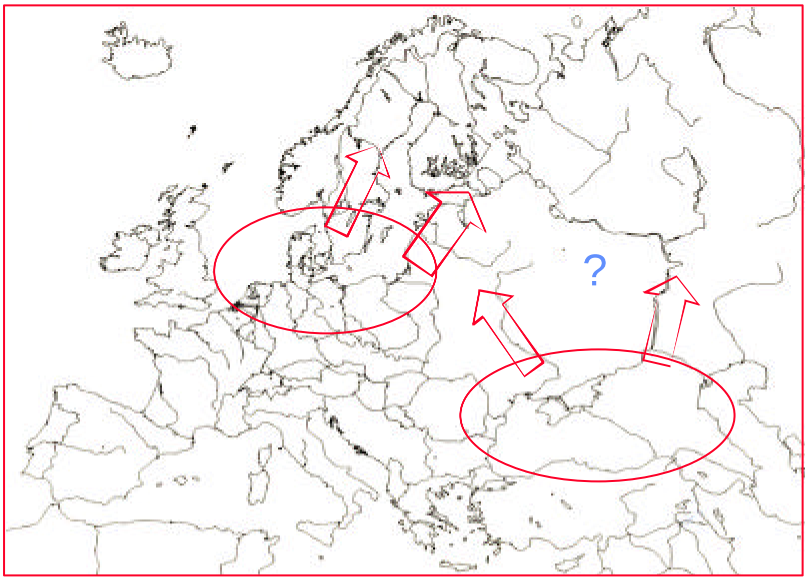

Figure 4.1 Core areas of Cormorant (*sinensis*) distribution in Europe with current direction of expansion (arrows).

In Europe, about 240 fish species are known. In fresh water systems about 24 fish species play a role as food for Cormorants (but see Table 3.5). Of these, about 12 fish species (see Table 3.5 for scientific names) are known to be of commercial interest in at least some of the Cormorant's range: Eel, Carp, Whitefish, Rainbow Trout, Grayling, Perch, Tench, Pike, Perch, Roach and Pikeperch. In salt water systems about 15 fish species are of importance for Cormorants and about 7 of them are of commercial interest: Eel, Cod, Sea Bass, Dab, Flounder, Gilthead and Mullets.

One of the main questions concerning Cormorants as a potential 'problem' for commercial fisheries is whether or not the species can be seen as an opportunistic generalist predator. Changes in the number of predators in response to the numbers of prey is termed a 'numerical' response. There may also be changes in the number of prey eaten per predator as a result of variation in prey density: this is termed the 'functional' response. Considering predator-prey interactions within the functional response framework leads on to predictions that several factors besides densities of predators and prey are important. Predators may be 'specialists', consuming a single, or small number of prey types, or 'generalists' feeding on a wide variety of prey. Generalist predators may show a weak numerical response to changes in density of a particular prey (see information in 4.9.3), compared with a specialist, preying almost exclusively on that prey. From the information above, and that presented in Chapter 3 (see section 3.3.4), it is clear that Cormorants are opportunistic generalist fish predators. As a result of their broad ecological requirements (see this Chapter), Cormorants do therefore have the potential for considerable conflicts at specific fisheries. This is because, as well as flexibility in feeding site choice, generalist predators like the Cormorant could have considerable impact on their preferred prey species because their numbers are buffered to some extent against declines in these prey by their ability to switch to other types.

4.3 Cormorant ecology and physiology

4.3.1 General Cormorant ecology and habitat features

A generalised abstraction of the complex world of Cormorant ecology should be used to deal with the Pan-European scale required in the present REDCAFE synthesis. The major ecological factors that influence the foraging behaviour of Cormorants were reviewed and grouped into factors acting on their behaviour either directly or indirectly.

Direct factors: Geographical orientation, use of ecotopes , weather (e.g. wind direction, wind force, temperature), water transparency (i.e. min. 40 cm Secchi disk, see Figure 4.2), prey morphology and size of individual fish (commonly 6 - 30 cm), fish body shape (e.g. fins not too pointy) and local fish biomass.

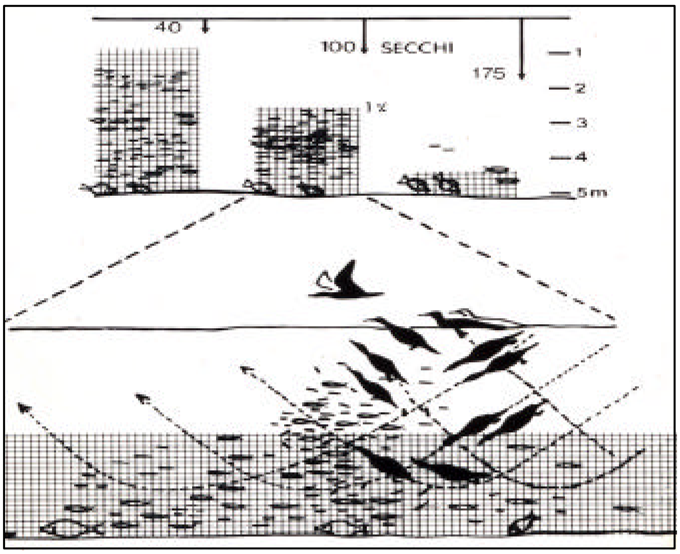

Figure 4.2 Cormorants foraging socially in intermediate turbid waters, pushing fish up towards the clear part of the water column.

Indirect factors: Availability of night roosts or colony locations (including disturbance, predation risk, availability of nest material). Fish ecology (e.g. spawning period), fish migration (horizontal and vertical), shoaling, distance of foraging grounds to night roosts or colonies (optimally < 20 km). Inter-colony competition, mass fishing and status (breeding, migrating or wintering). Most interactions of two or several of these factors have been described in the existing literature on the Cormorant. However, we found no record of integrating all the above factors in a site-specific geographical context on a Pan-European scale. *Mennobart van Eerden*.

REDCAFE discussions: comments in the discussions of published knowledge pointed to a lack of understanding about the influence of (individual) fish behaviour on Cormorant behaviour.

4.3.2 Cormorant ecology: general features

The general ecology of the Cormorant can be described through general dispersion patterns, habitat characteristics, foraging behaviour and roosting behaviour. Cormorants breed and roosts in trees, reed beds and on bare soil or rock. Colonies can, given certain conditions, sustain up to 10,000 pairs and roosts up to 12,000 individuals. Most colonies settle close to foraging waters. Colonies and roosts are spaced out according to hinterland (usually associated with waters of less than 20 m depth: see also 4.4). Colonies and roosts are social assemblies where sex and age classes are unevenly distributed.

In Europe, one core Cormorant area includes the Netherlands, Denmark, Germany and Poland. From this core area Cormorants have expanded into Baltic countries, Sweden and less into central Europe and Great Britain. A second core area exists in Romania, Ukraine and southern Russia. The Cormorant is a migratory species that winters in the Mediterranean and the Back Sea but also at northerly latitudes.

Active fishing by Cormorants occurs during daylight and shows a bimodal pattern often associated with early mornings and later in the day. Birds usually dive to depths of 2-6 m, up to 40 m exceptionally. Most fishing takes place individually or in small flocks. Mass fishing occurs in moderately turbid waters with a flat bottom, both in summer and winter. Diving in cold water raises energy expenditure and thus food requirements. Adults feed their young for 50 - 70 days. Cormorants show individual, age and sex-based differences. The Cormorant is a highly adaptive species and uses a great variety of waters and ecotopes to breed and roost. The social habit of colonial breeding and roosting makes it respond effectively to changes in the environment. We are extremely well informed about distribution and population changes, though less well about the exact causes. Data on East European *sinensis* and Atlantic *carbo* are necessary for understanding the West European *sinensis*, which, according to REDCAFE synthesis (see Chapter 3), causes most conflicts. *Mennobart van Eerden*.

REDCAFE discussions: comments in the discussion focused on the occurrence of mass fishing by Cormorants in relation to turbidity, salinity and bottom characteristics of water bodies. Given dense fish stocks, this type of foraging behaviour occurs over flat bottoms in open areas without any structures like water plants or stones.

4.3.3 Bio-energetic bottlenecks for Cormorants

Some basic questions in relation to the foraging behaviour of the Cormorant are: Do Cormorants have abnormally high energetic requirements ? Can we explain differences in this fish consumption ? Can we predict the distribution of Great Cormorants and their impact on prey stocks? These questions relate to the general impression by fishermen that Cormorants have exceptional skills to catch fish prey. It was found by scientific methods that food intake (300-1000 g/bird/day) is less than that of other seabirds (Figure 4.3). A study estimating the Daily Energy Expenditure (DEE) of wintering Cormorants using the doubly-labelled water technique also found Cormorant DEE to be within the range of other seabirds of similar body mass. Methods used to measure food intake were automatic weighing, stomach temperature records and time energy budgets (Figure 4.3).

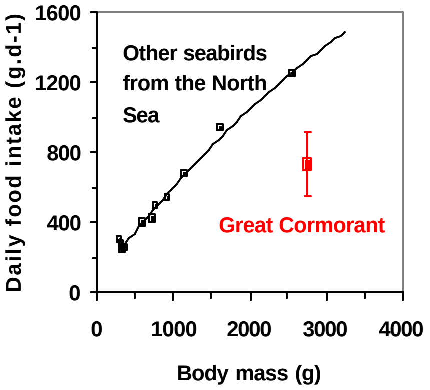

Figure 4.3 Measuring Cormorant food intake (left: comaprison of Cormorant food intake with that of other seabirds; right: breeding Shag *Phalacrocorax aristotelis* on a nest balance).

The partly wettable plumage of the Cormorant may be a morphological adaptation to optimise diving (allowing reduction of buoyancy). However, diving costs in cold water are relatively high due to the wettable plumage. The thermo-conductance adaptation to a cold environment seems to be partly physiological and behavioural. Along with an increase in energy consumption, body temperature rises and foraging efficiency is increased. Less deep dives are made and time in the water is minimised, the catch per unit time increases to the highest recorded in birds. In this way the birds seem to cope with the hostile environment. It was concluded that Cormorants forage close to optimal by adapting their behaviour. *David Grémillet*

REDCAFE discussions: comments in discussion were restricted to remarks on the importance of high quality data loggers and materials to do this kind of research.

4.3.4 The Cormorant's eye: limits to prey detection

Fundamental research into the biology and physics of the Cormorant's eye is necessary to understand the underwater vision of Cormorants. The refractive power of the cornea has been studied together with the eye's capacities of underwater accommodation. While the eye is accommodating, the lens changes shape (see Figure 4.4 for Merganser *Mergus* spp.).

This physiological knowledge is necessary to understand the role of vision in prey detection. Y-maze underwater prey selection experiments in the laboratory with dead prey (fish) show the limits of the Cormorant in detecting prey under different turbidity conditions. On the basis of MAR (minimal angle of resolution) the underwater vision of the Cormorant is better than that of humans but not as good as that of most fish. It is, however, better than that of most marine mammals. Cormorants could have the ability to distinguish between various polarisations of light. This may be relevant when Cormorants are foraging as fish scales polarize light. The existence of mechanoreceptors in fish detection is not confirmed, nor denied. Furthermore, light diffraction depends on many factors among which light polarisation by fish scales is only one.

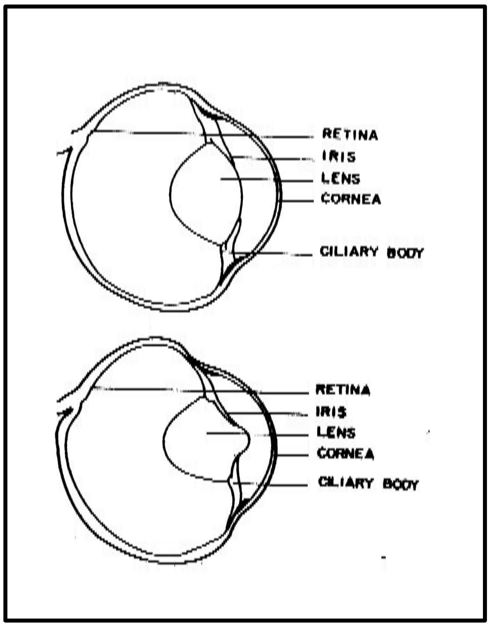

Figure 4.4 Merganser eye, at rest (top) and accommodating (bottom).

In order to understand the role of vision in prey detection, the effects of prey size and distance mu
The underwater light climate thus influences the bird's acuity to detect prey. How light intensity, algal biomass, suspended matter interact is only partly understood. Nevertheless, the fact that Cormorants' feed intensively in large numbers in both the IJsselmeer and Sea of Galilee in relation to conditions of turbidity probably has a basis in this prey detection theorem. *Gadi Katzir.*

4.4 The Cormorant's broad environmental requirements

REDCAFE participants considered the 'factors affecting the appearance or disappearance of Cormorants, apart for foraging waters, roosts and breeding colonies' (Table 4.2).

Cormorant roosts can be divided into day roosts and night roosts. Both types of roosts require:

1. Suitable habitat: *sinensis* trees with suitable access (branch structure), *carbo* mostly rocks (although there are now many tree-nesting carbo in S.E. England). Other roosts can be found on sand flats, dikes, or artificial structures like weirs, high tension pylons etc.

2. Protection from human disturbance, at the ground also from predatory mammals like fox (*Vulpes vulpes*).

Foraging waters	Breeding colonies	Roosting
Fish density and distribution (+)	Predators (ground colonies) (-)	site security (+)
Fish refuges natural / artificial (-)	Availability of fish and predictability (+)	Availability of fish (+)
Fish behaviour (+/-) e.g. spawning concentrations (+)	Proximity from colony to forage area (+)	Proximity of neighbouring roost(s) (+/-)
Water temperature; thermo conductance (+)	Availability of suitable nest sites (+)	Proximity from colony to forage area (+)
Swimming speed of prey (-)	(Human) disturbance (-)	Wind direction (+/-)
Negative response of fishermen (-)	Negative response from fishermen (-)	Negative Response of fishermen (-)
Collaboration with other species (Pelican) (+)	Existing colonies of Herons / Spoonbills/ Gulls / Egrets (+/-)	
Accessibility (+)	presence of a winter roost (+)	
Proximity to colony or roost (+)	Competition by other Cormorant colonies (-)	
Water depth (-)	Previous use of the area as roost (+)	
Vertical and horizontal migration of fish (+/-)		
High-water floods (+)		
Small rivers (+)		
Structure of rivers / creek / banks (+/-)		
Natural physical gradients (temp. salinity, oxygen) (+/-)		
Resting perches (+)		
Deep sandpits in lake (+)		
Water turbidity (-)		
Anthropogenic influence: disturbance (-)		
Weather (+/-)		

Table 4.2 Factors that contribute to Cormorant numbers apart for foraging waters, colonies and roosts: (+) indicates expected effect to be an increase in numbers with an increase in the factor, (-) a decrease in numbers and (+/-) could increase and/or decrease.

Ultimately, there may be a kind of hierarchy in the number of requirements to be met for the Cormorant in the type of preferred aggregation. The order of the hierarchy can be arranged from day roosts (only some requirements to be met), night roosts (more requirements needed), to colonies (which could be considered 'super roosts') meeting most requirements.

As day roosts are transitory, Cormorants will require a degree of both requirement (1) and (2) but "quality" may not be too important. The main factor here may be close proximity to foraging grounds. Night roosts require more environmental stability/predictability than do day roosts. They may also be considerable distances from foraging grounds. Given the permanence/predictability requirement, there can be a strong traditional element to night roosts. Any type of roost, but especially night roosts, requires shelter from harsh conditions, prevailing winds etc. We may also need to differentiate seasonally, as summer and winter roosts may require different conditions. Summer roosts are more often associated with breeding colonies, whereas winter ones are more often associated with migratory routes and with the birds' winter distribution. Summer roosts may therefore have to meet fewer requirements than winter roosts because of the availability of a nearby breeding colony (i.e. a 'high quality' site).

In Austria in autumn, the first birds to return are young birds on their first migration. They go to the traditional roost sites (15 -20 years established) despite never having been there and without guidance from their parents. Therefore it was suggested that Tinbergen's 4 principles be re-visited: function, mechanism, ontogeny and evolution and ask what is the function of a roost ? Perhaps it acts as an information transfer centre ? In Belgium too, the first birds to return to the wintering places are young birds, but the pattern of roost occupancy clearly differs between autumn and winter. Some roost are typically "autumn roosts" occupied by immatures coming in late summer, and subsequently remaining during the winter period, while some traditional roost sites are only used after November, when the vast majority of adult is present. Autumn roosts tend to be smaller, and more numerous, than the winter roosts. In winter, when birds are more numerous, they seem to congregate in larger roosts, from where they fly each morning to fish mostly in groups (50-200 individuals). Birds fishing together in these groups have left the roost together only a few moments before, which could be an argument in favour of the 'information transfer centre'.

The main principles outlined for roosts also apply for colonies. Protection from disturbance (human/predator) is vital. Cormorants in breeding colonies need to provide for themselves and their chicks. Colonies are traditional, Cormorants are focussed on them for a prolonged period of time. Colonies are required to be stable and predictable and also require a supply of adequate nest material in the proximity. Colonies may be negatively influenced by the proximity of large-sized neighbouring colonies. It is likely that, in these situations, competition for the nearby foraging grounds may occur (Hinterland hypothesis). Parasites (perhaps ticks in rock colonies) may be an important factor for colonies (in Normandy for example). There may be a threshold limit for all these factors below which no colony establishment may be possible. What limits the presence of a colony then depends on the factor that becomes limiting first. Occurrence of Cormorants on foraging grounds depends on the season, location and migration route and adequate access. General 'macro' factors also influence choice of foraging waters, these include the size of water body, fish density, abundance etc.

4.5 Migration and the annual cycle

4.5.1 Ecology, turnover and roost selection in the migratory phase

Typical landlocked pre-alpine lakes and Danube roost site selection (i.e. the colonisation) in Bavaria showed a sequence of events: first Cormorants assembled (i.e. appeared in larger numbers) on lakes, later on rivers and then on small creeks. The effects of shooting Cormorants are (1) an increase in the total number of roosts, and (2) the disappearance of large night roosts. In spite of the shooting of large numbers of birds, the winter population remained stable in Bavaria at the level that had been reached well before shooting started (see Figure 4.5). Some roosts showed high turnover, others remained stable for longer periods. Roost turnover is partly explained by differences in the fish population of the foraging areas involved. Determining the cause and effect in these multi-factorial ecological and demographic field studies is difficult. It was concluded that roosts are sociable systems but not too much is known about their exact function, development or evolution. It is felt that this information was needed with respect to the question of what role roosts role in the exploitation of a particular environment. *Thomas Keller*.

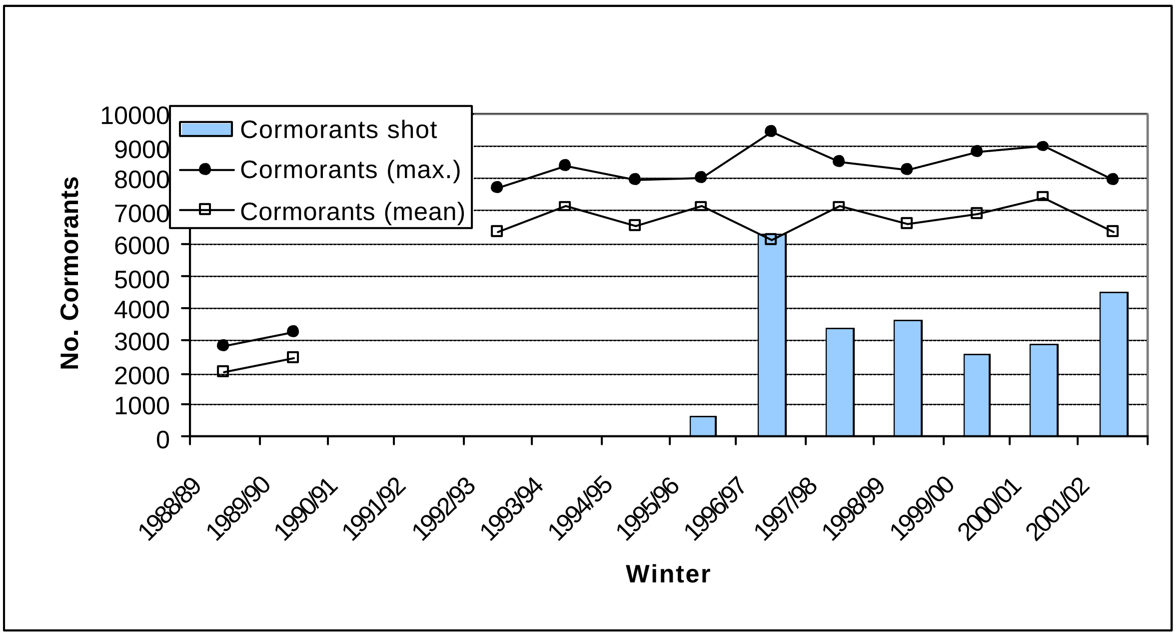

Figure 4.5 Mean and maximum Cormorant numbers (Oct-Mar) and numbers of birds shot in Bavaria, southern Germany.

4.5.2 Ecology and impact of wintering Cormorants in Italy

The situation in Italy was given as an example of a Cormorant wintering country (Figures 4.6 – 4.8). Population dynamics of major lakes and rivers in Italy are best known for the smaller water systems for which fish biomass is quantified. The overall trend in the Po Delta (Figure 4.9) showed that numbers are stabilising, perhaps due to more disturbances of the birds.

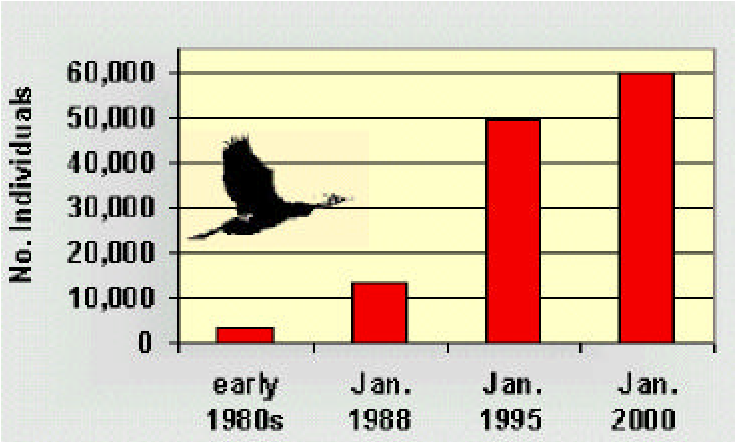

Figure 4.6 Cormorant wintering numbers in January in Italy

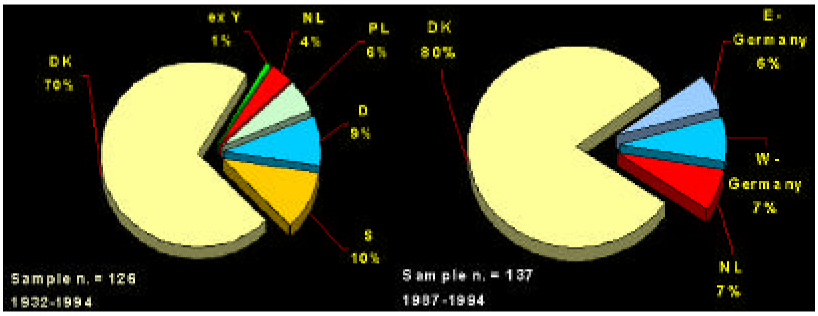

Figure 4.7 Origin of Cormorants wintering in Italy in the north Adriatic coastal area (Po Delta, Lagoon of Venice and Gulf of Trieste) and NW Italy (Piedmont).

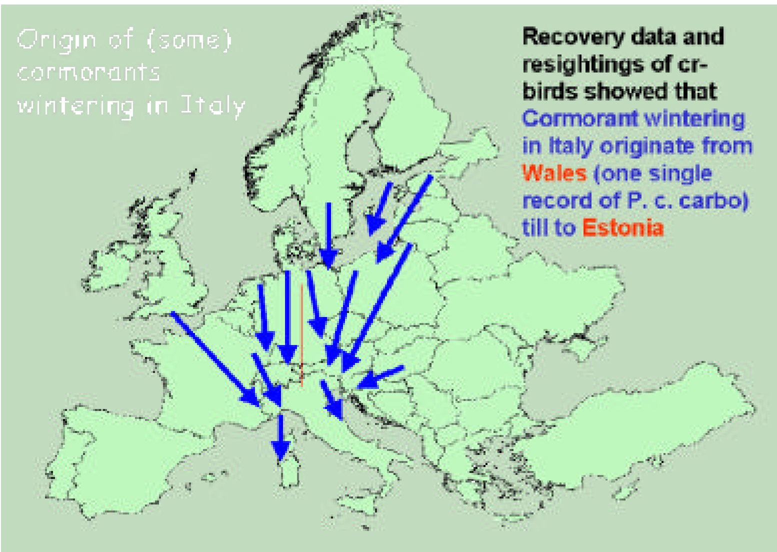

Figure 4.8 Migration patterns of birds wintering in Italy, reconstructed on the basis of ringed-bird recoveries.

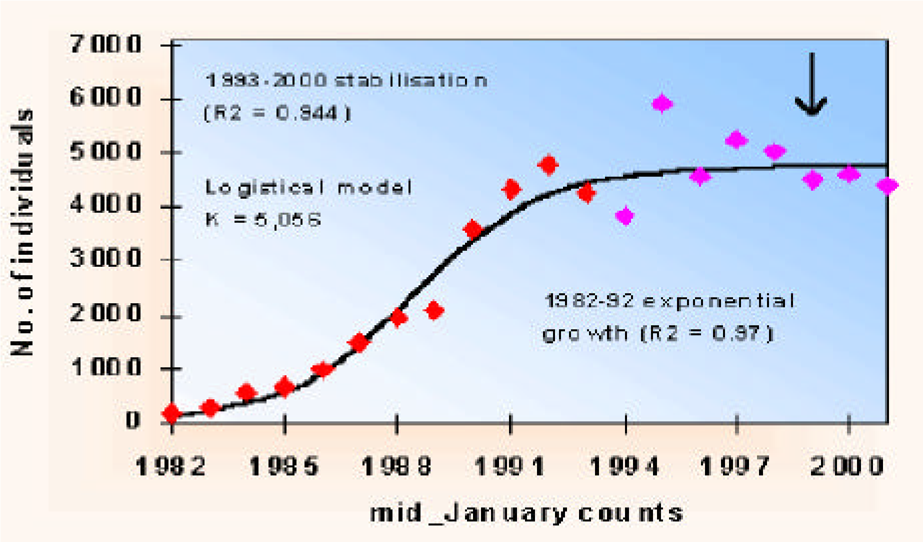

Figure 4.9 Trend of Cormorant numbers in the wintering seasons of 1982-2001 (North Po Delta).

The increase in number of roosts seems to be in accordance with this observation. Furthermore, fish biomass in large lagoons has declined and Cormorants seem to shift to so-called 'fishing valle' (extensive aquaculture systems) and other inland (freshwater) wetlands with high density of fish prey (Figure 4.10). Re-sightings of birds from the Baltic areas, Finnish Gulf and Scandinavia have increased along with the increase in colonies and Cormorant numbers in these areas. In Oristano lagoon (Sardinia) Cormorant numbers have declined after severe disturbance several years ago (from a maximum density of 309 birds/ha, the highest recorded in Italy, to less than 10 birds/ha). However, mild winters are a factor that could be of importance here as well. Most reported conflicts arise in 'fishing valle' areas and coastal lagoons where it is almost impossible to protect against fish-eating birds because of the scale of the habitat. *Stefano Volponi*.

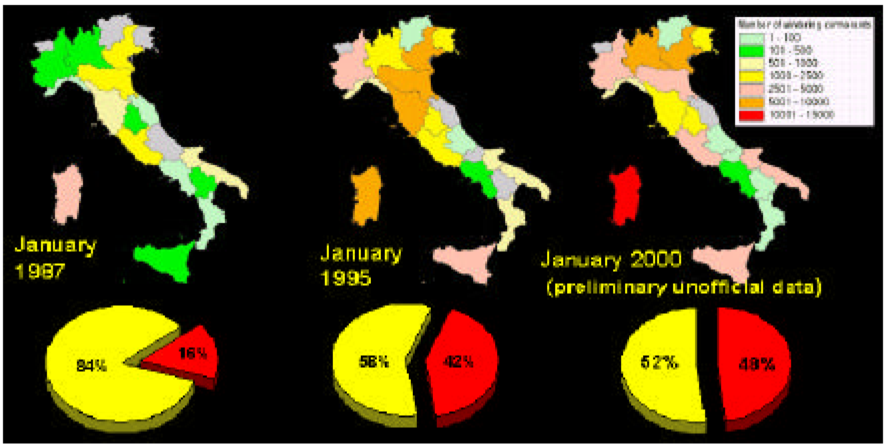

Figure 4.10 Changes in winter distribution and habitat choice (yellow = brackish wetlands, red = freshwater wetlands) from the late 1980s to 2000.

4.5.3 Migration in perspective: large scale patterns in demography and gaps in knowledge

The large-scale patterns on the Pan-European scale are less well known than the national patterns. However, to reach a Pan-European overview certain gaps in our knowledge need to be bridged. Especially, the lack of an integrated winter count in Europe has hampered these large-scale analyses. Based on recent inventories, the overall numbers on the western part of the continent seem to have stabilised. Old strongholds seem to be at their limit and numbers here are stable or even in decline. There has been considerable geographic expansion to previously unused areas in Europe. Especially into areas in the Baltic, the Finnish Gulf and Sweden (see Figure 3.6) where there have been recent increases in the number of colonies and the number of Cormorants. A second core area of distribution is in Eastern Europe, around the Black Sea (Romania, Ukraine). Migration patterns and direction of expansion of these populations is, however, less well described. It is suggested, and confirmed during REDCAFE discussions, that Cormorant numbers are increasing here too and new colony foundation is occurring inland in Ukraine and Russia.

Based on the distribution data from Cormorants colour-ringed in The Netherlands, the gross pattern of movements can be described. It is suggested that a decrease in numbers may have occurred at the southern wintering sites nowadays compared to some 15 years ago. More Cormorants are now tending to winter closer to the breeding areas and this might be confirmed by the international winter count undertaken in 2003. *Mennobart van Eerden.*

4.6 Fish communities and Cormorant diet

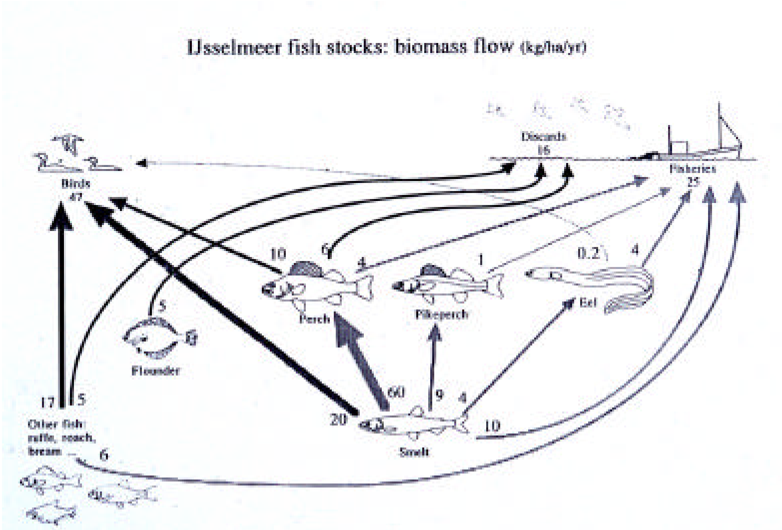

Figure 4.11 Biomass flow (kg/ha/yr) of fish in Lake Ijsselmeer: note that fisheries uptake and discards together are of the same magnitude as the outtake by birds but that, except for some (e.g. Perch), most species differ largely.

4.6.1 Fish community structure in relation to human impact and food availability for Cormorants

Calculations of (a) individual mass and growth rate of fish, and (b) predation rate explain much of the size structure of fish populations. In the Dutch situation, the model PISCATOR uses these parameters to create digital fish populations that closely follow the trends in the natural populations. Worldwide, fisheries manipulation causes a shift of size class to smaller fish (commercial fish tend to be bigger and are taken preferentially). The same goes for Lake Ijsselmeer, comparing 1989 and current distributions of fish length frequency. Trophic interactions may also result in species shifts. For instance, high mortality in piscivorous fish may favour the abundance of zooplanktivorous fish. When zooplanktivorous fish increase, this may result in the increase of algae and, thus, reduced prey visibility for Cormorants (e.g. see 4.3.4). It may also increase algaevorous fish, which will then become more preferable to Cormorants.

In the PISCATOR model, there was emphasis on the strong shift in length class distribution related to fishery pressure. However, no consideration has yet been given in the model to the absolute total biomass involved (though see earlier work summarised in Figure 4.11). The model makes population dynamics calculations purely on the basis of size class distributions. It is therefore less useful if one wants to compare or distinguish between the impact of fisheries and Cormorants on fish stocks. However, insight is gained that size distribution shift is the result of heavy fishery mortality. *Joep de Leeuw*.

4.6.2 Cormorant diet in relation to fish species abundance: examples from Lake IJsselmeer area

An overview of different studies of Cormorant diets in various water systems in The Netherlands shows that the 'between water system' variation in diet is large and more than the 'within water system' variation. Cormorants thus depend on many water systems and a great variety of fish species (see also 4.2 and section 3.3.4). Systematic sampling of fish within a water body during the course a season and over several years is rare. Therefore, in 1998 and 1999 lake IJsselmeer was systematically fished by RIZA along 21 predefined trajectories that correspond with distance to Cormorant colonies on the near shores. These data were combined with Cormorant diet information (obtained from the examination of fish otoliths recovered from Cormorant pellets) obtained from corresponding colonies. Details of fish species composition, abundance and temperature and size-dependent availability to Cormorants were given. Major conclusions were that: (1) large variation between water systems occurs, (2) fish species composition within one system is rather robust in terms of yearly variation, (3) peak years of fish recruitment are reflected in Cormorant diet. Within the group of fish consumed by Cormorants, a preference existed for Perch, Ruffe and Roach (see Table 3.4 for scientific names), whereas Smelt (*Osmerus eperlanus*) was severely underrepresented in the diet (i.e. it was more abundant in the environment than in dietary analysis). There was also preference for fish ranging in size from 1 - 30 g (range 0 - 450 g). Cormorants thus largely rely upon young fish and small species in this system, showing no selection, apart from the apparent avoidance of small Smelt. *Stef van Rijn*.

REDCAFE discussion: this focussed on the assumed sustained swimming speed and the uncertainties in the catch efficiency calculation of the fishing trawl. Also, the accuracy of estimating fish size from otoliths in Cormorant pellets was discussed. The general conclusion reached highlighted the Cormorant as an opportunistic forager, though the smallest prey are underrepresented presumably because of poor detection in this turbid water system.

4.7 Cormorant ecology and impact on fisheries

4.7.1 Cormorant impacts: perceptions and realities

The Cormorant has various 'roles' in everyday society: from 'nature's wonder' to the 'black plague'. Viewpoints of conservationists and fisheries' stakeholders are often very different (see Chapter 3). The main scientific difficulty with quantifying the 'Cormorant problem' seems to be the definition of impact: it is proposed to define it as the proportion of stock removed versus relative loss due to the take from fishing by humans. The practicality of this approach, however, is low. The issue of the definition of stock as a sum of the recruitment and survival of the older fish is complex. Many factors determine the recruitment and survival and not much is known about the natural survival rates of young fish. Modelling fish populations is a much more developed approach in marine sciences and could be applied to Cormorant–fish interaction studies. Modelling the impact of Cormorant foraging behaviour on fish populations, however, is complicated by the species' ability to switch both prey species (e.g. see 4.2 and 4.5.2) and foraging strategy (e.g. see 4.3.2). The fish size-class model discussed in section 4.6.1, however, so far ignores crucial total biomass estimates. *Ian Russell.*

REDCAFE discussion: this addressed many of the conflict situations across Europe. Some countries showed progress in bridging the gap in viewpoints, others were still split in opposed camps. The question remained if we should make distinction between commercial and sports fishing claims on fishing areas. However, all REDCAFE participants agreed that no distinction should be made between angling and commercial fisheries stakeholders, both having equal 'relevance/importance'. Furthermore, restocking of fish was not viewed as a sustainable ' solution' to the Cormorant problem. Small water bodies are more easily managed and therefore much stocking and manipulations take place in these areas. It was stated that eutrophic habitats tend to have unnaturally structured fish populations and the best way to manage the conflict may well be to ensure the good environmental conditions for fish populations, for example in Greece the management of lakes has become the most important strategy. Public awareness campaigns have helped to resolve issues where pelicans and Cormorants were blamed for lower economic profit. Fishermen often shift to tourism and thus have a stake in protection of bird populations that are interesting to tourists. In Romania in 1990 hunting was banned but the problem remains. Therefore, the perception is that shooting does not affect the birds in a major way. From here discussion went into the issue of shooting Cormorants (see also Chapter 5). Denmark, Romania and other South-Eastern European Countries tended to regard shooting of Cormorants as a tolerable management option from an ecological viewpoint. However, in Romania people tend to prefer to direct their shooting effort towards commercially viable species (e.g. edible or valuable for fur) rather than towards Cormorants. However, people might shoot Cormorants if financial subsidies were available. The argument (referring to studies showing no effect on the overall number of Cormorants) being that shooting does not harm Cormorant populations. This, however, obviously depends on the scale of the shooting. Further, the argument was put forward that shooting may soothe some of the high pitched emotions of people that perceive damage and thus may, to some extend, solve the conflict at the perception level. A view apparently favoured in Denmark for example. Most other counties, however, prefer to limit the danger of uncontrolled dispersion of the Cormorants, particularly across political borders, as this would make management in other regions more difficult. There is also an ethical issue about shooting, which was considered important, but the ethics of Cormorant culling have not yet been considered, publicly at least, across Europe.

4.8 Habitat 'vulnerability' to Cormorants

In this workshop, REDCAFE participants considered 'ecologically relevant measures to alter the vulnerability (or attractiveness) of water bodies to Cormorants'. Here the types of water bodies detailed in case-study datasheets (see Table 4.1) were used. These discussions are summarised in Tables 4.3 and 4.4.

Coastal waters / lagoons / estuaries (100-300 kg/ha)	**Large lakes (eutrophic 200-500, mesotrophic 50-100, oligotrophic 10-40 kg/ha)**	**Large rivers (100 kg/ha)**	**Small rivers (< 100 kg/ha lowland)**
	Prey density (some species / lake / sites)	Prey density (stocking)	Prey density (stocking)
Increase fish refuges	Reduce predictability	Reduce Predictability (stocking)	Reduce Predictability (stocking)
Zonation of disturbed / protected areas helps to keep the birds "locally"	Reduce proximity of roosts/nests	Reduce proximity roosts/nests	Reduce proximity roosts/nests
	Availability of alternative sites	Availability of alternative sites	Availability of alternative sites
	Refuges natural/artificial	Refuges natural/artificial	Refuges natural/artificial
	Improve Habitat quality	Habitat quality	Habitat quality
	Water quality	Water quality	Water quality
Increase predators of Cormorants		Improving fish colonisation	Increase predators of Cormorants
Improve fish colonisation			Human presence

Table 4.3 Ecologically relevant measures to alter the vulnerability (attractiveness) of larger water bodies to Cormorants. Fish standing stock is estimated and indicated in kg/ha.

Clearly, the number of management options, from an ecological point of view, declines with increasing size of the water body (see also 5.8.2). The highest fish density is also to be expected in smaller water bodies. It would be tempting to focus on these smaller waters but that would neglect serious conflicts reported in the Baltic for instance with coastal waters and/or lagoons and estuaries.

Small running waters + gravel pits (50)100-500 kg/ha	Fish farms (stocked biomass 1,000 - 10,000 kg/ha)
Introduce buffer stock (fish)	Introduce 'buffer' species
Adapt timing of stocking	Prey density (introduce seasonality)
Gradual re-stocking	Reduce Predictability
Increase availability, turbidity, barriers	Increase availability, turbidity, barriers
Reduce proximity of roost/nest sites	Reduce proximity of roost/nest sites
availability of alternative sites	Availability of alternative sites
Underwater refuges natural or artificial	Underwater refuges natural or artificial
Increase human presence	Increase human presence
Water quality	location on migration routes/natural habitats
	15 October warning: “increased alert”
	Avoiding; disturbing colonies < 5 km, roosts < 15 km
	Protection by shooting, netting, disturbance etc.

Table 4.4 Ecologically relevant measures to alter the vulnerability (attractiveness) of smaller (artificial) water bodies to Cormorants. Fish standing stock is estimated and indicated in kg/ha.

4.9 Pan-European synthesis

4.9.1 Cormorant distribution

Three maps of Europe were used as background material, one on roosts (partly finished), and two additional ones: a map indicating the locations of Cormorant colonies and another indicating cases of reported damage. In this way, spatial patterns on the Pan-European scale became available for speculation on cause and effect. The main insights of the maps were the many conflicts in the new Cormorant expansion areas and relatively fewer conflicts in the eastern states. Gaps in geographical coverage became clear. After introduction of a prefabricated GIS map of the water bodies in Europe in which a true representation of water and wetland areas with relevance to Cormorants was plotted, some major trends in the geographical location of Cormorant colonies and recent population dynamics were discussed. The ‘water map’ was a good background to understand the Cormorant’s distribution in summer and winter. Moreover, the use of layered maps with distributions of roosts, colonies and damage cases across Europe seems a viable way of improving our pan-European approach to understanding Cormorant distribution in the future.

4.9.2 System characteristics in Europe

In European water systems, we can recognize gradients in the trophic status (Figure 4.12) from the oligotrophic systems in northern countries (e.g. Estonia) and mountainous regions (e.g. alpine lakes and rivers) to mesotrophic and eutrophic systems, which cover a wide range on the continent. Eutrophic systems can be found in delta areas such as the large Dutch water systems. Hypertrophic systems, often manipulated by man, can be found in small, stocked lakes, river sections, deltas and fish farm areas.

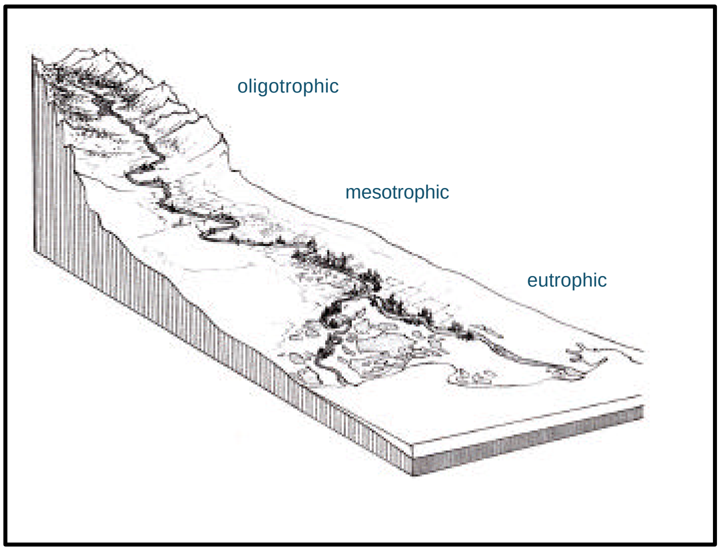

Figure 4.12 Schematic representation of a river system showing natural trophic zones.

To understand the distribution and densities of Cormorants in Europe, REDCAFE participants provided information about water system parameters, fish and Cormorants (see Table 4.1). Information was obtained from 13 countries and 64 water systems (Table 4.5). Although this dataset did not represent a complete pan-European picture, it gave good indications of the relationship between Cormorant densities and water system characteristics. These included natural, semi-natural and artificial waters all with their own specific trophic state. The cases also represented a wide range of habitats from large open seas, estuaries, lakes and rivers to small streams, reservoirs and fish ponds.

Although widely scattered, there was a distinct relationship between the presence of Cormorants and the size of the water system (Figure 4.13). Although there was an overlap in the descriptions of system size, especially between small and medium systems, larger systems were clearly occupied by more Cormorants (see also Figure 3.7). The between-site variation must be explained by other characteristics in the system. Data suggested a tenfold difference in some parts of the intermediate systems (5-100 km^2). Larger systems thus carry most Cormorants on an annual basis and this is an understandable but important finding. It shows that the large scale configuration of Europe, with its large rivers, coastal seas and lakes form the natural basis for the distribution of the species.

HABITAT	Estonia	Germany	Netherlands	Italy	Belgium	Scotland	Romania	Eng/Wales	Poland	Spain	Greece	Switzerland	France
1. Open Sea	2												
2. Estuaries (+ Brackish Lagoons)	1			5			1			7	1		
3. Inland sea			2						4				
4. Large Lakes		2	1	7		1			3		1	1	1
5. Large Rivers		1		1	1			2					
6. Impounded Rivers		1											
7. Streams/Small Rivers		2								2			
8. Reservoirs/Small Lakes/Sandpits		1	1					6	2				
9. Fish Ponds									3				
TOTAL	3	7	4	13	1	1	1	8	12	9	2	1	1

HABITAT	Estonia	Germany	Netherlands	Italy	Belgium	Scotland	Romania	Eng /Wales	Poland	Spain	Greece	Switzerland	France
LARGE	3		3	5			1		4	7	1		
MEDIUM		4	1	8	1	1		2	3		1	1	1
SMALL		3						6	5	2			

Oligotrophic	3												
Mesotrophic		5	1	5	1			2	1			1	
Eutrophic		2	3	8		1		2	8	9	2		1
Unknown									3				

Table 4.5 Input data (i.e. number of case studies) from 13 different European countries, in relation to habitat type, system size and trophic state as recorded by REDCAFE participants. Note: this is a biased sample and may not be representative on a pan-European scale: cases were those where conflicts were perceived to occur.

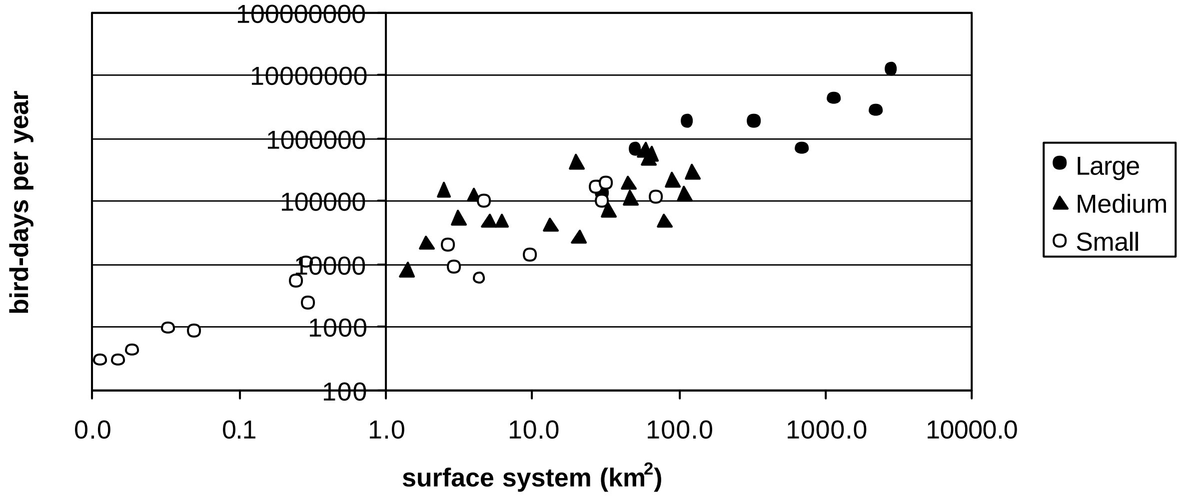

Figure 4.13 Relationship between Cormorant density (bird days/ha/year) and system surface (square km). Note the logarithmic axes. Based on data from 64 case studies (see Table 4.5).

Focussing on actual Cormorant densities (Figure 4.14), clear differences in system types were apparent. Low Cormorant densities occurred mainly in natural and semi-natural water systems, whereas in artificial systems high densities were noticeable. High Cormorant density may thus be related to fish density, which is variable but highest in artificial systems, such as fish ponds and reservoirs.

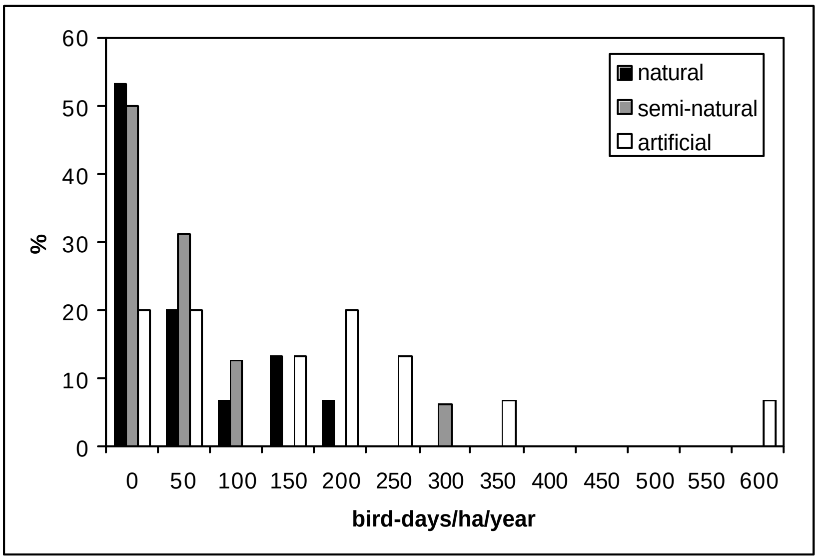

Figure 4.14 Frequency (%) of Cormorant densities for the different system types, based on data from 64 case studies (see Table 4.5).

It would be interesting to estimate impact on fish populations in relation to Cormorant density but this is not easily derived from the available data. For example, the relationship between Cormorant density and the biomass of the most frequently eaten fish species is not clear. This may be expected because generalist predators such as the Cormorant may show only a weak numerical response to changes in density of a particular prey. Another, not mutually exclusive, explanation for this is that there is often very little, or no, rigorous data available on fish biomass (see 4.7.1). Similarly, natural fish population dynamics in fresh and brackish waters are poorly understood. Currently, therefore, the best workable option, in the absence of specific data, is to 'guesstimate' fish biomass based on appropriate data from the scientific literature and site-specific local knowledge and expertise.

Despite the reservations, it was clear from the information recorded by REDCAFE participants that artificial systems had the largest reported fish biomasses (i.e. over 1000 kg/ha) although these were not always associated with the highest Cormorant densities. Some of the artificial systems were associated with the highest Cormorant densities reported whilst natural systems had relatively lower bird densities often with lower fish biomass (Figure 4.15).

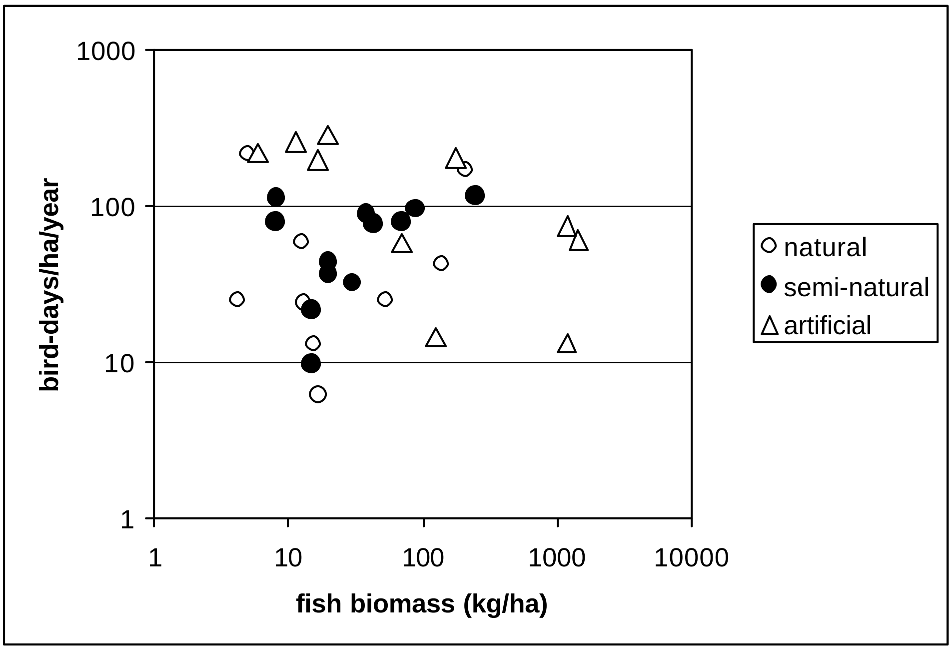

Figure 4.15 Relationship between Cormorant density and fish biomass of the most frequently eaten species for the different system types.

In 37 (58%) of reported cases, information about the fish species eaten by Cormorants was available. It was clear that the largest proportion (>50%) of the most frequently eaten species consisted of Cyprinid fish *Cyprinidae* (Figure 4.16). Other substantial parts consisted of Ruffe (see Table 3.5 for scientific names), Big-scale Sand smelt, and European anchovy (*Engraulis encrasicholus).* The remaining fishes included many species but only one case reported a commercially important species, the Eel as being the most 'important' food item for Cormorants. This was in accordance with the published literature and other information presented in this Chapter.

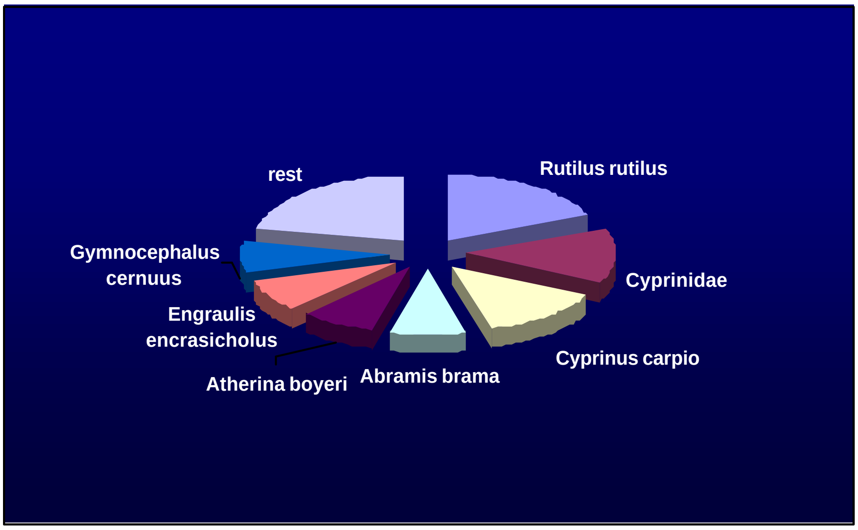

Figure 4.16 Frequency distribution (%) of most frequently eaten fish species (number of cases, n=37, see Table 3.5 or text for common names).

Cormorants are thus opportunistic foragers that may successfully prey on a large number of species, but, depending on aquatic habitat, take common, often small species. The Cormorant is, however, highly flexible in its feeding ecology and in many artificial water bodies such as Carp ponds, feeds solely on these captive fish.

4.10 Conclusions

Three sets of conclusions can be drawn from the information synthesised in this Chapter:

(1) In relation to Cormorants

- Cormorant ecology has been well studied; with respect to numbers, distribution, migratory movements, foraging behaviour and diet it is one of the best known wild living bird species in Europe.

- The opportunistic way of foraging, its great adaptability to a variety of habitats, both freshwater and marine makes it a successful forager which is at present in western Europe at maximum levels, in eastern Europe still expanding.

- This expansion in numbers and area is the result of European wide protective measures, eutrophication, the reduction of pesticides in the environment and alterations of water systems such as dams, sluices which facilitate foraging.

(2) In relation to fish

- Fish species eaten by Cormorants are, for the most part, common, widespread species.

- The heavy fishery pressure in many water systems in Europe has resulted in a shift in size distribution towards the smaller classes, which facilitates Cormorant foraging conditions.

- Fewer large predatory fish are now present because of over-fishing that enables smaller species to expand, and which in turn favours the Cormorant.

- Eutrophication of water bodies has increased the possibilities for Cormorants to exploit larger prey densities.

(3) In relation to damage to fisheries

- Fish species eaten by Cormorants are, for the most part, common, widespread species.

- The heavy fishery pressure in many water systems in Europe has resulted in a shift in size distribution towards the smaller classes, which facilitates Cormorant foraging condition.

- Reduction of eutrophication will decrease Cormorant numbers through reduction in carrying capacity of fishing waters.

- Restoration of waterways, aiming at a greater connectivity will favour fish populations and reduce predation risk.

- In fish farming areas, specific knowledge on prey detection underwater may help to reduce predation of small fish.

- Enlarging fish above the range commonly eaten (i.e.>500 g) may act to reduce Cormorant damage.

- Reducing the conflict involves distraction of birds to quiet areas, thus periods of large-scale Cormorant movements through Europe (e.g. March and October) require extra management attention to avoid the establishment of any tradition to visit stocked water bodies or fish farm areas.

- A combination of ecological, demographical, climatologic and geographic data into a GIS based Decision Support System may help to predict future Cormorant ‘problems’ and reduce current ones by integrated management (see section 3.7) rather than ‘pest’ management.

5 Potential Cormorant management tools

5.1 Introduction

This Work Package was an attempt to synthesise potential Cormorant management tools for resolving the conflicts synthesised in Chapter 3. Potential management tools will be assessed on two spatial/temporal scales: long-term control of European Cormorants at the population level and shorter-term site-specific control measures. At the 'population level' the synthesis involves a brief review of existing Cormorant population models for Europe and a broader discussion of the latest predictions from such work. Modelling has been used to (a) to predict the ultimate size and geographical distribution of the European Cormorant population and (b) to determine the levels of control necessary to reduce the overall population size. The ultimate aim of the modelling review will be to evaluate the possibility of Cormorant control at the pan-European population level, as proposed by, for example, EIFAC (1996).

At the 'site-specific level' the synthesis of site-specific control measures recognises that this must include the most recent (1995-2000) information (e.g. McKay *et al*. 1999) and, as far as possible, take into account the efficacy (i.e. effectiveness, practicability, acceptability, and cost of measures. The primary source of information was those REDCAFE participants involved with Cormorant population modelling and those with experience of site-specific Cormorant control. However, in addition, contributions were invited from relevant stakeholders in order that the synthesis was as complete as possible.

5.2 Methods

5.2.1 Cormorant population modelling review

Within Europe, two previous attempts have been made to model Cormorant population growth in a management context (Lebreton & Gerdeaux 1996; Bregnballe *et al*. 1997). In addition, more recent findings on Cormorant population dynamics are available (Frederiksen & Bregnballe 2000a,b; 2001). Population modelling has been used to investigate the interplay between large-scale Cormorant culling[11] and aspects of the species' population dynamics (Frederiksen *et al*. 2001). This latter study formed the basis for the REDCAFE review of Cormorant population modelling as a tool for investigating the possible effects of Cormorant control at the continental, pan-European scale.

5.2.2 Site-specific actions

Three types of information were collected for the present synthesis of site-specific actions taken against Cormorants. First, general information on those actions taken against Cormorants in each country. Second, details of national and regional Cormorant management plans and legal regulations in each country. Third, the types of Cormorant damage control activities undertaken in different Cormorant feeding habitats, including semi-quantitative information on their effectiveness (i.e how long the technique works for), practicability (i.e. how easy the technique is to use), acceptability (i.e. how the technique is viewed by both stakeholders and the general public) and costs. Five types of feeding habitat were distinguished in relation to Cormorant damage control activities: (1) small rivers (width < 100m), (2) large rivers (width > 100m), (3) small still waters (< 100 ha) not used for aquaculture, (4) very large water bodies (> 100 ha, still waters and coastal waters) and (5)

[11] 'Culling' is generally considered to mean the co-ordinated killing of Cormorants with the ultimate aim of controlling (i.e. reducing) the overall population size. This definition is used here in connection with Cormorant population modeling. However, 'culling' is also commonly used to describe any killing of Cormorants, regardless of the ultimate aim and this definition is used elsewhere in this Chapter.

aquaculture sites. REDCAFE participants at the national level provided this information, although often after discussions with local stakeholders over their experiences.

Information was provided on standard spreadsheets and in order to standardise the information collection procedure as much as possible, comprehensive instructions were provided (Table 5.1)

General information on actions against Cormorants in your country		
(1) In this section we are interested in annual national and regional numbers from your country and their accuracy.		
(2) When giving regional numbers, please replace "Region 1", "Region 2", etc. by the actual name of the respective regions.		
(3) Please feel free to add all your comments and all details below the tables!		
Management plans / legal regulations		
(1) In this section we are interested in details of management plans and legal regulations from your country and its regions.		
(2) Also, we would like to know if there is any financial compensation of fish losses or financial aid for Cormorant management actions or exclosures etc.		
(3) Please fill in this table with "yes" or "no" AND give all details and additional information (like the details of management plans or the amounts of financial compensation etc.) below the tables.		
(4) When giving regional information, please replace "Region 1", "Region 2", etc. by the actual name of the respective regions.		
(5) Please feel free to add all your comments and all details below the table!		
Cormorant Damage Control Activities		
(1) For Cormorant feeding sites, there are tables for five types of water bodies: "Small Rivers", "Large Rivers", "Small Still Waters", "Very Large Water Bodies", and "Aquaculture". Please fill in all tables that are applicable to your country.		
(2) In this section we are interested in site specific control activities that are used in your country and in a number of details.		
(3) These tables are designed to make it easy and convenient for you to fill in most columns. But, in order to give us as much information as possible, we ask you to give as many details as possible in the "Remarks, Details, & Additional information" column.		
Column	**Possible Answers**	**Additional explanation**
Technique is used?	regularly / rarely / not used / unknown	Here we would like to know if a certain technique/method is commonly used and widespread in your country (or region).
Effectiveness?	days / months / years / not efficient / not known	Here we are interested in the effectiveness of techniques/methods.
Practicability?	1 - 2 - 3 - 4 - 5	Please fill in a rank from "1" to "5" with: "1" = very high practicability, "2" = high practicability, "3" = medium practicability, "4" = low practicability, "5" = no practicability. Note: If a technique is highly practicable in one situation, but not at all in another, then fill in "1 / 5".
Acceptability?	1 - 2 - 3 - 4 - 5	Here "acceptability" means acceptability to the majority of stakeholders or the general public. Please fill in a rank from "1" to "5" with: "1" = very high acceptability, "2" = high acceptability, "3" = medium acceptability, "4" = low acceptability, "5" = no acceptability. Note: If a technique is highly acceptable in one situation, but not at all in another, then fill in "1 / 5".
Costs?	1 - 2 - 3 - 4 - 5	Please fill in a rank from "1" to "5" with: "1" = very high costs, "2" = high costs, "3" = medium costs, "4" = low costs, "5" = very low costs. Note: If a technique is expensive in one situation, but of very low costs in another, then fill in "1 / 5".
Location(s) where in use	Give regions where technique is used. In special cases, give locations and co-ordinates.	Give regions where the technique is used. But, if it is meaningful or of interest (i.e. locations of study areas), please, give names of locations AND geographical co-ordinates (longitudes and latitudes).
Remarks, Details, & Additional information	Give your remarks or comments here - Give details and more extensive information on the techniques here.	**Please give us here as many additional information and details as possible. Give costs/ha or costs/year, etc.**
References	Please give full literature references (if applicable).	Please give full literature references AND make a copy available to us if possible.

Table 5.1 Instructions for the provision of information relating to site-specific actions taken against Cormorants.

5.3 Cormorant population modelling

This section is based on the most recent published study of Cormorant population modelling (Frederiksen *et al*. 2001). Previous attempts to model European Cormorant population growth in a management context (Lebreton & Gerdeaux 1996: Bregnballe *et al*. 1997) have both been limited by data availability. Despite this, some robust conclusions were reached (see Frederiksen *et al*. 2001 for discussion). First, Cormorant population growth rate is more sensitive to changes in adult survival than in fecundity (i.e. the production of young), indicating that the shooting of adults may be the most efficient way to regulate population size. Second, if density-dependence[12] is assumed to occur naturally, hunting or culling may both reduce the level of population stabilisation and induce faster stabilisation.

Frederiksen *et al*. (2001) took advantage of recent work on Cormorant population dynamics and cull estimates from several European countries in the 1990s to achieve detailed projections of population growth and full details are given in this reference. They modelled the size of both the breeding population and the population present in autumn (i.e. before culling), because the major conflicts involving Cormorants often occur during the non-breeding season (e.g. see Table 3.8 and Figure 3.9) in areas outside the breeding range (e.g. see Table 5.2). Frederiksen *et al*. (2001) acknowledged several 'weaknesses' of their model: it was based initially on information from a single Cormorant colony (Vorsø in Denmark), knowledge about the strength of density-dependent mechanisms on the whole population scale was very limited, uncertainty over the actual numbers of birds culled. Nevertheless, they made several important findings.

Frederiksen *et al*. (2001) showed that during 1979-92, the breeding population of Cormorants in northern Europe (defined as the Netherlands, Germany, Denmark, Sweden and Poland) increased by 18% per year, in accordance with observed life-cycle parameters before the appearance of density-dependent declines. They then modelled six scenarios with varying assumptions about the strength of density-dependence in adult survival and the proportions of breeding Cormorants. A series of cull estimates were also included, based, in the first instance, on the approximate numbers of birds killed during the winter (1992-9) in France, Switzerland, Italy and Germany. Scenarios with moderate or strong levels of density-dependence provided predictions that fitted the observed numbers of breeding pairs whilst those without density-dependence in survival overestimated real (i.e. observed) population growth. It should be noted that the continued population growth after about 1999 was not predicted by the model, most likely because of the lack of geographical structure (i.e. density-dependence has not occurred at the same time in all parts of the range). The most well-supported scenarios indicated that the effects of culls at the present (1998-99) level (i.e. 17, 000 Cormorants shot) was limited. Modelling suggested that increasing the annual cull to 30, 000 birds would still have only a limited effect whereas shooting 50, 000 birds per year would lead to population extinction within 20-40 years.

Frederiksen *et al*. (2001) concluded that culls, to date, have probably had a limited effect on Cormorant populations, but if carried out in a density-dependent way (i.e. increased culling when the population was high, reduced culling when it was low) they could stablise numbers near a desired level. If culling is to be continued, Frederiksen *et al*. (2001) recommended the adoption of an adaptive and co-ordinated management strategy across Europe. They also advocated the need to account for density-dependent mechanisms in any general culling strategies.

[12] 'Density-dependence' is a biological term implying that the growth or decline of a population is regulated by mechanisms themselves controlled by the size of that population. Simply put, when population size increases, survival and/or production of young decreases, and *vice versa*.

5.4 General information on site-specific actions against Cormorants

Information was available for all 25 countries involved in the REDCAFE project (Table 5.2). This information is reviewed below, in relation to the actions taken (section 5.4), management plans and legal regulations (section 5.5) and remarks provided for individual countries (section 5.6).

NAME OF RESPONDENT AND YOUR AFFILIATION	Information given by REDCAFE participants
COUNTRY	Europe as covered by REDCAFE
REGION / PROVINCE / etc. (if applicable)	---
Period which is concerned [year(s)]	Current situation (2001/02), unless otherwise given.

General information on actions against Cormorants in each country (please give annual numbers)

	Total numbers	Country numbers																									
	European numbers	Austria (1995-2002)	Belgium	Bulgaria (1998-2002)	Czech Republic (1990-2002)	Denmark (1994-2002)	Estonia (1997-2001)	Finland	France	Germany	Greece (1995-2002)	Ireland	Israel	Italy	Latvia	Lithuania	The Netherlands	Norway (P. c. carbo)	Poland	Portugal	Romania (only Danube delta)	Slovenia (2001/2002)	Spain	Sweden (2000)	Switzerland	UK/England & Wales	UK/Scotland (1995-2002)	Remarks
Number of breeding colonies destroyed or disturbed	102	0	0	2	2	10	7	0	2	9	1	0	0	5	0	1	0	0	0	0	0	0	0	63	0	0	0	
Number of nests destroyed	<5194	0	0	81	0	3000	1800	0	0	113	0	0	0	<100	0	0	0	0	0	0	0	0	0	?	0	0	0	
Number of nestlings killed	c. 600 - 650	0	0	0	0	0	50-100	0	0	500	>50	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0	0	
Number of adults killed in the non-breeding season	c. 60953 - 63003	>460	0	>1000	1600-2800	2700	102	0	20000	7131	260-350	<20	200	2000-2500	>200	1000	0	10000	2100-2300	0	>200	>200	0	0	1300	200-250	300	
Is there any killing of breeding adults??? Please give numbers	<4599	0	0	yes	0	400	0	0	0	78	0	<20	0	<100	0	0	0	0	0	0	0	0	0	4000	0	0	0	
Number of night roosts destroyed or disturbed	<<249	>4	2 - 3	5	yes	1	0	0	200	yes	1	0	2	12	0	0	0	0	0	0	0	0	0	0	yes	<20	0	yes = roosts are not especially protected; shooting happens, but no data available.

Management plans / legal regulations (please give details below the table)

		Austria (1995-2002)	Belgium	Bulgaria (1998-2002)	Czech Republic (1990-2002)	Denmark (1994-2002)	Estonia (1997-2001)	Finland	France	Germany	Greece (1995-2002)	Ireland	Israel	Italy	Latvia	Lithuania	The Netherlands	Norway (P. c. carbo)	Poland	Portugal	Romania	Slovenia	Spain	Sweden (2000)	Switzerland	UK/England & Wales	UK/Scotland (1995-2002)	Remarks
Are there any management plans in effect? Please list all national or regional plans and give details		yes	no	no	no	yes	no	no	yes	yes	no	yes	yes	yes	no	no	no	yes	no	no	no	yes	no	yes	yes	no	no	
Are there any regulations in effect that allow Cormorant culling? Please list all national or regional regulations and give details		no	no	yes	yes	yes	no	no	yes	yes	no	yes	yes	yes	no	no	no	yes	yes	no	yes	yes	no	yes	yes	no	no	
Are there any coordinated culling programmes in your country?		no	no	no	no	yes	no	---	yes	no	---	no	no	(yes)	---	no	---	no	no	no	no	no	no	no	(yes)	no	no	(yes) = in some regions yes.
Is it mandatory to obtain single permits for Cormorant killing?		yes	yes	yes	yes	yes	yes	---	yes	(no)	---	yes	yes	(no)	---	yes	---	no	(no)	---	no	no	yes	yes	(no)	yes	yes	(no) = in some regions not and/or during some parts of the year not.
Has a general permit for Cormorant killing been issued?		(yes)	no	no	no	yes	no	---	yes	(yes)	---	no	(yes)	(yes)	---	no	---	yes	(yes)	no	yes	yes	no	(yes)	(yes)	no	no	(yes) = in some regions yes.
Is there any financial compensation for fish losses?		no	yes	no	yes	no	no	no	no	(yes)	no	no	no	(yes)	no	no	no	no	no	no	no	no	no	no	no	no	no	(yes) = in some regions yes.
Is there any financial aid for the construction of Cormorant exclosures or for scaring programmes, etc.?		no	(yes)	no	no	yes	no	no	(yes)	(yes)	no	no	no	no	no	yes	no	no	no	no	no	no	yes	no	no	no	no	(yes) = in some regions yes.

Table 5.2 General information on actions taken against Cormorants and relevant management plans and legal regulations for the 25 countries covered by REDCAFE.

5.4.1 Breeding colonies destroyed or disturbed

In recent years (1990-2002), 102 Cormorant breeding colonies were reported to have been destroyed or disturbed annually in countries covered by REDCAFE. Most of these colonies (62%) were in Sweden. Far fewer colonies were destroyed or disturbed in Denmark (10%), Germany (9%), Estonia (7%), Italy (5%), Bulgaria (2%), the Czech Republic (2%), France (2%), Greece (1%), and Lithuania (1%).

5.4.2 Nests destroyed

At least 5,194 Cormorant nests were reported to have been destroyed annually, including nests where eggs were oiled (i.e. Denmark). Most nests were destroyed in Denmark (58%) and Estonia (35%). In Germany and Italy about 100 nests each (2% each) were reported destroyed annually, about 81 in Bulgaria (1.6%). Although nests were known to have been destroyed in Sweden, numbers were not known.

5.4.3 Nestlings killed

About 600 – 650 Cormorant nestlings were reported to be killed in European countries covered by REDCAFE, most of them (about 80%) in north-eastern Germany. About 50 – 100 nestlings were reported killed annually in Estonia (12%) and more than 50 (about 8%) in Greece. Again, although nestlings were known to have been killed in Sweden, numbers were not known.

5.4.4 Adults killed in the non-breeding season

Between 50,953 and 53,003 adult Cormorants (including young birds in their first winter) were reported shot annually. This figure included 10,000 birds of the 'Atlantic' (*P. c. carbo*) race hunted legally in Norway. Thus, 40,953 – 43,003 adult Cormorants, mostly the 'Continental' (*P. c. sinensis*) race, were reported to be killed annually as a control measure. The highest proportion (48%) of these birds were shot in France. However, the number shot in France in 2001/02 can not be said to be an annual cull as this was the first year that so many birds had been killed. Other countries with more than 1,000 adult Cormorants reported shot annually were Germany (17%), Denmark (6%), the Czech Republic (5%), Italy (5%), Poland (5%), Switzerland (3%), Bulgaria (2%) and Lithuania (2%).

5.4.5 Breeding adults killed

More than 4,598 adult Cormorants were reported to be killed annually during the breeding season. By far the most were killed in Sweden (87%) from April to September. Far fewer breeding adults were shot in Denmark (9%), followed by Italy (2%), Germany (2%), and Ireland (0.4%). The killing of adult Cormorants during the breeding season was also reported in Bulgaria but numbers were not known. In no other countries were Cormorants reported to be killed during the breeding season.

5.4.6 Night roosts destroyed or disturbed

It was not possible to produce an overall estimate of the number of night roosts destroyed or disturbed annually in the countries covered by REDCAFE. Although Cormorants are known to be disturbed and shot at night roosts in Germany, the Czech Republic and Switzerland, no numbers were available. Of over 248 roosts reported destroyed or disturbed annually in the present study, most were from France (81%). Far fewer roosts were reported affected in the UK (England & Wales) (8%), Italy (5%), Bulgaria (2%), Austria (2%), Belgium (1%), Israel (0,6%), Denmark (0.4%), and Greece (0.4%).

5.5 Management plans/legal regulations

5.5.1 Management plans in effect

Of the 25 countries covered by REDCAFE, 11 (44%) reported that there were national or regional Cormorant management plans in effect. These countries were Austria, Denmark, France, Germany, Ireland, Israel, Italy, Norway, Slovenia, Sweden and Switzerland. Additionally, four countries (Bulgaria, the Czech Republic, Poland and Romania) reported subsequently that there was a regulation in effect allowing Cormorant culling.

5.5.2 Regulations in effect that allow Cormorant culling

In 14 of the 25 countries covered (56%), there was a regulation in effect that allowed Cormorant culling. These countries were: Bulgaria, the Czech Republic, Denmark, France, Germany, Ireland, Israel, Italy, Norway, Poland, Romania, Slovenia, Sweden, and Switzerland. In contrast, there was no legal Cormorant culling in Belgium, Estonia, Finland, Greece, Latvia, Lithuania, The Netherlands, Portugal, Spain, and the UK (both England & Wales, and Scotland). However, in Austria, Belgium, Estonia, Lithuania, Spain, and the UK (both England & Wales, and Scotland) single permits may be obtained, or at least could be obtained in future, for limited killing of Cormorants at particular sites as an aid to scaring.

5.5.3 Co-ordinated culling programmes

In most countries there were no co-ordinated culling programmes. Only Denmark, France, Italy, and Switzerland reported co-ordinated culling programmes and in Italy and Switzerland these were only at the regional or local level. In Switzerland, the culling programme was restricted to rivers with Grayling (*Thymallus thymallus*) populations and small still waters. In Denmark, culling usually involved egg oiling (see 5.6.5). In all other countries Cormorant culling was either unco-ordinated or there was no reported shooting of Cormorants.

5.5.4 'Single' permits vs. 'general' permits for Cormorant killing?

In 13 countries (52%) it was mandatory to obtain single permits for the killing of Cormorants. General permits for the killing of Cormorants were issued for the whole country, or at least parts of it, in 12 (48%) countries. In five countries (20%, i.e. Denmark, Germany, Italy, Poland, and Switzerland), single permits to kill Cormorants were only necessary in parts of the country or at some types of water body. In France, the Environment Ministry gives quota numbers for Cormorant killing to the local authorities (Departements) each year. This operates like a 'general' permit. However, some Departements are not authorised to kill Cormorants. For those where killing is allowed, the local authorities have to control the 'hunters'. Only in Norway, Romania, and Slovenia (12%) were no single permits for the killing of Cormorants necessary.

5.5.5 Financial compensation for fish losses

Financial compensation for fish losses attributed to Cormorant predation was rarely reported as being paid in the European countries covered by REDCAFE. Only four countries (16%) reported paying compensation or would consider doing so under their legislation. These were Belgium, the Czech Republic, one state in Germany (Saxony, see Box 6.4) and some Italian regions.

5.5.6 Financial aid for the construction of Cormorant exclosures or for scaring programmes

Only in six countries (24%), and sometimes only at the regional level, was financial aid reported to be paid for the construction of Cormorant exclosures or for scaring programmes. These countries were Denmark, Lithuania and Spain and some regions of Belgium, France and Germany.

5.6 Remarks from individual countries

5.6.1 Austria

Fishing, hunting and nature protection laws in Austria are subject of regulation by provincial governments and provincial management plans differ substantially in relation to such aspects as defined shooting-areas, time-periods, and bag limits. The general aim of all management plans is to displace Cormorants from small river systems (Grayling, Rainbow Brown Trout sections, or other sensitive fish-grounds) to alternative areas such as bigger river systems, reservoirs, and large lakes. Essentially the aim is to reduce the 'local' impact of Cormorants.

5.6.2 Belgium

There is no legal shooting of Cormorants in Belgium. However, a few birds are known to be killed illegally each year.

5.6.3 Bulgaria

Cormorants were a legal object of hunting in Bulgaria until August 2002. However, such hunting is no longer permitted under new Biodiversity legislation, which took effect at the end of 2002. Single licenses (at present) can be issued by the Minister of Environment and Waters only under special circumstances (e.g. when there is proven damage at fish-ponds or for scientific investigations).

5.6.4 Czech Republic

Under Czech legislation, the Cormorant is a specially protected species. Shooting, disturbance etc. is allowed only with exception permitted by competent authorities. The unlimited shooting of Cormorants is permitted at the breeding localities only during the non-breeding season, with the exception of specially protected areas. In other areas, only defined numbers of Cormorants may be shot. Since autumn 2001, fishery managers can ask for financial compensation for damage caused by Cormorants.

5.6.5 Denmark

Culling is not undertaken but oiling of eggs is used as method to control unwanted population growth in certain regions. The effort is concentrated on sites where Cormorants attempt to establish new colonies on the ground on small islets. However, the majority of eggs are oiled in large ground nesting colonies in western and northern Jutland in an attempt to reduce the number of Cormorants foraging in the fjords in West Jutland. A general permit is given to all owners of standing fishing gear[13] to shoot Cormorants within 1000 m of standing fishing gear when it is in use. Individual permits were given on an annual basis to hunters to shoot Cormorants in two fjords (Ringkøbing Fjord and Nissum Fjord) between 1 September and 28 February during 2002 - 2004.

5.6.6 Estonia

A national management plan is being prepared for Estonia. The Cormorant is on the list of hunted seabirds (hunting is allowed from 20 August – 31 October). The Minister of the Environment can give single permits to shoot birds outside the hunting season or for destroying nests if there is evidence of Cormorant damage. Many cases of illegal persecution

[13] 'Standing fishing gear' is a term applied to any netting structure used to catch fish that is attached permanently to the shore (often by a leader net forcing fish into on offshore net bag or trap). Some types of standing fishing gear (e.g. fly nets) are exposed, and fish may be removed, at low tide, others (e.g. bag and pound nets) remain submerged throughout the tidal cycle and fish are removed from boats.

by local fishermen (i.e. destruction of nests and eggs and sometimes killing of nestlings) are known to have taken place.

5.6.7 Finland

There is no management in Finland concerning Cormorants. As yet, there have been no real conflicts concerning fisheries and Cormorants (see Table 3.1). Nevertheless, a few cases of illegal persecution (i.e. destruction of eggs or nests) have taken place.

5.6.8 France

In France, there is a national management plan of culling wintering Cormorants, with local quotas determined by the Environment Ministry, both in fish ponds and open waters (rivers with supposed endangered “patrimonial” species, these are fishes that have both high conservation status and high value as quarry species). This culling involves both immature and adult Cormorants and about 20,000 birds were killed in 2001/02. The Environment Ministry gives quota numbers for Cormorant killing to the local authorities (Departements) each year. Some Departements are not authorised to kill Cormorants. For those where killing is allowed, the local authorities have to control the ‘hunters’. Generally, these hunters are guards of the National Hunting Office (*Office National de la Chasse et de la Faune Sauvage*) or of the National Fish Council (*Conseil Supérieur de la Pêche*), and some local private individuals who are controlled by the official guards for killing operations on rivers. For fish farmers on their own fishponds, local authorities give personal (i.e named) permits. Thus, regulations ensure that ‘anonymous’ hunters are not allowed to kill Cormorants in France.

5.6.9 Germany

In Germany, regional management plans differ substantially. In some regions, especially in Bavaria, there is a general permit to shot Cormorants at most water bodies during the non-breeding season.

5.6.10 Greece

All sites where the ‘Continental’ (*sinensis*) race breeds in Greece are in protected areas (i.e. Ramsar, Special Protected Areas) and no intervention is allowed legally. No financial aid or compensation is given to fishermen (according to the Ministry of Agriculture no aid was required). Similarly, no permission was given in order to kill Cormorants (never required by fishermen).

5.6.11 Ireland

There is no national management plan for Cormorants in Ireland. Cormorants are protected in Ireland under the Wildlife Act (1976) and can only be disturbed or shot by license in exceptional circumstances under Section 42 of the Act.

5.6.12 Israel

Since 1996, there has been killing of Cormorants by a special team and fishermen everywhere in the fishpond areas of Israel, including roosting sites. Since 2002, there has been controlled shooting for frightening Cormorants at all fishponds simultaneously and the monitoring of the birds’ subsequent use of alternative foraging sites.

5.6.13 Italy

The Cormorant is a fully protected species under Italian national legislation. At the regional level there are management plans that differ quite substantially and allow shooting of birds during both the wintering and the breeding seasons to reduce predation and prevent the establishment of new colonies.

5.6.14 Latvia

No official permit for the killing of Cormorants exists in Latvia. But it is estimated that some hundred birds are shot illegally every year (especially at private fishponds) although exact numbers are unknown.

5.6.15 Lithuania

The unco-ordinated shooting of Cormorants at fishponds is considered ineffective in Lithuania. Thus, it is considered necessary to start a longer-term (e.g. three-year) co-ordinated regulation of the Cormorant population on a pan-European scale and to check the subsequent effects of any such action.

5.6.16 The Netherlands

There is no overall management of Cormorants in the Netherlands. There is some habitat management in nature restoration sites in the IJsselmeer area that are being freed from Willow (*Salix* spp.) growth. However, in a recent report it was shown that Cormorant density was highest at ground breeding sites, which would go against this particular management option. Cormorants have been disturbed on several occasions, sometimes as 'experiments' by local fishermen chasing birds away with fast boats on the IJsselmeer. In all colonies (either established or new) interference is zero up to now. Illegal actions are thought to have been taken only in very few cases. Colonies are found in protected areas belonging to either State, or private organisations. Any interference thus currently meets the various standards for management directives and responsibilities in particular areas. National (Flora en Faunawet) and International Law (EC Bird Directive) are followed closely; the majority of habitat is now included under these Directives.

5.6.17 Norway

The Management Authority in Norway considers Cormorants (*P. c. carbo*) and Shags (*P. aristotelis*) as valuable game species that should be managed in such a way that sustainable populations are maintained in all parts of their distribution area.

5.6.18 Poland

There is no management of Cormorants in Poland. The Cormorant is protected and the Minister of the Environment can give single permits to disturb birds (all year except for breeding colonies) or shoot them (except for breeding season, from 15 July till birds leave colonies). According to the latest regulations, this species can be hunted or disturbed all year on the fish ponds without special permissions. Some illegal destruction of nests occurs.

5.6.19 Portugal

There is no Cormorant management in Portugal.

5.6.20 Romania

Information was only available for the Danube delta, not for all of Romania. According to Romanian hunting law, the Cormorant can be shot from 15 August – 15 March. Shooting of Cormorants occurs especially at private fishponds. The Danube delta is a Biosphere Reserve and there is no programme to reduce Cormorant numbers here. Some illegal destruction of nests and roosts occurs, i.e. in 1991 approx. 180 young chicks were illegally killed in a colony in the lagoons by fishermen.

5.6.21 Slovenia

There is a national management plan for the culling of wintering Cormorants in Slovenia, with local quotas attributed since 2000/01 by the Ministry of Agriculture, Forestry, and Food. However, there has been no success in reducing bird numbers. Shooting occurs all over the country, except on sites protected under IBA and Ramsar Conventions, because neither bureaucracy nor anglers are willing to protect most vulnerable waters with threatened fish species at 'the expense' of larger water bodies.

5.6.22 Spain

Hunting and disturbing Cormorants is illegal in Spain. In some regions, financial aid for the construction of Cormorant exclosures of up to 50% of the total costs is paid.

5.6.23 Sweden

A national Cormorant management plan has recently been produced and implemented in Sweden. This plan suggests protective hunting be allowed close to (< 300m) standing fishing gears. Alternative non-lethal methods to reduce Cormorant predation should be developed at standing fishing gears. It also suggests that disturbance at colonies is used carefully due to the risk of spreading birds to new sites where they are not wanted. The plan also suggests that Sweden should work, within the EU, for an open hunting season on Cormorants.

5.6.24 Switzerland

Cormorant management in Switzerland is primarily to protect the Grayling. There is no Cormorant shooting on water bodies of less than 50 ha but locally co-ordinated Cormorant scaring/culling is undertaken on Grayling rivers.

5.6.25 UK

In England & Wales, licences to shoot limited numbers of Cormorants at specific sites can be issued as an aid to scaring. Applicants need to be able to demonstrate that 'serious' losses are occurring and that other management options have been tried and have failed or are impractical. There is an unknown level of illegal shooting. In Scotland, a mix of about 300 adult and immature birds is shot annually under licence during the non-breeding season. Licences to shoot limited numbers of Cormorants at specific sites can be issued as an aid to scaring. Applicants need to be able to demonstrate that 'serious' losses are occurring and that other management options have been tried and have failed or are impractical. There is an unknown level of illegal shooting.

5.7 Cormorant damage control activities at feeding sites

Of the 25 countries covered by REDCAFE that reported general information on site-specific actions (see 5.4), 16 (64%) also reported on the Cormorant damage control activities undertaken at feeding sites. These countries were Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Germany, Greece, Ireland, Israel, Italy, Lithuania, Poland, Portugal, Spain and the UK (England & Wales and Scotland). Only general information on the management of Cormorants was provided for the remaining countries because there was either little management there or because it was restricted to shooting (see 5.6). Two major datasets arose from the analysis of information provided on Cormorant damage control activities at feeding sites. First, a set of tables that show which management actions were taken in each country: the complete database is given in section 5.10 and the main findings in section 5.7 below. Second, a set of tables summarising the assessments of the effectiveness, practicability, acceptability, and costs of each technique or action: the complete database is given in section 5.11 and the main findings in section 5.8.

5.7.1 Cormorant damage control methods used in Europe

An important outcome of this synthesis of information is that, in spite of the long list of techniques and actions that have been tested against Cormorants at feeding sites, only a small number of them are used regularly. Most potential methods are either rarely used, not used at all, or have only been used in trials (see 5.10).

(1) Small rivers (width < 100m)

Eleven (69%) countries reported on small river habitats. Of these, three countries (i.e. Estonia, Poland, and Portugal) reported that no actions were taken against Cormorants in this habitat. A relatively small number of techniques or actions were used regularly on small rivers, in at least one country (Table 5.3).

(1) Resource management

Habitat

- Improve habitat quality for fishes

Fish

- Altering the timing of fish stocking
- Altering the stocked fish size

(2) Bird-proof barriers

- Wire, lines or string in parallel patterns
- Submersed fish refuges

(3) Wildlife Management: non-lethal techniques

Human harassment

- Human patrol on foot or in vehicles

Audio frightening techniques

- Gas bangers / cannons (propane gas exploders)
- Pyrotechnics / Fireworks (shell crackers, screamers, whistling projectiles, exploding projectiles, bird bangers, flash/detonation cartridges)
- Live ammunition

Wildlife Management: lethal techniques

- Shooting adults and immatures to reinforce non-lethal harassment
- Shooting adults and immatures to reduce bird numbers at specific sites

Table 5.3 Techniques or actions used regularly in efforts to reduce Cormorant impacts in small river habitats.

(2) Large rivers (width > 100m)

Nine (56%) countries reported on large river habitats. Of these, four countries (i.e. Estonia, Poland, Portugal and the UK [England & Wales]) reported that no actions were taken against Cormorants in this habitat. Only a small number of techniques or actions was used regularly on large rivers, at least in one country (Table 5.4).

(1) Resource management
Habitat management
- Improve habitat quality for fishes

(3) Wildlife Management: non-lethal techniques
Audio frightening techniques
- Live ammunition

Wildlife Management: lethal techniques
- Shooting adults and immatures to reinforce non-lethal harassment
- Shooting adults and immatures to reduce bird numbers at specific sites

Table 5.4 Techniques or actions used regularly in efforts to reduce Cormorant impacts in large river habitats.

(3) Small still waters (< 100 ha) without aquaculture

Ten (62%) countries reported on the small stillwater habitats. Of these, three countries (i.e. Belgium, Estonia, and Portugal) reported that no actions were taken against Cormorants in this habitat. Only a small number of techniques or actions was used regularly on small (non-aquaculture) stillwaters, at least in one country (Table 5.5).

(1) Resource management
Habitat management
- Increase of turbidity

(3) Wildlife Management: non-lethal techniques
Human harassment
- Human patrol on foot or in vehicles

Audio frightening techniques
- Gas bangers / cannons (propane gas exploders)
- Pyrotechnics / Fireworks (shell crackers, screamers, whistling projectiles, exploding projectiles, bird bangers, flash/detonation cartridges)
- Live ammunition

Visual frightening techniques
- Simple human effigies or scarecrows
- Combination of audio and visual techniques

Wildlife Management: lethal techniques
- Shooting adults and immatures to reinforce non-lethal harassment
- Shooting adults and immatures to reduce bird numbers at specific sites

Table 5.5 Techniques or actions used regularly in efforts to reduce Cormorant impacts in small (non-aquaculture) stillwater habitats.

(4) Very large water bodies (> 100 ha; stillwaters and coastal waters)

Nine (56%) countries reported on the very large water habitats. Of these, two countries (i.e. Estonia and Portugal) reported that no actions were taken against Cormorants in this habitat. Only a small number of techniques or actions were used regularly on large water bodies, at least in one country (Table 5.6).

(2)Bird-proof barriers
- Covering of fyke nets

3. Wildlife Management: non-lethal techniques
Human harassment
- Human patrol on foot or in vehicles or by boats

Audio frightening techniques
- Tin plates
- Gas bangers / cannons (propane gas exploders)
- Pyrotechnics / Fireworks (shell crackers, screamers, whistling projectiles, exploding projectiles, bird bangers, flash/detonation cartridges)
- Live ammunition

Wildlife Management: lethal techniques
- Shooting adults and immatures to reinforce non-lethal harassment
- Shooting adults and immatures to reduce bird numbers at specific sites
- Shooting adults and immatures to reduce regional population levels

Table 5.6 Techniques or actions used regularly in efforts to reduce Cormorant impacts on very large waterbodies (stillwaters and coasts).

(5) Aquaculture

All but one country (94%) reported on aquaculture habitats. The only country that did not was Greece. All of these countries reported that actions were taken against Cormorants in this habitat. A large number of techniques or actions were used regularly at aquaculture facilities (Table 5.7).

(1) Resource management
Fish management

- Altering the timing of fish stocking
- Altering the frequency of fish stocking
- Altering the density of fish stocked
- Altering the stocked fish size
- Locating most susceptible fish species and size close to the centre of human activity or near buildings

Facility construction

- Design / construction

(2) **Bird-proof barriers**

- Physical exclosures with narrow meshed systems (mesh sizes < 20 cm) using wire, lines or string in parallel or grid patterns
- Wire, lines or string in grid patterns (5 m mesh size)
- Wire, lines or string in grid patterns (7.5 m mesh size)
- Wire, lines or string in grid patterns (10 m mesh size)
- Wire, lines or string in grid patterns (>15 m)
- Wire, lines or string in parallel patterns (0.25 - 0.3 - (0.6) m)
- Partial exclosures (narrow meshed)
- Vertical nets in parallel patterns (set 5 - 10 m apart)
- Submersed anti-predator nets with 10 cm square mesh - submerged as curtains around floating net pens

(3) Wildlife Management: non-lethal techniques
Human harassment

- Human patrol on foot or in vehicles or by boats
- Simple human presence

Audio frightening techniques

- Sirens
- Vehicle horns
- Gas bangers / cannons (propane gas exploders)
- Pyrotechnics / Fireworks (shell crackers, screamers, whistling projectiles, exploding projectiles, bird bangers, flash/detonation cartridges)
- Live ammunition

Visual frightening techniques

- Simple human effigies or scarecrows
- Animated scarecrows (moving and/or in combination with automated sound devices)
- Mylar tape
- Combination of audio and visual techniques

Wildlife Management: lethal techniques

- Shooting adults and immatures to reinforce non-lethal harassment
- Shooting adults and immatures to reduce bird numbers at specific sites
- Shooting adults and immatures to reduce regional population levels

Table 5.7 Techniques or actions used regularly ion efforts to reduce Cormorant impacts at aquaculture facilities.

5.8 Assessments of techniques and actions used regularly

The full database for these assessments is given in section 5.11 and the main findings for each technique/action and for each of the five Cormorant feeding habitats are summarised in this section.

5.8.1 Assessments of each technique and action

1. Resource management

1.1. Habitat management

(a) Improve habitat quality for fishes

This was used only at small rivers and to some extent at larger rivers and very large water bodies. In general it was stated that the actions taken to improve habitat quality for fishes are not aimed directly at reducing Cormorant predation but are general measures to improve fish habitat and, consequently, fish populations. It was thought that, to some extent at least, more natural habitats also help fishes to avoid predation and/or to improve their reproduction. The effectiveness was given as months to years. Its practicability was mostly high, its acceptability was also mostly high. However, costs were recorded as being high to very high.

(b) Increase of turbidity

Only REDCAFE participants from the UK (England & Wales) mentioned the increase of turbidity as being regularly used at small still waters. However, this technique is not used specifically against Cormorants. Stocking of large benthic species (e.g. Carp *Cyprinus carpio*) at fisheries (now commonplace in England & Wales) is responsible for increased water turbidity. The effectiveness of the method was not known. It was considered to be of medium practicability and costs. However, acceptability seemed questionable on biodiversity/aesthetic grounds.

1.2. Fish management

(a) Altering the timing of fish stocking

Regularly used at small and large rivers and in aquaculture. Effectiveness was from days to months at small rivers and from not effective to months in aquaculture. Practicability was mostly medium to very high, acceptability ranged from low to very high and costs ranged from very low to very high. This wide variation appeared to be dependent on the individual case and group of stakeholders concerned.

(b) Altering the frequency of fish stocking

Only used regularly in aquaculture. Effectiveness was months, practicability was medium to high, acceptability also medium to high, and costs low to medium.

(c) Altering the density of fish stocked

Only used regularly in aquaculture. Effectiveness ranged from not effective to months, practicability from medium to very high, acceptability was mostly medium to high, costs low to high. This technique was used in two ways. For example, in Austria, Carp pond owners increased stocking, while Germany reported lowering fish density in Carp ponds. In general, anglers, as stated for small rivers in the UK (England & Wales), would not favour lower fish densities.

(d) Altering the stocked fish size

Used regularly on small rivers and aquaculture. Effectiveness was months at small rivers while it ranged from not effective to months in aquaculture. Practicability was medium to high, acceptability was medium to very high at small rivers, but low to high in aquaculture.

Similarly costs were give as medium to very high at small rivers and low to medium at aquaculture, depending on the size of the fish stocked. A shift towards the stocking of larger fish would almost certainly be more expensive than the stocking of smaller individuals.

(e) Locating most susceptible fish species and size close to the centre of human activity or near buildings

Only used regularly in aquaculture. Ranged from not effective to days and even months. Thus effectiveness was strongly dependent on the local situation. For example in Italy, fishing gears and fish wintering basins are often located close to buildings and areas used by humans. However, Cormorants were not discouraged from foraging if active means were not used (e.g. blank shots, shooting, human patrolling, etc.). Practicability was mostly given as medium to high, acceptability was low to high, costs were very low to high, again highlighting considerable site-specific differences.

1.3. Facility construction

Design / construction

This referred to the fact that all aquaculture facilities (i.e. for salmonid production) in Denmark were designed in a way that allows use of wires (see below).

2. Bird-proof barriers

(a) Physical exclosures with narrow meshed systems (mesh sizes mostly < 20 cm) using wire, lines or string in grid patterns

Narrow meshed systems (spacing. 10 – 20 cm) were used widely at salmonid rearing facilities in Europe mostly using polyester string. Sometimes, these systems were also used at other types of aquaculture facility. For example, to protect wintering ponds or for partial exclosures (see below) in Carp production. In Denmark, all freshwater aquaculture facilities must be protected with these systems by law. Two important commercial producers of narrow meshed systems are the Danish companies Forelco and Gamsen, both based in Billund. Both companies sell their systems in many European countries. Sometimes these systems cause high visual impact as the strings and wires are mounted 4 – 5 m overhead on wooden poles to avoid negative impacts on the daily work operations of the fish farms protected. The effectiveness was generally given as years. The systems sometimes need maintenance after severe weather, especially ice rain and storms. Practicability was mostly medium to high, acceptability ranged from medium to very high. Costs were generally considered to be high (e.g. 15,000 – 20,000 €/ha). However when calculating over a ten year minimum life-span, the costs break down to 1,500 – 2,000 €/ha/year. In the UK (England & Wales) these systems were mainly used to reduce Grey Heron (*Ardea cinerea*) predation. Aquaculture facilities of up to 20 ha can easily be protected with narrow meshed systems.

(b) Wire, lines or string in grid patterns (5 m mesh size)

(c) Wire, lines or string in grid patterns (7.5 m mesh size)

(d) Wire, lines or string in grid patterns (10 m mesh size)

Only used at aquacultures in Germany, Italy and the UK (England & Wales). Its effectiveness was given from days to years. Practicability was given as low/medium to high, acceptability was medium to high and costs were low to high. Problems with this technique involved the potential for non-target waterbird species to crash into the wires and strings when trying to land on protected ponds, especially at night. Cormorants may learn quickly how to avoid the wires and strings. If there are large numbers of birds present, the protected ponds are densely stocked and/or there are only few alternative feeding sites, it is likely that Cormorants will learn to fish in ponds protected in such a way. In the UK (England & Wales) these systems were mainly used to reduce Grey Heron predation.

(e) Wire, lines or string in grid patterns (>15 m)

Used in Israel against Great White Pelican (*Pelecanus onoccrotalus*). However considered not effective for either Pelicans or Cormorants.

(f) Wire, lines or string in parallel patterns (0.25 - 0.3 - (0.6) m)

(i) Similar systems, use and assessments of effectiveness, practicability, acceptability and costs as described above at a) Physical exclosures with narrow meshed systems (mesh sizes < 20 cm) using wire, lines or string in grid patterns.

(ii) Parallel strings of unknown spacing are also used regularly to protect special sections of the two small Belgian rivers Amblève and Loue (both salmonid rivers) where fly fishing is traditional and during the winter months.

(g) Partial exclosures (narrow meshed)

These systems have been tested and used only in Italy and Germany. Here, large ponds were partially covered (mostly about 10% of the water surface) by a narrow meshed system as described above at a) Physical exclosures with narrow meshed systems (mesh sizes < 20 cm) using wire, lines or string in grid patterns. The protected part of the pond served as a fish refuge that the fish (Carp in Germany) enter during the day when attacked by Cormorants. The Carp are also given supplementary food in the protected part of the pond. At night, the Carp then can use the whole pond for feeding. The effectiveness is given as months to years. Its practicability ranged from low to medium to high, depending on the local situation. Acceptability was medium to high and costs were generally medium. As only about 10% of a pond can be covered, costs in general were only 10% of a regular (full) narrow-meshed system (e.g. 150 – 200 €/ha/year).

(h) Submersed fish refuges

Only regularly used at small rivers in Germany and the UK (England & Wales). As the improvement of habitat quality (see above 1.1. Habitat management; a) Improve habitat quality for fishes) this method was not directly aimed at reducing Cormorant predation but it was a general measure to improve fish habitat and, consequently, fish populations. The effectiveness was given as years. Its practicability was low to high, its acceptability mostly medium to very high, and costs were medium to high. Problems with navigation and land drainage may occur. The structures also need to be secured against flood flows.

(i) Vertical nets in parallel patterns (set 5 - 10 m apart)

Submersed fences that do not allow Cormorants to dive through; in Germany used on Carp ponds, in Italy used to discourage Cormorant access to canals connecting large growth basins and small basins used for fish wintering and stocking. Effectiveness was days to years, practicability was medium to high, acceptability was medium and costs were given as low to medium.

(j) Submerged anti-predator nets with 10 cm square mesh - submerged as curtains around floating net pens

Ireland & UK (Scotland): The nets used are generally standard predator nets at aquaculture sites and are not usually specific for Cormorants. In use were submerged anti-predator nets with 10 cm square mesh (submerged as curtains around floating net pens). Effectiveness was years, practicability and acceptability were very high, costs were high.

(k) Covering of fyke nets

In Denmark and Germany (Mecklenburg-Vorpommern) fyke nets in the Baltic Sea are regularly covered with nets. Also the roosting of Cormorants on the poles of the fykes is prevented. Unfortunately, the effectiveness was unknown, practicability and acceptability were given as high, costs as medium.

3. Wildlife Management

3.1. Non-lethal techniques

3.1.1. Human harassment

(a) Human patrol on foot or in vehicles or by boats

Human patrol was one of the most commonly used actions taken against Cormorant predation in the countries covered by REDCAFE. This technique was regularly practised at small rivers, small still waters, very large water bodies and at aquaculture facilities. In spite of its wide use, it was generally considered as being only effective in the short-term, ranging from not effective to being effective for hours or sometimes days. To keep Cormorants away for longer periods, an almost constant presence of humans was considered necessary. Consequently, costs can be high if working time has to be paid for (i.e. wages). However, if human presence involved volunteers (e.g. unpaid anglers, hunters), then the costs of this method can be quite low (e.g. fuel costs for vehicles). Practicability and acceptability ranged from low to very high and depended on the local situation and the stakeholders involved.

(b) Simple human presence

In Poland a regularly used method in aquaculture was simple human presence. But, this was considered ineffective.

3.1.2. Audio frightening techniques

(a) Sirens

Only used at aquacultures in Israel and Italy, but not effective or effective for hours at best.

(b) Vehicle horns

Only used at aquacultures in Israel and Italy, but not effective.

(c) Tin plates

A special technique of unknown effectiveness, only used regularly at Lake Kerkini in Greece.

(d) Gas bangers / cannons (mostly propane gas exploders)

One of the most widely used techniques in countries covered by REDCAFE. Regularly used at small rivers, small still waters, very large water bodies (in special situations such as fyke nets), and in aquaculture facilities. In spite of its wide use, it was generally considered as being only effective in the short-term, ranging from not effective to being effective for hours or up to days (weeks under rare conditions). Practicability was mostly high (but ranged from low to high), acceptability ranged from low to very high, depending on the local situation and the stakeholders involved. Costs were mostly given as low to medium. In Germany this techniques was often used for short, highly sensitive, periods to restrict local damage, i.e. during the draining of Carp ponds. In Italy its use was limited to small water basins. The sounds (noises) may negatively effect other non-target species as well as workers and other people. In general, it was most effective if moved regularly and used in conjunction with other visual deterrents.

(e) Pyrotechnics / Fireworks (shell crackers, screamers, whistling projectiles, exploding projectiles, bird bangers, flash/detonation cartridges)

Also a rather widely used technique. But, its use was restricted due to legal restrictions in some countries. It was used at small rivers, small still waters, very large water bodies and in aquaculture. Its effectiveness mostly ranged from not effective to days (up to weeks at small still waters and up to months in aquaculture). Practicability and acceptability ranged from low to very high, depending on the local situation and stakeholders involved. Like the gas bangers, the noises can have negative impacts on other wildlife and people. Costs were mostly given as medium to high which, at least in part, depended on whether wages were paid.

(f) Live ammunition

The use of live ammunition was one of the most widely used techniques in countries covered by REDCAFE. It was one of the few techniques reported from all five types of waterbody habitat. It was more widely distributed than the use of pyrotechnics, as live ammunition is often cheaper and more readily available. Also, there are fewer legal restrictions for its use. Again, in spite of its wide use, it was generally considered as being only effective in the short-term, ranging from not effective to being effective for hours or up to days (weeks or months under rare conditions). Its practicability and acceptability ranged from low to very high, depending on the local situations and stakeholders involved. Costs ranged from low to high which, at least in part, depended on whether wages were paid.

3.1.3. Visual frightening techniques

(a) Simple human effigies or scarecrows

Widely used in aquaculture and sometimes also regularly used at small still waters. It was more or less not effective or effective for up to days at best. Costs were mostly given as low. Practicability and acceptability ranged widely from low to very high.

(b) Animated scarecrows (moving and/or in combination with automated sound devices)

Regularly used in aquaculture facilities in Germany and the UK (England & Wales). Best when used in conjunction with other audio scarers and if moved regularly. Effective only for days, practicability was high and acceptability was medium. Costs were given as low to medium.

(c) Mylar tape

Regularly used in aquaculture facilities in Germany, Italy, and the UK (England & Wales). Effective only for days at best. Mylar is short lasting and breaks very easily in bad weather conditions. Thus, it may be a cause of both visual and water pollution. Costs were very low to low. Practicability ranged from low to high depending on local situations. Acceptability was medium.

(d) Combination of audio and visual techniques

Audio and visual techniques are mostly used in combination at aquaculture facilities but also at small rivers and in few cases at large rivers. At small still waters and in aquaculture its effectiveness was given as days to weeks, at very large water bodies only as hours to days. Practicability ranged from medium to high, acceptability was generally given as medium. Costs were given as very low to medium.

3.2. Lethal techniques

(a) Shooting adults and immatures to reinforce non-lethal harassment

Shooting of Cormorants to reinforce non-lethal harassment was reported from most of the countries included in this part of the REDCAFE synthesis. Only Estonia, Portugal and Spain reported no legal shooting at all. This technique/action was reported from all five types of water body. Its effectiveness was generally short-term, ranging from not effective to days at large rivers and very large water bodies to being effective for days to even weeks and months in aquaculture. Clearly, shooting can only be effective for weeks and months in special conditions, especially when there are stable bird populations and when there is little exchange ('turnover') of birds. The practicability ranges from low to very high, depending on the local situation and the size of the water body that is to be protected. Acceptability ranged from low to very high, depending on the stakeholders involved. Costs ranged from low to very high, depending on whether wages had to be paid or not. Similar to the audio techniques, noise from shooting may have negative impacts on other wildlife and people.

(b) Shooting adults and immatures to reduce bird numbers at specific sites

Shooting of Cormorants to reduce bird numbers at a specific site was reported in most countries. Only Estonia, Portugal and Spain reported no legal shooting at all. This technique/action was also reported from all five types of water body. Its effectiveness was also generally short-term, ranging from not effective to days at large rivers to being effective for days to even weeks and months in aquaculture. Clearly, shooting can only be effective for weeks and months in special conditions, especially when there are stable bird populations and when there is little exchange ('turnover') of birds. Some recent papers showed that shooting was not effective in reducing Cormorant numbers in France, Germany, and Austria due to the migration of birds. Shot birds were quickly replaced by new ones, especially at very attractive feeding sites (Keller & Lanz 2003; Marion 2003; Parz-Gollner 2003). The practicability ranged from low to very high, depending on the local situation and the size of the water body that was to be protected. Acceptability ranged from low to very high, depending on the stakeholders involved. Costs also ranged from low to very high, depending on whether wages had to be paid or not. Similar to the audio techniques, the noises of shooting may have a negative impact on other wildlife and people. As in some German states, the shooting of Cormorants was often only considered a means for fishermen to work off their frustration with Cormorants. Also, shooting often only appeared to change the distribution of Cormorants, rather than reducing their numbers even locally.

(c) Shooting adults and immatures to reduce regional population levels

At least officially, shooting to reduce regional population levels was only practised in a few countries covered by REDCAFE. Nevertheless, some of the shooting done in France and Germany probably comes under this category, although it is not officially stated as such. Shooting adults and immature Cormorants to reduce regional population levels was only, or has been, practised at very large water bodies in Denmark (two fjords), in Italy (Sardinia), and Sweden, and at aquacultures in the Czech Republic, Israel, and in Italy (Oristano lagoons in Sardinia). Its effectiveness ranged from unknown to days in the cases of Denmark, the Czech Republic, and Sweden, and from days or months in Israel and Italy (Sardinia). Clearly, an effectiveness of months can only be achieved when the bird populations are rather stable and shot birds are not being replaced quickly, as may be the case in mid-winter in Israel and Sardinia. Practicability was mostly given as low. Acceptability ranged from low to very high, depending on the stakeholders involved. Costs were considered to be medium to very high.

5.8.2 Assessments in relation to Cormorant feeding habitat

The following five figures (Figures 5.1 – 5.5) summarise effectiveness, practicability, acceptability and cost information for those techniques/actions used against Cormorants in five different feeding habitats.

Technique/action	Effectiveness					Practicability					Acceptability					Costs				
	yrs	mon	dys	not	?	v. high	high	med	low	not	v.high	high	med	low	not	v.high	high	med	low	v.low
Habitat management																				
improve fish habitat quality	■	■					■					■				■	■			
increase turbidity																				
Fish management																				
alter fish stocking: timing		■	■			■	■	■			■	■	■	■		■	■	■	■	
alter fish stocking: frequency																				
alter fish stocking: density																				
alter fish stocking: fish size		■					■	■			■	■	■			■	■	■		
relocate susceptible species																				
(2) Bird proof barriers																				
narrow meshed systems																				
wires etc 5m mesh																				
wires etc 7.5m mesh																				
wires etc 10m mesh																				
wires > 15m																				
parallel wires																				
partial exclosures																				
submerged fish refuges	■						■	■	■		■	■	■				■	■		
vertical parallel nets																				
submerged anti-predator nets																				
covering fyke nets																				
(3) Wildlife management: non-lethal																				
Human harassment																				
human patrol on foot/vehicles			■	■		■	■	■	■		■	■	■	■			■		■	
human presence																				
Audio techniques																				
sirens																				
vehicle horns																				
tin plates																				
gas bangers/cannons			■	■			■				■	■	■	■				■	■	
pyrotechnics/fireworks		■	■	■		■	■	■	■		■	■	■	■			■	■		
live ammunition		■	■	■		■	■	■	■		■	■	■	■			■	■	■	
Visual techniques																				
simple scarecrows																				
animated scarecrows																				
Mylar tape																				
audio:visual combination			■				■	■					■					■	■	■
Wildlife management: lethal																				
shooting to reinforce harassment		■	■	■		■	■	■	■		■	■	■	■		■	■	■	■	
shooting to reduce numbers at sites		■	■	■		■	■	■	■		■	■	■	■		■	■	■	■	
shooting to reduce regional numbers																				

Figure 5.1 Effectiveness, practicability, acceptability and cost of techniques used regularly in small rivers.

Technique/action	Effectiveness					Practicability					Acceptability					Costs				
	yrs	mon	dys	not	?	v. high	high	med	low	not	v.high	high	med	low	not	v.high	high	med	low	v.low
(1) Resource management																				
Habitat management																				
improve fish habitat quality	■	■					■					■				■	■			
increase turbidity																				
Fish management																				
alter fish stocking: timing		■	■	■		■	■	■			■	■	■	■		■	■	■	■	■
alter fish stocking: frequency																				
alter fish stocking: density																				
alter fish stocking: fish size																				
relocate susceptible species																				
(2) Bird proof barriers																				
narrow meshed systems																				
wires etc 5m mesh																				
wires etc 7.5m mesh																				
wires etc 10m mesh																				
wires > 15m																				
parallel wires																				
partial exclosures																				
submerged fish refuges																				
vertical parallel nets																				
submerged anti-predator nets																				
covering fyke nets																				
(3) Wildlife management: non-lethal																				
Human harassment																				
human patrol on foot/vehicles																				
human presence																				
Audio techniques																				
sirens																				
vehicle horns																				
tin plates																				
gas bangers/cannons																				
pyrotechnics/fireworks																				
live ammunition		■	■	■		■	■	■	■		■	■	■	■			■	■	■	
Visual techniques																				
simple scarecrows																				
animated scarecrows																				
Mylar tape																				
audio:visual combination			■				■	■					■					■	■	■
Wildlife management: lethal																				
shooting to reinforce harassment		■	■	■		■	■	■	■		■	■	■	■		■	■	■	■	
shooting to reduce numbers at sites		■	■	■		■	■	■	■		■	■	■	■		■	■	■	■	
shooting to reduce regional numbers																				

Figure 5.2 Effectiveness, practicability, acceptability and cost of techniques used regularly in large rivers.

Technique/action	Effectiveness					Practicability					Acceptability					Costs				
	yrs	mon	dys	not	?	v. high	high	med	low	not	v.high	high	med	low	not	v.high	high	med	low	v.low
(1) Resource management																				
Habitat management																				
improve fish habitat quality																				
increase turbidity					■			■						■	■			■		
Fish management																				
alter fish stocking: timing																				
alter fish stocking: frequency																				
alter fish stocking: density																				
alter fish stocking: fish size																				
relocate susceptible species																				
(2) Bird proof barriers																				
narrow meshed systems																				
wires etc 5m mesh																				
wires etc 7.5m mesh																				
wires etc 10m mesh																				
wires > 15m																				
parallel wires																				
partial exclosures																				
submerged fish refuges																				
vertical parallel nets																				
submerged anti-predator nets																				
covering fyke nets																				
(3) Wildlife management: non-lethal																				
Human harassment																				
human patrol on foot/vehicles			■	■		■	■	■	■		■	■	■	■			■		■	
human presence																				
Audio techniques																				
sirens																				
vehicle horns																				
tin plates																				
gas bangers/cannons			■	■			■				■	■	■	■				■	■	
pyrotechnics/fireworks		■	■	■		■	■	■	■		■	■	■	■			■	■		
live ammunition		■	■	■		■	■	■	■		■	■	■	■			■	■	■	
Visual techniques																				
simple scarecrows			■	■		■	■	■	■		■	■	■	■					■	
animated scarecrows																				
Mylar tape																				
audio:visual combination																				
Wildlife management: lethal																				
shooting to reinforce harassment		■	■	■		■	■	■	■		■	■	■	■		■	■	■	■	
shooting to reduce numbers at sites		■	■	■		■	■	■	■		■	■	■	■		■	■	■	■	
shooting to reduce regional numbers																				

Figure 5.3 Effectiveness, practicability, acceptability and cost of techniques used regularly in small stillwaters.

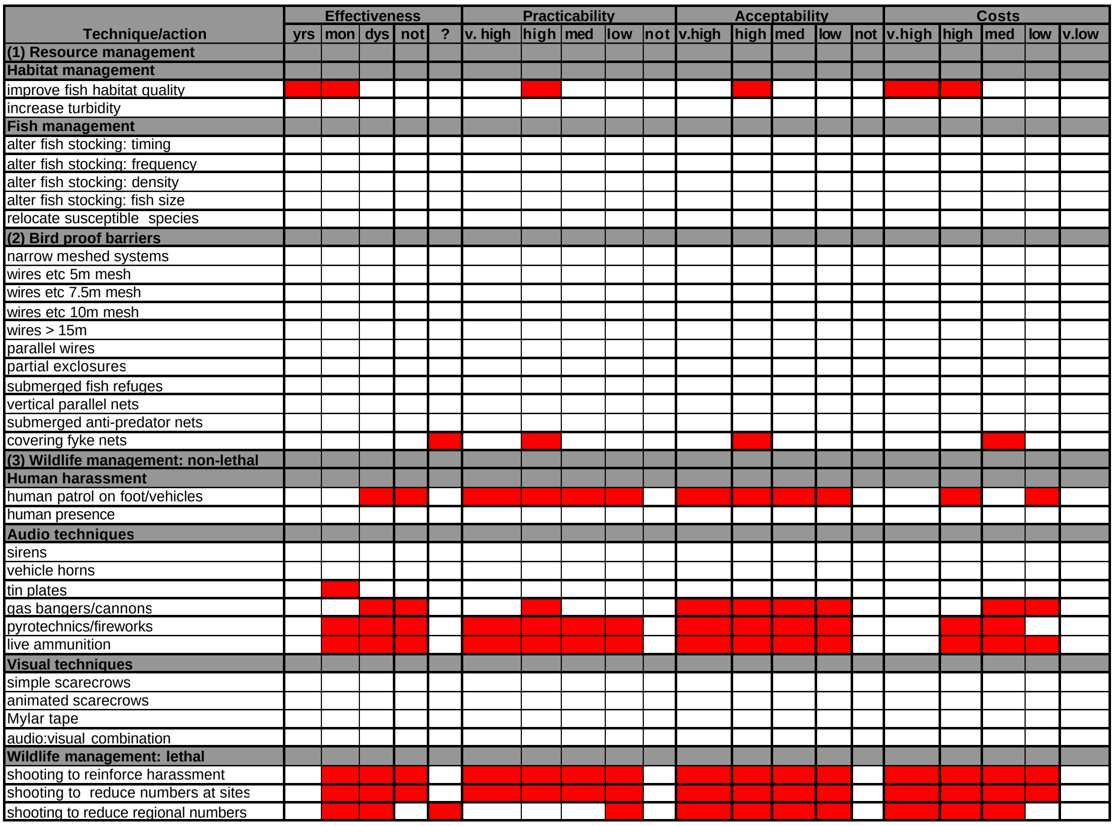

Figure 5.4 Effectiveness, practicability, acceptability and cost of techniques used regularly in very large waters: lakes and coasts.

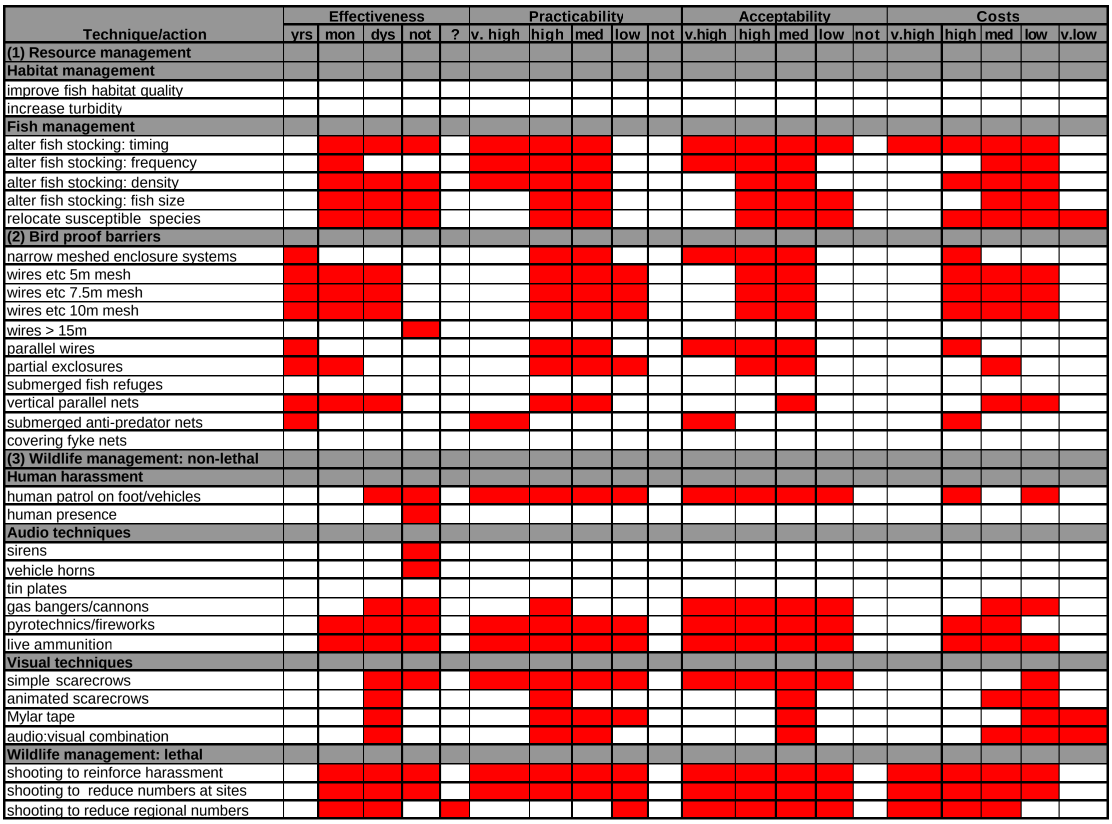

Figure 5.5 Effectiveness, practicability, acceptability and cost of techniques used regularly in aquaculture.

5.9 Discussion

Work for this synthesis aimed to provide a comprehensive overview of potential Cormorant management tools. This Chapter provides a review of population modelling and a synthesis of site-specific techniques and actions used against Cormorants. The synthesis also includes semi-quantitative information on the 'usefulness' of techniques in relation to their effectiveness (i.e. how long a technique works for), practicability (i.e how easy the technique is to use), acceptability (i.e. how the technique is viewed by both stakeholders and the general public) and costs. REDCAFE participants provided information for this synthesis, often after discussions with local stakeholders over their experiences.

5.9.1 Cormorant population modelling

Current, state-of-the-art, Cormorant population modelling suffers from a number of uncertainties (see 5.3). These uncertainties arise over measurements of Cormorant population size, the strength of natural regulating mechanisms , and the extent of planned or unplanned human interventions Frederiksen *et al*. (2001). Such uncertainties are, however, a general phenomenon in the management of wildlife and natural resources, and this is one of the most compelling arguments for the use of adaptive management strategies (Walters 1986). Frederiksen *et al*. (2001) offered suggestions for the use of population modelling in planning any pan-European Cormorant cull. The most well-supported model scenarios using current information indicated three important things. First, that the effect of culls at the 1998-9 level (i.e. 17, 000 birds shot) was limited. Second, that increasing the annual cull to 30, 000 birds would have limited effect at the population level. Third, that shooting 50, 000 birds per year was predicted to lead to population extinction in 20-40 years.

Frederiksen *et al*.'s (2001) modelling approach also demonstrated that increasing the number of culled Cormorants was risky because once the compensatory power of the population is overcome, it will inevitably decline towards extinction if the cull is unchecked. One general inference was that culls should be planned so that they become the most powerful density-dependent mechanism affecting the target population. This strategy would require a well parameterised population model and should also be accompanied by monitoring programmes.

Furthermore, Frederiksen *et al*. (2001) considered that even though Cormorant population control through culling was feasible it may not be the most efficient, economical or ethical way of limiting Cormorant damage to fisheries, and other interests, across Europe. They also cited research that suggests several limitations to culling. First, large-scale culls are inevitably expensive to carry out and they do not necessarily discourage Cormorants from continuing to use roosts and associated feeding areas (McKay *et al*. 1999). Second, subsequent to any cull, the numbers of Cormorants feeding at particular sites might decline less than the total number (or not at all) because these sites are high (optimal) quality habitats. Culls in such optimal foraging habitats may thus even reduce populations primarily in sub-optimal habitats where economic interests are less important (Bregnballe *et al*. 1997). Third, there is growing evidence that culling is inefficient in situations with large turnover of individuals (Keller & Lanz 2003). Large numbers of birds may be shot but are quickly replaced by new individuals (see also Box 6.2).

Current (2001-02 unless otherwise stated) estimates of the numbers of Cormorants killed in Europe recorded for the present synthesis (Table 5.2) have implications for the Cormorant modelling reported here and these are discussed in section 5.9.2 below.

5.9.2 Relatively large-scale Cormorant control

The current synthesis of general information on actions against Cormorants included information from all 25 countries covered by the REDCAFE project (see full list in Table 5.2, also map Figure 2.1). REDCAFE participants reported that some form of national or regional Cormorant management plan was in effect in 11 (44%) of these countries (for full lists of relevant countries see section 5.5). A further four countries (16%) had a legal regulation in effect that allowed Cormorant culling. Overall, such a regulation was in effect in 14 (56%) counties. In a further 6 (24%) countries licences could be obtained for the limited killing of Cormorants at particular sites as a aid to scaring. In most countries (84%), there was either no killing of Cormorants or it was uncoordinated. Few countries (16%) had a co-ordinated culling programme, these operated only in Denmark and France and in parts of Italy and Switzerland. In 13 countries (52%) it was mandatory to obtain single permits for the killing of Cormorants. However, many of these countries had issues general permits for some areas or regions. Altogether, 12 countries (48%) had thus issued some kind of general permit. Few countries (or regions therein) provided either financial compensation for fish losses caused by Cormorants or financial aid for Cormorant exclosures or scaring programmes (16% and 24%, respectively).

Of the 25 countries covered by the REDCAFE project, ten (40%) recorded the destruction or disturbance of Cormorant colonies in recent (i.e. 1990-2002) years, with 102 colonies reported to be affected annually. As a result a minimum of 5,194 Cormorant nests were reported to be destroyed annually in five countries (20%). A total of between 600-650 Cormorant nestlings were also reported to be killed in three (12%) countries. Numbers of both nests and nestlings are known to be under-recorded because such actions have also been undertaken in Sweden although numbers are unavailable. Around 10, 000 adult Cormorants (of the 'Atlantic' *carbo* race) are hunted legally as game in Norway outside the breeding season. During this time of year, a further 18 (72%) countries reported killing Cormorants (mostly the 'Continental' *sinensis* race) as a control measure. Here, between 41-43, 000 adult birds (including young birds in their first winter) were reported to be killed annually. However, given the unprecedented number of Cormorants killed in France in 2001/02, and the fact that many of the birds killed were juveniles in their first winter, it is more appropriate to say that between 41-43, 000 fully grown birds were killed in 2001/02.

The only countries were no birds were reported to be killed legally were Belgium, Finland, the Netherlands, Portugal, Spain and Sweden (in Sweden this was only outside the breeding season). A further 4,598 Cormorants were reported to be killed annually during the breeding season in six (24%) countries. However, this was an underestimate because the numbers for Bulgaria were unknown. Over 248 night roosts were reported to be destroyed or damaged annually in nine (36%) countries. This figure was presumed to be a considerable underestimate because roosts were known to have been destroyed or disturbed in three other countries (Czech Republic, Germany and Switzerland) but the numbers involved were unknown.

Unfortunately, a proper evaluation of how these figures for killed cormorants might affect the pan-European population would require a new modelling exercise, with spatial structure. However it seems clear (Frederiksen pers. comm.) that the consequences must be smaller than originally predicted in Frederiksen *et al.*'s (2001) study, simply because the total Cormorant population is now bigger than it was expected to be.

Finally, Frederiksen *et al*. (2001) suggested that, before deciding on a pan-European culling strategy for Cormorants, management authorities should consider whether to control Cormorants, or the damage that they cause. The present synthesis of techniques currently used to reduce Cormorant damage, at the site-specific level, is discussed in the next section.

5.9.3 Site-specific actions

A total of 33 site-specific techniques used regularly to reduce the effects of Cormorants at feeding sites were recorded for 16 countries (see 5.7 for full list). However, only three techniques were used regularly at all five feeding habitats (small rivers, large rivers, small stillwaters, very large waterbodies, aquaculture): the use of live ammunition to scare birds, shooting birds to reinforce other forms of scaring, and shooting birds to reduce their numbers at specific sites.

Eleven techniques were recorded in regular use on small and large rivers. Only two of these appeared to be effective in the long-term (i.e. years), both of them (improving fish habitat quality and submerged fish refuges) were primarily related to the management of fishes rather than to that of Cormorants. Nevertheless, they were reported to have positive effects in relation to reducing Cormorant impacts. Several other techniques appeared to be effective on rivers for months. However, their practicability, acceptability and costs were variable, presumably reflecting, at least to some extent, site-specific circumstances at particular fisheries.

Eight techniques were recorded in regular use on small lakes. All of these techniques appeared to be effective only for days, the exceptions being the use of two audio techniques (pyrotechnics/fireworks and live ammunition) and two lethal techniques (shooting to scare or to kill limited numbers of birds). Again as for rivers, practicability, acceptability and costs were highly variable, presumably reflecting site-specific circumstances.

Ten techniques were recorded in regular use on very large water bodies (lakes and coasts). Three audio techniques and three lethal Cormorant control techniques appeared effective over the time-scale of weeks to months. Other techniques appeared effective for only days. Again as in other feeding habitats, practicability, acceptability and costs were highly variable, presumably reflecting site-specific circumstances.

By far the greatest number of techniques was used at aquaculture facilities where 28 techniques were recorded in regular use. Eight bird-proof barrier techniques appeared to be effective for up to years, although in some cases the same techniques were reported only to be effective for days. Alterations to fish stocking at aquaculture facilities appeared to be effective for up to months, as did the use of two audio techniques (pyrotechnics/fireworks and live ammunition) and three forms of lethal Cormorant control. However, as for all other Cormorant feeding habitats, there was considerable variation in practicability, acceptability and costs, presumably reflecting site-specific circumstances. This synthesis also highlighted two other techniques for aquaculture facilities that appeared to warrant further research. The first involved the production of large one-year old (> 100 g) and two-year old Carp (> 700 g) through supplementary feeding, a technique tested successfully in Saxony (eastern Germany). The main principle is to let the Carp quickly grow too big for Cormorants in their 2nd summer of life (in Saxony this is the most problematic time as the Carp are normally of optimal size for Cormorants at this age under 'normal' growth conditions). The second involved the use of high-pressure water jet systems, also tested successfully on Carp ponds in Germany. A very positive side effect of this technique is that the ponds also get aerated, this is especially important during summer when oxygen levels in Carp ponds can fall to very low levels. These two techniques, or variants of them, may be applicable to other regions in Germany and elsewhere in Europe where fish are grown in large ponds.

5.9.4 Concluding remarks

It was clear that very few techniques were, according to the experience in 16 countries covered by this part of the synthesis, considered to be effective in the long-term (i.e. years). These long-term techniques appear to fall into two broad categories. First, those involving the alteration of fish habitat at some 'natural' rivers and lakes. These techniques are primarily employed as a fishery management tool, as opposed to a Cormorant management one. Second, those involving the erection of various bird proof barriers (e.g. narrow mesh enclosures, wires, submerged anti-predator nets) at aquaculture facilities (both ponds and net pens/cages). Many other techniques used regularly can be effective for up to months at some sites. However, the same techniques were reported to be effective for only days, or not at all, at other sites.

Overall, the practicability, acceptability and costs of all techniques used regularly were highly variable. The most likely explanation for such variation is that it is related to site-specific features. These are likely to be two-fold. First, the physical location of the site, its size, the type of fishery, the number of Cormorants involved etc. Second, the scale of the Cormorant 'problem' in financial terms.

Stakeholders thus have a long list of possible management actions against Cormorants but relatively little guidance on their likely effectiveness, practicability, acceptability or costs at a specific site. Therefore it seems likely that adopting 'new' techniques to reduce Cormorant impacts at feeding sites, in whatever habitat, is likely to be a case of trial-and-error in the majority of cases. There are also numerous possibilities for using various techniques in combination, or for changing techniques used in time and/or space as a reaction to changing site-specific conditions. Clearly, considerably more work is required to trial the use of techniques to reduce Cormorant impact at feeding sites. There is also an urgent need for detailed information on the site-specific effectiveness, practicability, acceptability and costs of specific techniques to be disseminated as widely as possible to relevant stakeholders. Thus the formation of an information exchange network would be a very useful tool to facilitate the rapid transfer of ideas, experiences, techniques, their implementation and subsequent outcomes. It could also offer stakeholders opportunities for discussion and could provide them with clear information on the actual costs (both invested and saved) of specific techniques.

6 Cormorant-fishery conflict resolution: a case study

6.1 Introduction

This Chapter reviews the REDCAFE analysis of a specific Cormorant-fishery conflict case study. This work Package was designed to give REDCAFE participants and local stakeholders the opportunity to share their knowledge and experience. This case study also formed the basis for evaluating REDCAFE progress and the applicability of the 'REDCAFE experience' to the real world. Furthermore, it allowed participants to explore whether the project's concept of equitable stakeholder involvement was a useful framework for future Cormorant-fisheries conflict resolution elsewhere in Europe. The case study was discussed and analysed during a three-day Workshop attended by REDCAFE participants, local stakeholders and other experts.

This Workshop was perhaps the most important single event of the REDCAFE project and so considerable thought was given to both the case study itself and to the most appropriate and effective mechanism for discussing it. Three issues relating to the choice of case study were important. First, given that the working language of the REDCAFE project was English, choosing a case study from a country where English was a second language might mean that local stakeholders and others were unable or unwilling to discuss matters as fully as they would if speaking in their native tongue. Second, it would be beneficial if there were some historical information available on the case study, particularly in relation to conflict management. Third, it would be unwise to choose a case study where REDCAFE involvement might inflame a conflict.

REDCAFE originally proposed to develop and run a Multiple Criteria Decision Model for the specific case study. However, an opportunity arose to link the project to a 'live' conflict case study - that of Cormorants and recreational fisheries in the Lea Valley, Hertfordshire, south-east England. This conflict has received considerable attention in the UK at the national level,, e.g. see Moran Committee 2001, 2002 and elsewhere, see footnote #3). Importantly, selecting the Lea Valley Cormorant-fishery issue also allowed REDCAFE to link with Fisheries Action Plans, and the government agency-led process being developed to address and prioritise issues affecting inland fisheries at a catchment scale (see 6.3). Adopting the Lea Valley case study thus presented REDCAFE with an opportunity to explore strategies that could link policy and practice, through conflict analysis and management processes that have been successfully tested in other natural resources contexts (see 6.5.1).

6.2 Values and dialogue in conflict resolution and management

Before briefly describing Fisheries Action Plans and their development, background to the Lea Valley and reporting on the Workshop, it is perhaps useful to discuss some important aspects of environmental conflicts and their management.

All individual and collective action is informed by *values*. These may be the personal values that each person holds and which are the motives, reasons, and justification for their actions. Conversely, these values may be those embedded in a social context (e.g. family, community, work or recreation) which influence individual actions whether or not they accord with personal values (O'Brien & Guerrier 1995). Furthermore, the effects of values (or 'preferences') on human experience only become apparent when one 'action framework[14]' encounters another and a choice has to be made. Thus environmental issues often involve value/preference conflicts and these may occur within individuals, between individuals, between individuals and groups and between different groups of people (Chase & Panagopoulos 1995).

Given that various stakeholder groups often hold different values, and consequently have different preferences for the use of limited natural resources, conflict in natural resource management is inevitable. The successful management of such conflicts is often complicated by the fact that they occur at a variety of scales: local, regional, national and global (Buckles & Rusnak, 1999). Such 'people-wildlife conflicts' typically involve antagonism because different individuals or groups are competing for the same resources. Conflict is also prevalent generally in fishery systems where people and institutions interact in a variety of ways (Charles, 2001). Cormorant-fisheries conflicts provide many examples in Europe (van Eerden *et al.* 1995, also Chapter 3) and elsewhere (e.g. Nettleship & Duffy 1995).

Considerable scientific effort has resulted in a much improved understanding of the ecology of both birds and fish, their interactions and potential conflicts. However, in addition to addressing environmental problems from a biological perspective, the social and cultural dimensions of human society that influence conflicts with wildlife usually demand as much attention (Knight, 2000). Indeed by taking such a pluralistic approach to conflict analysis, many people-wildlife conflicts can be understood as people-people or people-state conflicts (Knight, 2000).

REDCAFE participants responded to the specific biological, cultural and socio-economic issues that Cormorant-fisheries conflicts raised among a variety of stakeholders, including local individuals and groups, government and non-government agencies and scientists. They also began to develop responses to conflicts where scientific input is necessary, but where individuals and groups often have difficulty linking science to the local context in helpful ways. Building trust between REDCAFE scientists, community members and other stakeholders was actually achieved quite quickly once the need to do this was recognised by all. Maintaining that, and building on the communication and information needs of all stakeholders, continues to be an important element of REDCAFE participants' work.

In fact, a common source of Cormorant-fisheries conflict stems from feelings of exclusion among local people, to which poor communications and simplistic understandings of information transfer needs have contributed. For example, in England and Wales, four years of government–funded research was undertaken into the impact of fish-eating birds on inland fisheries (1994-1998) at a cost of about 1.5 million euro. The work resulted in the publication of six major scientific reports[15], containing 1447 pages of text, tables and figures. But, to many key stakeholders, it was '*a waste of time and money*' because it didn't appear to address their specific

[14] An 'action framework' is defined by O'Brien & Guerrier (1995) as one way of acting in and on the world. Conflicts arise when more than one action framework is possible and a choice must be made.

[15] Russell *et al.* 1996a, 1996b; McKay *et al.* 1999; Hughes *et al.* 1999; Feltham *et al.* 1999; Wernham *et al.* 1999.

concerns nor offer a practical solution to their problems. Similarly, in many environmental conflicts elsewhere, local experts often believe that scientists and policy makers ignore their knowledge and experiences (Charles, 2001). However, taking a broader, holistic approach highlights multiple stakeholder perspectives (Buckles & Rusnak 1999) and facilitates a greater understanding of the inter-relationships among stakeholders (Ramirez 1999). Above all, successful conflict management depends on conflicting parties opening communication channels and developing networks of trust for effective collaboration and dialogue (Warner & Jones, 1998).

The Lea Valley case study emerged as an important example of good practice in conflict management because participants considered the needs, fears and concerns of the various stakeholders involved and sought ways of integrating relevant biological information into the dialogue that was required for successful conflict management there. If trust and confidence were two critical aspects of this dialogue, having a process such as that of a Fisheries Action Plan to link with was equally important. In this way, the Lea Valley dialogue was not merely biological insights and mutual understanding but linked a meaningful debate to a concrete planning process.

6.3 Fisheries Action Plans

The UK Environment Agency (**http://www.environment-agency.gov.uk**) is a non-departmental public body operating in England and Wales, sponsored partly by government. The Environment Agency (EA) provides environmental protection and improvement and has numerous responsibilities and duties, including the maintenance of air, land and water quality, regulation of water abstraction and waste management, and conservation and recreation. The Agency is also involved with fisheries management issues affecting commercial and recreational fisheries in England and Wales and is responsible for issuing rod licences to all recreational anglers here. The Agency has pioneered the development of Fisheries Action Plans (FAPs), partnership schemes involving the EA, recreational anglers, conservationists and other interest groups. As well as providing greater local stakeholder involvement in the management and development of local fisheries, FAPs also ensure EA accountability in delivering its fisheries duties at the local level.

Although Fisheries Action Plans are based on river catchments, they cover canal and stillwater fisheries as well as those on rivers. They may deal with a wide range of issues from fish habitat to angling promotion and land management. Each FAP is different and reflects the concerns and priorities of local angling and fisheries interests. A FAP Group, comprising 12-15 members representing relevant stakeholders, develops a specific FAP through a formal process. The FAP Group compiles a list of key issues reflecting the concerns of local angling and fisheries stakeholders. Targets to resolve each of these issues are then agreed by the Group who set out the actions required to achieve each target. Responsibility for delivering each of the actions is ascribed to the EA or other stakeholders as appropriate. Funding for actions may be provided by the EA but Groups are also expected to seek funds from a wide range of sources. As many actions are spread over a number of years, the Group is expected to review progress at least annually. Thus FAPs provide a clear route for local angling and fisheries interests to influence the way that their local fisheries are managed and developed.

Five pilot FAPs were launched by the EA in England & Wales in 2001 and, following the success of these schemes and discussion with the Moran Committee[16], the agency agreed to help create four further FAPs, including one to cover the Lea Valley catchment in Hertfordshire, south-east England. Cormorants were cited as one of the 'problems' facing the Lea Valley (but see also 6.4), specifically in relation to conflicts with recreational angling, and would certainly require consideration in the development of a local FAP. Moreover, the 'Cormorant problem' here is believed to be typical of that faced by 80-90% of catchments in England and Wales (Adrian Taylor, Environment Agency, pers. comm.).

As discussed above, FAPs provide a mechanism for managing local fisheries in a holistic way through participation (see footnote #3) and dialogue between all interested stakeholders. Indeed, high levels of participation and dialogue are regarded as necessary prerequisites of successful conflict management through the FAP process. Thus REDCAFE chose the Lea Valley as a conflict resolution case study, not only because of the wider relevance of its 'Cormorant issues', to England and Wales at least, but because, through the FAP process, the social, economic and cultural dimensions of these issues could also be explored. It also gave local stakeholders the opportunity to participate in an externally facilitated conflict management process that would help them move forward with the Lea Valley FAP in specific and measurable ways.

6.4 The Lea Valley

The River Lea (sometimes spelled 'Lee') runs some 90 km, roughly north to south, from rural Bedfordshire to the River Thames in east London at the East India Dock Basin (Figure 6.1). Although much of the upper river is natural or semi-natural, the lower catchment is a mosaic of countryside areas, urban green spaces and completely urban areas. The river itself has been extensively managed for much of its length, particularly in the lower catchment where much has been canalised. Most of the lower river flows through the Lea Valley Country Park (**http://www.leavalleypark.com**) and here there is also a variety of stillwaters ranging from small natural lakes and wetlands to large artificial reservoirs. As some 3 million people live within 30 minutes drive of the Lea Valley, it is a much-valued resource used by walkers, runners, cyclists, water sports enthusiasts, birdwatchers and recreational anglers.

There are a variety of recreational fisheries on the River Lea, particularly in the lower reaches. These comprise trout fisheries and two main types of 'coarse' angling. Trout fisheries are restricted to a small number of stillwaters and are 'put-and-take' fisheries, where trout (both Brown and Rainbow Trout see Table 3.5 for scientific names) grown in hatcheries on site or elsewhere are released into the water for subsequent capture by anglers.

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[16] The Moran Committee was set up in 1997 to provide a co-ordinated platform of organisations to address angling and fisheries interests in England and Wales. It represents 13 of the major fisheries organisations here and, through its Joint Bird Group, has recently forged links with other nature conservation groups to ensure that 'a reasonable balance is struck between the need to conserve both fish and birds'.

Coarse fisheries tend to vary considerably in the target species. For example some fish such as Barbel, Chub, and Dace (see Table 3.5 for scientific names) predominantly occur in riverine fisheries, whereas other species such as Roach, Pike and Perch are much more widespread. A range of other species are also fished for including Bream and Tench. Fishing for carp has become increasingly popular over recent years, largely in view of the large size of this species, Carp fishing tends to occur at specialist 'specimen' fisheries.

Figure 6.1 The location of the River Lea, south-east England.

As well as requiring a national rod licence (see 6.3), local fishing is regulated by a 'permit' system, anglers can purchase either season tickets or day tickets, some fisheries also allow angling at night. Season tickets cost up to 270 euro, day tickets around 4 euro. Some fish stocks are enhanced through stocking hatchery reared fish: predominantly trout but also some coarse fish species.

The fisheries in the Lea Valley face a number of serious problems that suggest significant disturbance or change in ecological, economic and social systems. The sustainability of many standing and running water systems in the valley is in considerable doubt. Various explanations exist for this situation, some are agreed by nearly all stakeholders and some are the subject of debate. Cormorant-fishery conflicts contribute to this mix of issues and explanations. These conflicts are a strong focus for discussions among different local groups. Over recent years, conflicts have escalated as evidence and opinion indicate reduced numbers of anglers and supporting businesses, and a rapid decline in fish stocks, especially small fish and certain (mainly small) species such as Dace and Roach. Many fishing clubs have existed in the area for over a hundred years, however young people are not now joining them in significant numbers. As a result, the total number of anglers and clubs is falling. This represents a loss of social capital[17] and of key institutions that could assist community organisation and development in the Lea Valley.

One of the core members of the Lea Valley FAP group, representing the Lee Anglers' Consortium, which provides angling on 35 km of a canalised section called the Lea Navigation, explains:

> *"After the river recovered from heavy pollution it became an important fishery for Londoners and residents of the northern Home Counties. The fishing peaked around 1994 when good bags of Roach, Dace, Perch, Chub and Bream could be caught from the whole of its length… Many club and open matches were held on the river and there were several summer and autumn match series attracting 50 plus competitors… However, more important was its attraction to the pleasure angler and in particularly the senior citizens and juniors who cannot travel far from home for their fishing."*
>
> Dennis Meadhurst

Most clubs along the Lea now face economic difficulties as membership has dwindled alongside fish catches. For example, in 1992/93 (over a period of nine months) over 23,000 anglers purchased a day ticket. Additionally, 600 season tickets were sold and club membership numbered around 6,500. In contrast the forecast for the 12 months to December 2002 expects to see season and club membership dropping by approximately 54% with day membership decreasing by over 70%. Fishing tackle shops across north-east London have also suffered a significant downturn in trade and many have had to close. Many anglers claim that they have stopped fishing the Lea because of low catch rates and the associated increase in Cormorant numbers there.

[17] The term 'social capital' captures the idea of social bonds and social norms, incorporating relations of trust; reciprocity and exchanges; common rules, norms and sanctions and connectedness, networks and groups. (Petty & Ward (2001).

However, as the REDCAFE Workshop highlighted (see 6.5), Cormorant predation is only one of a number of issues thought to have contributed to declining fish numbers. Water quality and levels, pressure on particular waterbodies by other water users, poaching, safety issues, loss of key angling sites (as a result of the siting of overhead electricity pylons, barriers, moorings and residential development) and competition from commercial fisheries, are all areas of concern. Through greater collaboration, the Lea Valley FAP group hope to achieve better understanding of the major biological and social problems affecting the catchment and develop effective solutions.

6.5 Lea Valley Workshop

6.5.1 Introduction

Workshop delegates comprised 36 REDCAFE participants, representing 20 countries, and 16 stakeholders, representing 11 institutions or organisations (Table 6.1). Successful conflict management depends on conflicting parties opening communication channels and developing networks of trust for effective collaboration and dialogue (see 6.2). REDCAFE thus worked closely during the Workshop with a facilitator skilled in environmental conflict management. In this way, delegates – both REDCAFE participants and local stakeholders – could be guided effectively in their deliberations and maximise the opportunities afforded by the Workshop.

The three-day Workshop began the process of approaching the numerous environmental conflicts apparently affecting the Lea Valley. Although time was short, many important issues were addressed and developed during the Workshop during six working sessions (Table 6.2).

Stakeholder institution/organisation	**Type**	**Main area of interest**
Lea Valley Regional Park Authority	Local	Environmental management, recreation
Lea Anglers' Consortium	Local	Recreational angling
Lea Valley Consultative Association	Local	Recreational angling
RMC Angling	Local	Recreational angling
Hertfordshire Bird Club	Local	Birdwatching, ornithological studies
Moran Committee	National	Angling/fisheries
National Federation of Anglers	National	Recreational angling
Thames Water Utilities	Regional/local	Water Company – supply and conservation
British Waterway	National/local	Management of inland waterway network
Environment Agency	National/local	Environmental protection, water management
English Nature	National/local	Environment/biodiversity conservation

Table 6.1 Stakeholder institutions or organisations attending Lea Valley case study Workshop.

Day	Session	Issues	Format	Leader
One	One	Relating key REDCAFE experience to the Lea Valley Case Study	Plenary	
		1. Introduction to the REDCAFE project and concept		REDCAFE
		2. Learning from the REDCAFE experience: pan-European examples		
		3. General discussion/summary of key points		
	Two	The Lea Valley Case Study	Plenary	
		1. Introduction to the Lea Valley: geography, history and present day circumstances		Stakeholders
		2. Site visits: Walthamstow Reservoirs and Lea Valley Park		
Two	Three	Conflict Management Sessions	Plenary	
		1. Introduction to the Environment Agency's work		Facilitator
		2. Overview of Fisheries Action Plans and the planning process		Environment Agency
		3. Summary of issues facing the Lea Valley		
		4. Introduction to 'Stakeholder Analysis' and 'Conflict Management' techniques		Facilitator
	Four	Lea Valley Issues	Groups	
		1. Group discussions		
		(i) Lea Valley: problems		
		(ii) Lea Valley: stakeholder analysis		
		(iii) Lea Valley: Cormorant issues		
		(iv) General: approaches to building stakeholder dialogue		
		(v) General: economic issues relating to Cormorant-fishery conflicts		
		2. Summary presentations of Group discussions	Plenary	
Three	Five	Consensus Building		
		1. Relating the Lea Valley experience to the REDCAFE project and *vice versa*		
		2. Progress and plans		
	Six	Action		
		1. Establishing a route map for Lea Valley FAP progress		

Table 6.2 Timetable and issues covered at REDCAFE's Lea Valley case study Workshop.

Each of the six Workshop sessions and their outputs, where applicable, are described below. Where necessary, further information is provided to give context to, or interpretation of, the Workshop activities. The aim of the remainder of this section is to give the reader as clear a picture as possible of the dynamic Workshop processes and their outcomes.

Many of the most important points discussed in Sessions One and Two are described elsewhere in this report (Chapters 2, 3 and sections 6.3, 6.4 above, respectively). A field trip gave Workshop delegates the opportunity to relate conflict management and ecological issues in two contrasting areas of the Lea Valley: Walthamstow Reservoirs and an area of the Lea Valley Park. The reservoir complex comprises eleven concrete lakes (ca. 245 ha) that are fed from both the River Lea and with water pumped from the R. Thames. The reservoirs are situated in the south of the catchment in a mainly urban area. Three are stocked with Brown and Rainbow Trout and the remainder contain coarse fish species and all are used by day ticket anglers. In contrast, the Lea Valley Park site to the north is a semi-natural wetland complex comprising a stretch of the River Lea and several naturalised gravel pits all containing populations of coarse fish species.

6.5.2 *Conflict management experiences from continental Europe*

Four presentations were given by REDCAFE participants on issues pertinent to the Lea Valley: they described a range of learning from REDCAFE experience and were chosen to be relevant to the case study.

To many, including some anglers in the UK, the only solution to the ‘Cormorant problem’ is to kill birds. Such large-scale population culls have also been considered by biologists, both theoretically and in practice. Morten Frederiksen and Thomas Bregnballe discussed the theory of large-scale population control as a tool in Cormorant management (Box 6.1). Thomas Keller discussed relatively large-scale Cormorant culling in practice, based on experiences in Bavaria, southern Germany (Box 6.2). Could lessons be learned from the experience there of seven years of intensive Cormorant shooting? In terms of reducing Cormorant numbers, uncoordinated shooting in Bavaria had failed. However, Tamir Strod and Jonathan Harari described a successful Cormorant management programme in the Hula Valley, Israel where, about 8,000 Cormorants winter and the birds cause major conflicts at fishponds (Box 6.3). Cormorants also pose problems to fishpond aquaculture in Saxony, Germany. Kareen Seiche described an alternative approach to the mitigation of Cormorant damage to fish stocks there (Box 6.4).

Based on an analysis and synthesis of Cormorant ringing studies in Denmark, it is clear that many aspects of Cormorant 'performance' (e.g. production of young, survival of adults) is limited throughout the year by density dependence[18]. Thus, Cormorant populations are at present regulated naturally within relatively narrow bounds, and if population size is reduced artificially, remaining birds compensate through increased reproductive success, survival or immigration from other areas. In theory, Cormorant populations could be controlled at a large (pan-European) scale by preventing the foundation of new colonies, reducing the production of young, or by culling fully-grown birds (immatures and adults). Reducing the number of young produced is expensive and has only a small effect on population size. Culling would therefore be more effective. However, because of density dependence, large numbers of Cormorants would have to be killed every year to reduce the population size substantially: there would also be practical (and perhaps ethical) problems. Furthermore, population regulation may not reduce the most pressing conflicts because Cormorants are attracted to the most profitable ('optimal', see also 5.9.1) food sources – often where they are most likely to come into conflict with human interests. A more effective approach might be to take advantage of density dependence by making the environment less attractive to Cormorants and thus decreasing the carrying capacity[19]: this would often be consistent with limiting the damage rather than the 'pest'.

Box 6.1 Danish case study: Cormorant population control in theory.

Cormorant culling in Bavaria (mostly during the winter migration: August – March) began in 1995 and developed subsequently through various State regulations and legislation from the Bavarian State Government. Although 2,547 – 6,258 Cormorants have been shot each winter - sometimes in greater numbers than the average number counted during regular surveys – the number of birds wintering in Bavaria has remained remarkably stable. Moreover, since shooting began, the number of night roosts in Bavaria has increased. It was concluded that uncoordinated shooting of Cormorants over seven winters had not reduced the overall, nor the local, numbers of birds wintering throughout Bavaria. Thus, there must be a high turnover of migratory birds through Bavaria, even in midwinter. As Cormorant numbers had not been reduced, there was no reason to believe that there had been a reduction in the amount of fish consumed by them. However, the number of Cormorant night roosts in Bavaria increased during the years of shooting, suggesting that birds may now be more evenly distributed in the region than before.

Box 6.2 Bavarian case study: Cormorant population control in practice.

[18] 'Density dependence' is a biological term implying that the growth or decline of a population is regulated by mechanisms themselves controlled by the size of that population. Simply put, when population size increases, survival and/or production of young decreases, and *vice versa*.

[19] 'Carrying capacity' indicates the level at which the population is regulated by density-dependent processes in a given environment.

In the Hula Valley, Israel, about 8,000 Cormorants winter and the birds cause major conflicts at fishponds Hundreds of Cormorants have been shot every winter over the past ten years but the problem remains at the same level; shooting is costly and ineffective, it also pollutes the environment (bird carcasses and lead shot). In a collaborative partnership, biologists, fish farmers and NGOs developed a co-operative management scheme for the Hula Valley. On arrival, Cormorants are scared from fishponds, particularly those holding preferred prey *Tilapia* spp., in a co-ordinated manner. Cormorant numbers decline very quickly at fishponds and the programme is effective throughout the winter. As a result of this large-scale, co-ordinated disturbance (with minimum killing), Cormorants are now feeding at less sensitive, alternative foraging sites. As this control programme has developed, operating costs (e.g. staff time, ammunition), numbers of dead Cormorants, and estimated fish losses have all declined. Coupled with the availability of alternative foraging sites for Cormorants, the key to the success of the Hula Valley scheme has been due to:

- Organisation (e.g. interest/expert groups, manpower, resources)
- Information (e.g. Cormorant physiology and ecology, fish stock assessments)
- Timing (e.g. bird migration, co-ordinated scaring)

Box 6.3 Israeli case study: successful Cormorant management.

The most commonly cultivated fish in Saxony is Carp (see Table 3.5 for scientific name) which are farmed in a three-year cycle, the production of one- and two-year old fish being most important. Between May and November about 90% of the Cormorants in the region are roosting close to fishponds, numbers can reach around 3, 000 birds and Carp is their staple food. Cormorant damage at Carp ponds is assessed, for each year-class of fish, from (a) numbers of Cormorants visiting ponds daily, (b) an estimated daily food intake of 500g per bird, and (c) estimates of 'normal' stock losses in ponds (i.e. excluding Cormorant predation). In addition to fish consumed, an additional, arbitrary, 10% is added to account for 'stressed and injured' fish. Since 1996 fish farmers have been paid compensation for fish looses to Cormorants if this is seen as threatening to their livelihood. Up to 80% of the estimated damage is compensated on condition that reliable evidence of heavy Cormorant damage is available and that losses amount to at least 1, 000 euro per year.

Financial help is also available to those farmers who farm their fish in an environmentally friendly way (e.g. according to nature protection regulations, low stocking levels, no supplementary feeding, and long-term rotation of ponds). The interactions between Cormorants and fish appear to be very complex and, as a result, are not fully understood. Nevertheless, many feel that there is enough information available upon which to base a financial compensation scheme. Although sound information is needed about Cormorant-fish interactions at ponds, the conflict cannot be solved solely at a scientific level. Thus a forum has been developed whereby biologists, fish farmers and regional politicians can discuss these matters and work together to find a satisfactory solution. Although the compensation scheme is acknowledged to be subjective, all feel that it is based on current best estimates of the situation – and it has gone some way to mitigate local concerns about fish losses to Cormorants.

Box 6.4 Saxony case study: financial compensation scheme.

6.5.3 Lea Valley conflict management

Five key issues arose from discussions with Lea valley stakeholders and these are described in turn. First, many believe that the main problem facing the Lea Valley is an economic one (see also 6.4). Economic measures of angling 'effort' (i.e. day and season ticket sales and angling club membership) have all fallen considerably in the last decade. This has had a knock-on effect on the local economy. The Lea Valley case thus raises a number of important social issues in relation to young people, and community livelihoods and traditions. The problem is complex, urgent and related both to institutions and their survival.

Second. these economic problems are the result of too few anglers catching too few fish in the Lea Valley. Several lines of evidence suggest that many fish stocks and/or catches there have declined dramatically. The perception is that most small fish – both small individuals and small species - have declined whilst there may still be fisheries containing large individuals (i.e. 'specimen' fish) of some species such as Barbel and Carp. However, even for these latter species, the concern is that once these larger individuals die, the capacity for the species to breed successfully and sustain viable populations will be greatly reduced. In some cases, such perceptions have been confirmed by fish surveys. There is also some evidence that the distribution of fish has changed within the Lea Valley. Anglers often choose to fish adjacent to bridges in the belief that these structures are now the only places were fish aggregate in any numbers.

Third, the lack of fish, and the related economic decline, has local conservation implications. There are concerns at the species and genetic levels in relation to the stocking of non-indigenous fish. There are also concerns that other fish-eating birds will suffer as a result of the lack of small fish or due to the 'aggression' of Cormorants. As the fishery declines, it becomes uneconomical to pay bailiffs to maintain river banks, with resulting declines in littoral growth and associated fauna and increases in litter and pollution events.

Fourth, the lack of fish, and the related economic decline, has local social implications. Local angling clubs are considered critical social partners with the National Federation of Anglers (NFA), the Environment Agency (EA) and central government. The NFA operates a coaching scheme that teaches coaches to train young people in all aspects of angling and environmental issues, whilst the EA and central government operate an Angling Participation Scheme. This scheme aims to re-establish derelict urban fisheries and develop properly trained, motivated young people (active, outdoors, occupied, learning, contributing). Such 'stewardship' schemes, and the recreational opportunities associated with them (as well as things like local employment and transport demand) all decline as the number of local angling clubs, and anglers, declines.

Fifth, the lack of fish, and the related economic decline, has local planning and policy implications. With the decline of angling clubs, organised citizens groups loose a key player with its associated conservation and financial benefits. Moreover, falling motivation levels as a result of declining angling clubs mean that other Government initiatives suffer (e.g. angling/environmental awareness schemes) and other community links may be lost.

Many of the concerns described above can be addressed through the Fisheries Action Plan process – a policy instrument for the waters and wider environment of the Lea Valley. At this stage it is possible to summarise many of the issues facing fisheries in the Lea Valley as an initial 'problem statement' (Figure 6.2).

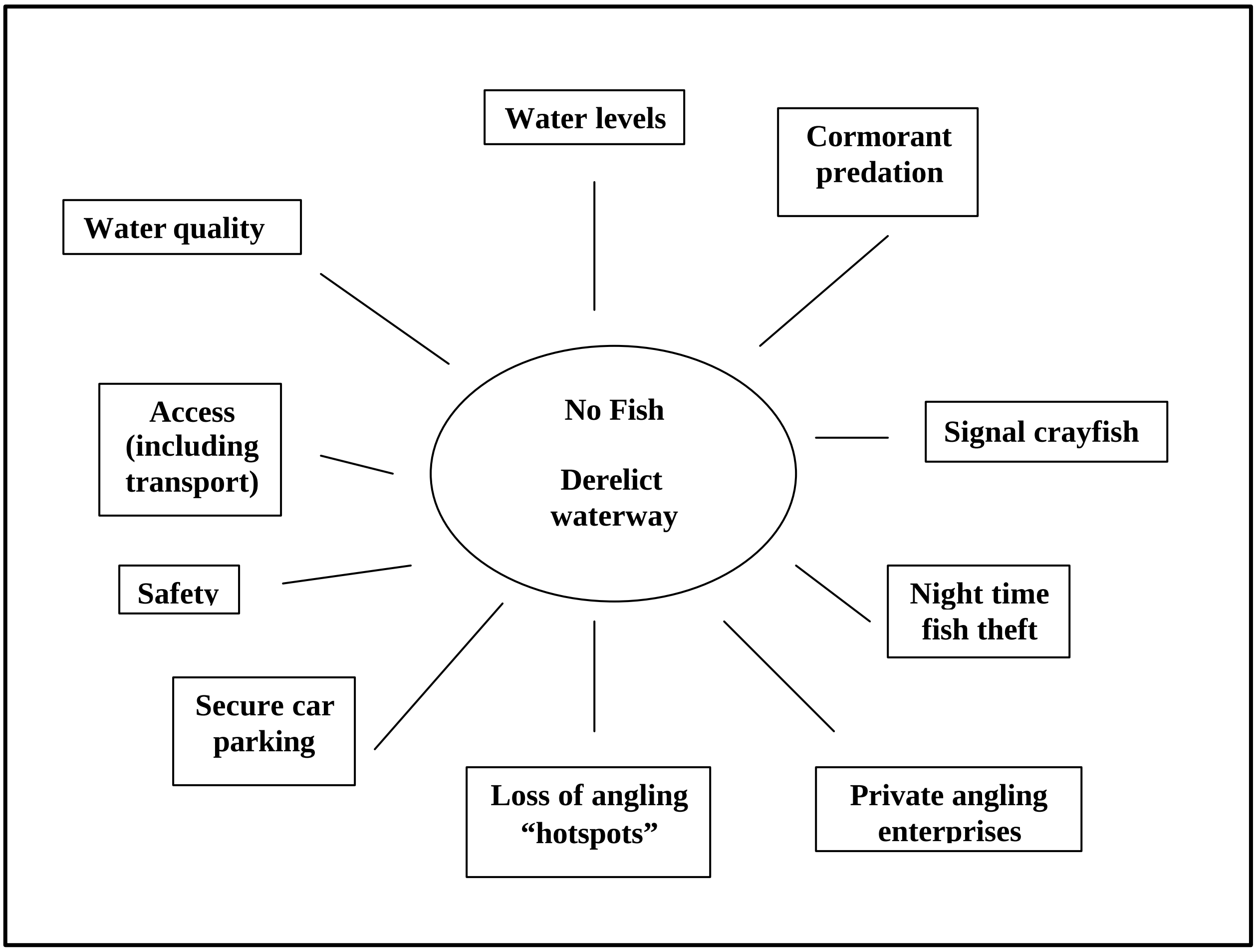

Figure 6.2 An initial 'problem statement' for fisheries issues in the Lea Valley.

Cormorant predation is only one of several problems facing the Lea Valley, though it is often the most conspicuous. There are some other biological issues involved including changes in both water quality and levels and the threat of the invasive Signal Crayfish (*Pacifastacus leniusculus*). However, many problems stem from social issues including poaching of Carp for the table, the influence of private angling enterprises, the loss of angling 'hotspots' as a result of poor planning, and several access and safety issues. This complex, and sometimes conflicting, social and biological situation will require time and effort to develop effective, sustainable processes for fishery management. The initial stages of this process are to determine who the relevant Lea Valley stakeholders are and to consider their needs and concerns (see Tables 6.3, 6.4). Consideration should be given to economic, social, technical, environmental and institutional issues. Once problems have been identified, solutions can be suggested and actions planned. Such a process will feed directly into the Fisheries Action Plan.

However, this process will only be effective if there is active participation and dialogue between all stakeholders and common ownership both of the dialogue process and the subsequent outcomes. As a first step towards opening dialogue among stakeholders, Workshop delegates considered a variety of conflict management styles (Warner 2000) that related the relative importance of 'goals' and 'relationships'. In the Lea Valley case, the importance of stakeholders' relationships was considered to be high, as was the importance of the goal of an effective and shared Fisheries Action Plan. Although 'compromise' is often cited as the best means to resolve conflicts, this requires all sides to make concessions with the result that none may be happy with the outcome. It was thus clear that the best, perhaps only, way forward in relation to conflict management in the Lea Valley context was through partnership and a negotiated consensus and through stakeholders developing mutual understanding of the problems facing fisheries in the area.

6.5.4 Lea Valley issues

Workshop delegates split into four groups (of 10-12 people) in order to examine three key issues of relevance not only to the specific Lea Valley case study but to other Cormorant-fisheries conflicts across Europe.

1. The problems, needs and concerns facing stakeholders in the Lea Valley.

As discussed earlier (6.5.3), this is the first stage in the conflict management process, and so discussions were restricted to the Lea Valley context.

2. Approaches to building stakeholder dialogue.

As discussed earlier (6.2, but see also 3.7), effective dialogue is a prerequisite for successful conflict management within the Lea Valley and elsewhere. Discussions were thus wide-ranging and reflected pan-European experiences.

3. Economic issues and reasons for non-disclosure of relevant financial information in relation to Cormorant-fisheries conflicts.

Economic issues are often at the heart of cormorant-fisheries conflicts. However, earlier REDCAFE experience in synthesising these conflicts (see Chapter 3) highlighted the fact that relevant financial information was often difficult to obtain from stakeholders (see 3.4, 3.5.5). Discussions were thus wide-ranging and reflected pan-European experiences on why this should be so.

The number of local stakeholders at the Workshop was relatively small, so it was decided to have two groups with both Lea Valley stakeholders and REDCAFE participants, and two other groups solely of REDCAFE participants. The former two groups would address specific Lea Valley issues whilst the latter two would address significant issues that could be helpful for the Lea Valley case and more generally to cormorant/fisheries conflicts. The tasks and deliberations of these four groups are summarised below.

The problems, needs and concerns facing stakeholders in the Lea Valley

The specific tasks for the first two groups were to focus on the Lea Valley and (a) agree the 'problems' facing stakeholders in the Lea Valley, (b) develop a preliminary list of stakeholders and analyse their needs and fears/concerns with respect to these problems, and (c) consider the specific 'Cormorant-fishery' issue there. Numerous Lea Valley problems were reported (Figure 6.3). These covered both individuals and institutions or organisations and affected both people and resources. Two lists of Lea Valley stakeholders were produced. One for the whole catchment (Table 6.3) and one for the Lower River Lea, excluding adjacent stillwaters (Table 6.4). In both cases, large numbers of stakeholders were identified and their general needs, fears and concerns detailed. Considering the specific Cormorant-fishery issue in the Lea Valley, 11 points were highlighted (Table 6.5). Although the impact of Cormorants was unquantified, there was a major concern over the effects of predation within the catchment. The need to collate available information and local knowledge was identified, as was the desire for no further research to be undertaken. Several potential management tools were highlighted but their effectiveness was questioned.

Lea Valley Problems

The People

Environment Agency – duties/failing

- Conservation bodies
- Anglers
  - Have different aspirations
  - Not all are unhappy (for now) – e.g. 'specimen' fish anglers
  - Angling clubs are in decline (membership and finance)
  - Perception of problems leads to decline in angling and to potential social problems
  - Angling ability may have declined (knowledge and skills gap?)
  - People today are more mobile and less loyal to clubs
  - Socio-economic and demographic changes
  - Not all stakeholders are 'interested' in solutions?
  - Job losses

Administration problems

- Poor dialogue

Responsibilities not always obvious

- Funding issues

- Fishery owners
  - Declining commercial asset
  - User base shrinking and becoming specialised
- Local economic interests
- Navigation users (and others) +ve and –ve impacts

The Resource

- Un-natural fish population structures
- Lack of small fish
- Difficulties over proof (scientific data not available)
- Less angling → less bait → fewer fish
- Problem centres largely (but not exclusively) on running/linear water bodies
- Fish movement – this occurs but severity is unknown
- Catch information ↘ Monitoring ↙ Survey information
- Sewage effluent at river head and possible endocrine disruption
- Signal crayfish (non-native invasive species)
- Habitat quality
- Cormorant/bird – fish interactions

Figure 6.3 Lea Valley problems identified in Workshop discussion.

Stakeholder group	Needs	Fears / Concerns
1. Anglers - general - big fish - trout	• Healthy, abundant fish stocks • (good quantity/quality fish to catch) • Enjoyable recreational experience	• Loss of preferred fishing area • Costs of alternative fishing • Loss of enjoyment
2. Angling clubs	• More members • More income • Preserve social traditions	• Disbandment of club (due to loss of members + income)
3. Fishery Owners and tenants	• Sustainable income • Secure perspective • Integrated management • Good public relations about Lea Valley / angling • Accessibility • Secondary activities	• Loss of core business • Loss of income
4. Commercial outlets (related to angling)	• Customers (bait, tackle, food, etc.) • Reasonable profit	• Financial instability due to loss of customer base • Closure of business – need to relocate, find alternative income
5. Water suppliers	• Sufficient water of suitable quality • Place to discharge effluent	• Lack of water, or low quality = failure to meet legal requirements
6. Environment Agency	• Sustainable fisheries • Customer satisfaction • Meet legal requirements • Appropriate resources	• Cannot meet operational and legal requirements • Insufficient resources
7. Conservation groups	• Healthy, sustainable ecosystems • Species survival and health • Recognition and status as a stakeholder • Protection of special sites and species	• Loss of biodiversity • Negative impacts of non-native species • Habitat degradation and fragmentation
8. Other recreation users	• Good access • Appropriate facilities • Quality recreational experience	• Conflict with other users • Loss of access
9. Local community	• Attractive local environment • As (8) above, especially access	• Over development • Dereliction

Table 6.3 Stakeholder groups, their needs, fears and concerns identified in the context of the Lea valley catchment.

Stakeholder Group	Needs	Fears/Concerns
1.Anglers and Fishery organisations	• Sustainable fishery • Better public image • Good access • Affordability • Recruitment of anglers	• Decline in fishery • Decline in infrastructure • Perceived cormorant impact
2. Tackle trade/local commerce	• Local anglers	• Loss of income
3. Riparian owners	• Sustainable fishery • Anglers	• Loss of income
4. Navigators	• Sufficient water • Infrastructure (moorings, access)	• Low water flows
5. Water companies	• Water (clean) • Profit for shareholders	• Pollution • Low water flows • Legislation and extra cost
6. Other recreational interests	• Access • Infrastructure • Pleasant environment	• Restrictions on access • Environmental degradation
7. Environment Agency	• Meet statutory responsibilities (fisheries, flood defence, water quality and resources etc.)	• Failure to meet requirements • Loss of public support (funding)
8. Lea Valley Park	• Meet statutory responsibilities (conservation and recreation)	• Failure to meet requirements • Loss of public support (funding)
9. English Nature	• Enhancing biodiversity • Sustainable habitats	• Impacts on adjacent statutory sites • Habitat degradation • Loss of public support (funding)
10. Local Authorities	• Local economic development • Meet statutory responsibilities (recreation, infrastructure, 'quality of life,' providing best value) • Public support • Social inclusion	• Legislation • Failure to meet obligations • Loss of public support • Urban decay, dereliction

Table 6.4 Stakeholder groups, their needs, fears and concerns identified in the context of the lower River Lea, excluding adjacent stillwaters.

What do we do about cormorants in the Lea Valley?

- Cormorant roost established late 1980's
- Perceived impact of birds on fish is unquantified - major concern is absence of 'medium sized' fish
- Need to identify what information is available (i.e. collect & collate information - bird counts, fishery data, 'anecdotal' information)
- No more R&D – instead a 'reasonable interpretation of available information'
- Awareness of other constraining factors - try to put cormorant problem in context
- Cormorant colony on Site of Special Scientific Interest site in urbanised area - can't shoot birds there
- Prevent new colonies forming - avoid situation getting worse
- Creation of 'honey pots' (but does problem get worse?)
- Promoting good habitat management, explore opportunities for providing artificial refuges for fish
- Conditioned Taste Aversion ?
- Providing dead fish as an alternative food source ?

Table 6.5 The specific Cormorant-fishery issue in the Lea Valley.

Approaches to building stakeholder dialogue

Group Three consisted of REDCAFE participants and its task was to examine approaches to building stakeholder dialogue in general and, specifically, to reach agreement on key principles that should be employed in developing dialogue amongst a variety of stakeholders each with different needs and goals.

Dialogue was identified as critically important if stakeholders are to work together towards common ownership of issues, ideas and solutions. The general approach to building dialogue identified (Box 6.5) involved the acceptance of initial mistrust and suspicion and the importance of the subsequent development of trust between stakeholders. Clarity was also highlighted, in relation to identifying issues, stakeholders, and their needs. Patience was also considered important, in terms of working at a pace that suits everyone. They key principle when considering dialogue amongst a variety of stakeholders with different needs was identified as being able to see issues from all points of view (Box 6.6), or at least respecting the differing views of others. In addition, dialogue could be helped if the 'group' involved do something together fairly early in the process.

Three other comments on building dialogue were recorded. First, all those involved in the dialogue process need to recognise, and take account of, different motivation levels amongst stakeholders. Second, all should be aware of a possible bias in the principle of dialogue: it will exclude groups who are not organised or who cannot organise themselves. Finally, dissemination issues are important both in terms of advertising meetings and of informing stakeholders (both individuals and institutions) about results and activities.

Building Stakeholder Dialogue

Dialogue takes time, but is critically important. WHY?

- Information exchange – people will not work together if they don't have information.
- Helps to involve everybody (if they want to be involved!) – creates ownership of the issue. Be open and welcoming to newcomers!
- Dialogue builds participation and participation is important for sustainability.

Process principles

- Accept that there will be mistrust and suspicion at the beginning. These are normal issues at the beginning a dialogue-building process. An example was given from Sweden where five meetings had taken place before a key NGO became involved but it was five years before a key business company did so. All this time, all stakeholders were sent periodic newsletters and updates on activities -- because their needs were known and because their eventual participation was important to the process.

- Be sure to communicate the positive aspects of dialogue

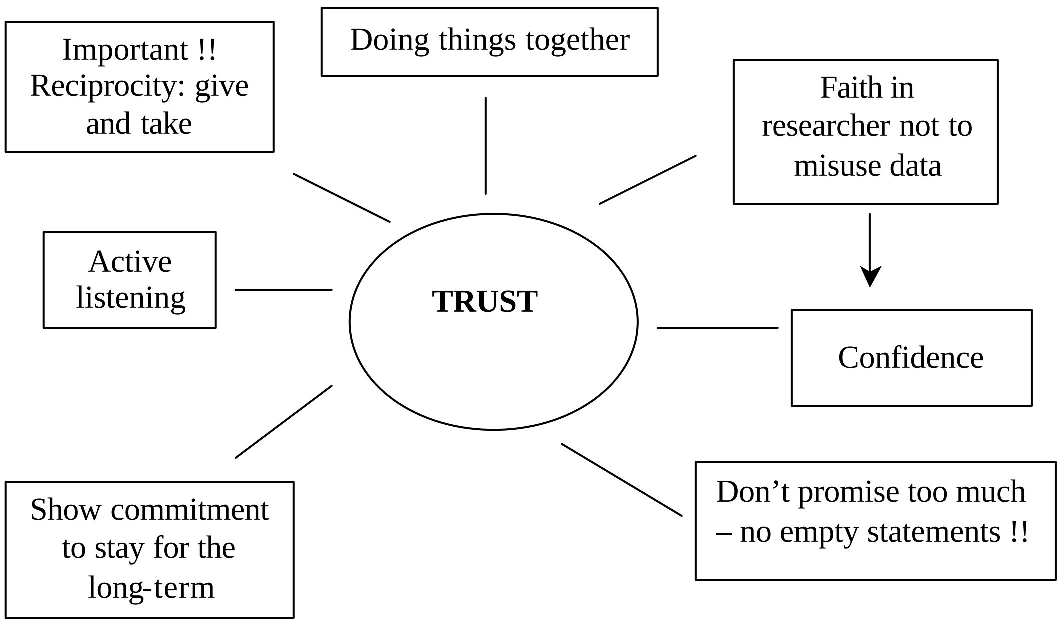

Diagram 1 – Some issues relating to Trust

- Identify the issue – for example, what do stakeholders want from the process.

- Identify stakeholders – remember that stakeholder groups are not homogeneous.

- Patience is important: set and maintain a pace with which everyone is comfortable, including when building and agreeing the consensus that may come later.

Box 6.5 General approach to building dialogue as identified by Workshop delegates.

Action Research

- It is very important for 'the group' to do something together fairly early in the process, to evaluate this (learning together from our mistakes and successes) and then to move forward. One possible route is outlined below.

1. Local meetings (advertised) and open meetings as groups develop consensus around issues (remember that there are conflicts within groups as well as among them). Then consider 'triangle of concern' for building dialogue (Diagram 2).

2. Identify representatives and form a group of representatives (Diagram 2)

- Remember to see issues from all points of view – find the fit between your self-interest and perceptions, and those of others.

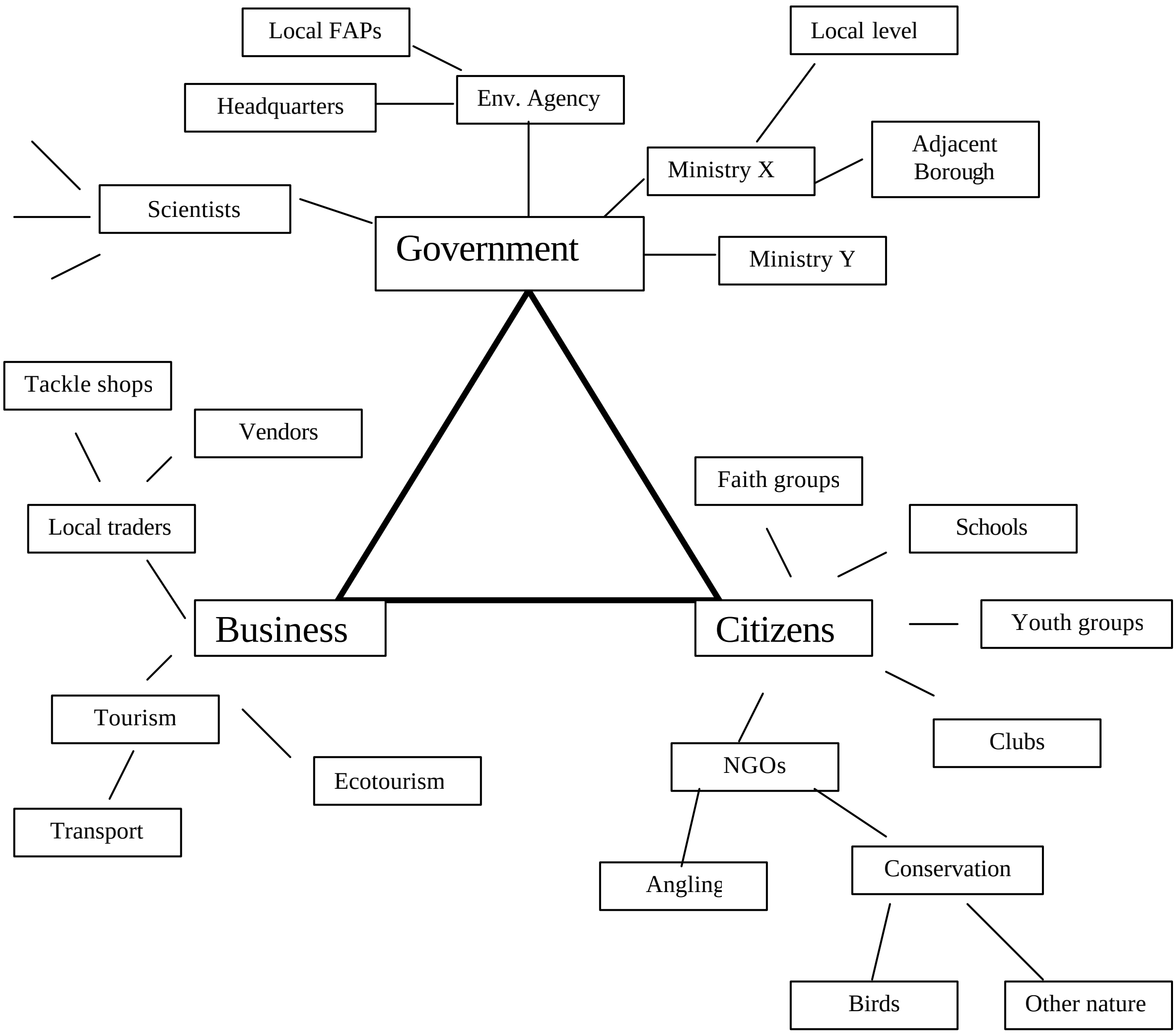

Diagram 2 - 'Triangle of concern' for building dialogue: although based on the Lea Valley case study, many elements will be common to situations elsewhere.

Box 6.6 Key principles when considering dialogue amongst a variety of stakeholders with different needs as identified by Workshop delegates.

Economic issues and reasons for non-disclosure of relevant financial information in relation to Cormorant-fisheries conflicts

Group Four consisted of REDCAFE participants and its task was to consider economic issues that relate to cormorant/fisheries conflicts in general, in the light of REDCAFE experience. It had been a concern of a number of REDCAFE participants that economic issues were among the most problematic to analyse, due partly to the lack of relevant financial data. Among the issues for discussion were the possible reasons for non-disclosure of relevant financial data.

The first point identified was that not all Cormorant-related conflicts are about money (Box 6.7). Indeed the synthesis of Cormorant conflicts (Chapter 3) highlighted that nature conservation stakeholders did not provide any financial information in relation to the conflict issues of concern to them (see 3.5.5). In general however, commercial fisheries stakeholder may not disclose financial information for business reasons whilst recreational angling stakeholders may be unable to put a monetary value on their quarry. Several possible reasons for the non-disclosure of financial information were reported (Box 6.7) highlighting some of the real difficulties in obtaining such information. These provide insight into why so little financial information was made available during the Lea Valley Workshop and why it was provided for relatively few (45%, see 3.3.5) of the case studies included in the pan-European conflict synthesis (Chapter 3).

Two other points were raised in relation to the disclosure of financial information. First, over much of eastern Europe there has been switch from State to private ownership (see also 3.6, Box 3.2). When fisheries were State owned, financial compensation was paid for any losses. However since the privatisation of many fisheries, compensation is no longer paid and fisheries have become increasingly competitive and secretive, presumably leading to a reluctance to disclose financial information. Second, not all stakeholders are concerned with losses of fish to Cormorants and some may offer financial information freely. For example, in Poland some Cormorant problems are related to forestry damage – bird guano damages and kills trees leaving them susceptible to insect pests. In such circumstances, forestry stakeholders are very open about the financial losses suffered to their industry and the information is in the public domain.

Finally, can any lessons be learned from financial incentives to kill Cormorants ? The Fishermens' Organisation in the Czech Republic introduced a bounty scheme whereby fishermen were paid a bounty of 10 euro or were given a Carp for every cormorant shot. As the fishermen's daily income was around 16 euro, this was a very big incentive to shoot birds. However, despite around 1,000 birds being shot each year there has been no reduction in the Cormorant population. Moreover, as a response to shooting, Cormorants began roosting on bigger islands where they are more difficult to shoot, and so fewer are shot regardless of effort. Although altering roosting distribution, shooting has not affected Cormorant distribution on foraging sites and so they are still considered a problem.

1. For some stakeholders, disclosure of financial information was not a problem, why should it be so for others ?

2. Some schemes provide extra financial support for ‘green’ aquaculture (e.g. see Saxony example in 6.5.2) – some stakeholders may be unwilling to divulge financial information in case they are caught cheating the system.

3. More generally: people don’t want anyone else to re-calculate their figures (e.g. for costs of fish, financial outlays, compensation, cost of damage etc.).

4. If the State is paying for fish, individual fishers do not worry about economic losses.

5. People are unwilling to divulge financial information for reasons such as tax, insurance, and subsidies.

6. There is competition between fishery owners – so they do not wish to give financial information.

7. Some stakeholders actually have no financial information (e.g. they are non-profit groups).

8. Fish cannot be seen most of the time without very special and expensive effort. Thus for most systems (perhaps with the exception of intensive aquaculture) information on fish communities and stocks is lacking. Thus placing financial values on such resources, or the losses to factors such as Cormorant predation, is very difficult.

Box 6.7 Possible reasons for non-disclosure of financial information as identified by Workshop delegates.

6.6 Lea Valley case study: summary of progress

The REDCAFE project has made substantial progress in identifying critical scientific and social issues in cormorant/fisheries conflicts. These cover a range of fisheries and habitat types where ecological and social processes vary across different spatial and time scales. REDCAFE participants' extensive knowledge was usefully brought to bear in the Lea valley case study, where a large range of stakeholders face complex issues relating to fishery, and institutional, sustainability. Cormorant-fishery conflicts play a part in the mix of issues facing the Lea Valley but one important outcome of the Workshop was to situate these conflicts in a broader social, economic and ecological context.

Local stakeholders made considerable progress where escalating conflicts had become significant obstacles. REDCAFE participants had the opportunity to explore part of a conflict management process that related directly to many Cormorant-fishery conflicts across Europe. The Workshop process enabled significant progress to be made in five areas, these are summarised below.

6.6.1 De-escalating conflict among key local stakeholders

With the disturbance or change in ecological, economic and social systems in the Lea Valley (see 6.4) in mind, many stakeholders were not optimistic in coming to the Workshop. Several groups had strong opinions about certain issues. The Workshop evaluations (see 6.7) confirmed informal conversations that many people felt able to move forward in a less discordant environment after the Workshop. There are several possible explanations for this, perhaps the most important of which are:

1. People felt listened to: REDCAFE participants and other stakeholders listened attentively, respectfully and with interest to the concerns and fears of local people and learned from their experiences. Delegates had the opportunity to understand the Lea Valley context in four ways; through presentations, by means of handouts supplied by local people, through informal meetings and during a field visit to two sites in the Lea Valley. An important aspect of the Workshop was that many delegates were experts in their field who were trying to come to grips with a British situation, explained in English. The significant efforts made to do this were very much appreciated by local stakeholders.

2. REDCAFE presentations about the science and learning from various research activities were well organised and clearly presented, in ways that local people found accessible, interesting and relevant. A number of local people commented on this and found themselves thinking through the practical implications of the science in new and challenging ways. These presentations had a clear impact on helping people approach scientific data in an objective way. Local people felt, some for the first time, that science was not just 'a waste of time and money' but could add value to discussions and possible solutions (see 6.2).

3. The tone of the Workshop was exploratory and collegial, setting a style for discussions that was enabling and supportive as people tried to get across their points of view. Local stakeholders worked hard to try to understand what science and REDCAFE experience had to offer, and everyone treated each other as equals and with mutual respect.

4. It was very helpful having a process with which to engage. The Fisheries Action Plan process offered a way forward, establishing a possible pathway for next steps. It was clear that the Workshop was not just a ‘talking shop’, but presented an opportunity to link policy with practice, through a planning strategy that had some evidence of success elsewhere. The Fisheries Action Plan also had legitimacy from the perspective of all the groups involved: government, community, NGOs and business stakeholders.

5. For the Lea Valley, the Workshop began the practical business of formalising stakeholder groups, their needs and concerns and the way that different groups might view ‘the problem’. It also enabled people to see that it was possible to reach consensus fairly quickly on the key issue – sustainability (see footnote #7). In fact, the process itself started to build early consensus on the economic, social and ecological realities of the situation. People also started to acknowledge how the issues informed others’ points of view, and to establish respect for the perceptions and views of others in a non-confrontational way.

6.6.2 Linking scientific processes and data to real-world social issues

There remained small differences of opinion among delegates about the nature of science and how science may be situated in a social and political context. Like it or not, the scientific aspects of the conflicts with which REDCAFE has been working have strong social and political travelling companions. Just as REDCAFE has been successful in enabling scientists to understand and work with multiple scientific views within the group, so at this Workshop, REDCAFE participants demonstrated empathy with the arguments about the social and economic context within which science must operate in the Lea Valley.

The Lea Valley stakeholders, likewise, appreciated the opportunity to hear from scientists directly and gained appreciation for what science has to offer. This was a particularly important outcome for REDCAFE since previous scientific reports on UK Cormorant-fishery conflicts (see 6.2) had been considered by some to be remote, jargon-ridden and largely irrelevant to their needs. In sum, considerable bridge building between local people, the scientific community and policy makers was achieved. This was helpful in reducing conflict and establishing a positive role for science in facilitating the development of the forthcoming local Fisheries Action Plan.

6.6.3 Agreeing initial problem statements, stakeholders and needs

The Fisheries Action Plan process will take forward the issues explored at this Workshop. The Workshop itself could not hope to achieve what is a fairly lengthy process of exploring stakeholder perceptions and needs, identifying and agreeing on problems, maintaining effective dialogue and actually building a plan with agreed implementation, monitoring and evaluation actions. This is a multi-stakeholder process that will take some time. However, the Workshop was successful in establishing the early part of a route map toward that process, as the outputs from the small groups (see 6.5.4) show.

6.6.4 Identifying relevant agencies, people and pathways for action planning

The introduction to the Fisheries Action Plan process and the associated resources (web and hard copy) indicated the range of stakeholders that have been involved in the pilot FAPs. At the Workshop, the small group activities (see 6.5.4), field trip and personal interactions allowed this introduction to be taken forward so that stakeholder identification, needs and concerns could be linked with a concrete process for next steps. In sum, the Workshop process identified ways of fitting stakeholder needs, problem identification and planning processes, and produced outputs that can be taken forward for verification with a wider group of stakeholders (i.e. those unable to attend the Workshop) under Environment Agency leadership.

6.6.5 Identifying research priorities and dissemination actions that link the need for strong, evidence-based scientific knowledge with social and strategic planning needs

Of particular significance in the Lea Valley case study Workshop were the parallel issues explored in other REDCAFE Work Packages in respect of the social and cultural impacts of fisheries decline (see 3.6 for discussion). In the Lea valley, long-standing family traditions, institutions and social capital were eroded as fisheries became unsustainable.

What was particularly useful about this Workshop was that local stakeholders and scientists were brought face-to-face to discuss these issues. Local people were not simply asked to read a scientific report. Scientists were not asked to 'imagine' the local context. In this Workshop it was possible to improve understanding (and motivation) through establishing good rapport and an effective Workshop process. Field trips and social evenings provided good opportunities for informal interaction while the formal sessions themselves enabled facilitated question and answer sessions. In these ways, both parties gained clarity on what the issues of importance were (e.g. more studies on fish population dynamics, community structure and spatial distribution and on Cormorant scaring techniques) and what processes were necessary for effective information dissemination.

6.7 Workshop evaluations

6.7.1 Overview

A specific element of this part of the REDCAFE project was to evaluate the conflict resolution Workshop in terms of determining whether the project's concept of equitable stakeholder involvement was a useful framework for future Cormorant-fisheries conflict resolution elsewhere in Europe. To this end, the Facilitator organised an anonymous questionnaire survey of delegates immediately after the Workshop. This section provides an overview of questionnaire returns.

Twenty-six responses (50% of Workshop delegates) were received and almost all agreed that the case study was useful and enjoyable and that REDCAFE had helped them relate conflict management methods to Cormorant-fisheries conflicts elsewhere (Table 6.6).

	Strongly agree	Agree	Disagree	Strongly disagree
REDCAFE has helped me relate conflict management methods to Cormorant-fish conflicts	23%	73%	4%	0
The case study was useful	35%	61%	4%	0
The case study was enjoyable	40%	51%	9%	0

Table 6.6 Summary of responses (n = 26) to anonymous REDCAFE evaluation.

A series of questions were also asked of delegates and those responding to the questionnaire provided over 200 responses. It is not possible to reproduce all of these within the present report. Nevertheless, responses are summarised below in three sections: the REDCAFE process of addressing Cormorant-fisheries conflicts, the main lessons learned, and looking forward. Further insights from the evaluation process are discussed in sections 7.1 and 7.2.

6.7.2 The REDCAFE process of addressing Cormorant-fisheries conflicts
The Main Strengths

By far the most commonly cited strength of the case study Workshop, and of the REDCAFE process in general, was the development of trust between project participants and other stakeholders, and effective dialogue between scientists and others. Next followed the pan-European involvement and collaboration produced by the project and the opportunity it has provided to bring international perspectives to bear on local case studies. This was often achieved through clear (but not oversimplified) presentations of issues across Europe. Another important strength identified was the enthusiasm, open-mindedness and friendliness of project participants and, through collaboration with social scientists, the project's attempts to reach consensus on Cormorant-fisheries conflicts. REDCAFE offered the first opportunity to apply recognised conflict management techniques to Cormorant-fisheries interactions at the pan-European level.

The Main Weaknesses

A number of weaknesses were identified. In relation to the case study Workshop, the commonest were lack of time and the involvement of too few local stakeholders. It was recognised that these constraints probably limited, to some degree, discussions on potential site-specific management tools. More generally, policy makers should have been included as REDCAFE participants and the continued need for effective dialogue between all interested parties was highlighted. Clearly, such participation is important because of the complexity of many of the central problems and issues to be addressed. A formal approach to applying REDCAFE philosophy to the thousands of other case studies across Europe is needed. Moreover, the onus is currently on biologists to solve what are essentially people-people conflicts (see 6.2), professionals in other disciplines should be increasingly involved in these conflict management issues.

6.7.3 The main lessons learned

Five lessons for the REDCAFE project were cited most frequently. By far the most frequent involved the vital importance of participation and dialogue. Almost all stakeholders stated that conflicts can only be resolved through relationships and trust: people must work together, ideally in face-to-face discussions, to develop solutions. It is clear that a neutral, comfortable and relaxed atmosphere is the best forum for such discussions and that reaching consensus (e.g. Warner 2000) is probably the best goal.

All those involved in dialogue must consider the language they use and be aware that different participants (individuals or groups) will have different levels of confidence and enthusiasm. It is also important to realise that, in complex or wide-ranging conflicts, scientists are stakeholders too.

Following this, respondents noted that it takes time to understand conflict and decide how best to manage it. There may be no ultimate solutions but effective dialogue will invariably help to resolve conflicts.

Another important lesson was that large-scale culling of Cormorants will almost certainly be ineffective. Cormorants are now an established element of many aquatic ecosystems and people need to learn to live with them. Scientific information is necessary to inform debate and potential mitigation policies, and REDCAFE has demonstrated that clear communication of scientific information can influence other stakeholders' perceptions and understanding and *vice versa*.

It seems clear that there can be no single solution to the pan-European Cormorant-fisheries conflict. Most, if not all, situations are a complex mixture of biological, social and economic issues and each will be slightly different. Nevertheless, a number of potential mitigation measures are available (see Chapter 5) and successful Cormorant management is possible (see 6.5.2).

Other REDCAFE lessons cited include the realisation that a conflict situation exists (sometimes regardless of scientific evidence to the contrary) if a particular stakeholder group perceives it to be so. Furthermore, it is clear that Cormorants are not always the main problem affecting fisheries: other issues may, ultimately, be more important. In some cases, Cormorant 'problems' are merely a symptom of a damaged aquatic system. Solutions may be very hard to devise if systems are artificial, for example some reservoirs and aquaculture facilities or fisheries enhanced through intensive fish stocking. Most, if not all, Cormorant-fisheries conflicts have an economic or financial element but financial information is rarely in the public domain (see 6.5.4). However, provision of such financial information will be crucial when assessing the cost-effectiveness of potential mitigation measures.

7 Concluding remarks: reiteration and looking forward

7.1 Overview; reiteration

REDCAFE has attempted to synthesise, for the first time, key stakeholder groups' views and perceptions on Cormorant conflicts with fisheries (and, to a lesser extent, with the wider environment) in a standardised way across Europe. Despite methodological limitations, many clear pictures emerged and these have been discussed. Just as importantly, collecting and collating information for this synthesis has allowed REDCAFE participants (primarily natural scientists or those working closely with them) to forge links with local stakeholders experiencing conflict issues at first hand. REDCAFE offered the first opportunity to apply recognised conflict management techniques to Cormorant-fisheries interactions at the pan-European level.

Through discussions with stakeholders it was clear that conflicts with Cormorants are not the only ones facing many fisheries and environmental stakeholders. To better understand the nature of Cormorant-fishery conflicts it is useful to consider other internal and external issues leading to conflicts over fisheries resources. These issues, both environmental and social, are often complex and closely linked. Environmental conflicts over resources, including those involving fisheries, usually involve numerous issues. This appeared true across Europe: many of the stakeholders who provided specific information on Cormorant conflict issues for the present synthesis also described other issues, fears and concerns affecting their businesses or recreation. Many stakeholders also recorded concerns over the creation of sustainable fisheries and the development and implementation of effective, 'holistic' fisheries management programmes. Some of the other wider concerns affecting fishermen contributing to the present synthesis related to ownership and property rights and to changes in market economies.

The Workshop evaluation process confirmed that the REDCAFE philosophy of developing interdisciplinary links within and between the fields of natural and social science was very useful. Moreover, the project clearly demonstrates the necessity, and value, of dialogue and participation between all stakeholders (or their legitimate representatives) involved in Cormorant-fishery conflicts. Evaluations also showed that REDCAFE's approach to a specific Cormorant-fishery conflict case study provides a useful framework for similar activities elsewhere. Many people currently working in Cormorant-fisheries conflicts acknowledge that further conflict management training is essential if they are to maximise the effectiveness of their work. There is acknowledgement that the process of conflict management will take time and require appropriate resources, including funds. Interestingly, several Workshop delegates noted that the costs of funding these initiatives are likely to be far lower than they would be if conflicts were left unmanaged.

7.2 Looking forward: next steps

The important next steps for managing Cormorant-fisheries conflicts in Europe, as determined from the REDCAFE evaluation process (see also 6.7), can be described in two ways: in relation to (a) specific case studies, individuals, or groups of local stakeholders, and (b) to the scientific community in general.

7.2.1 *Case studies, individuals and stakeholder groups*

At the local level, by far the most commonly anticipated next step was to consider potential site-specific management techniques based on lessons learned from the REDCAFE synthesis (Chapter 5). There is a strong desire to put theories into practice and to try mitigation measures that have been shown to work elsewhere. For many, next steps should include exploring the possibilities of developing and implementing local fishery management, or action, plans for specific case studies and/or the building of partnerships at the national level between fishery and conservation organisations such as the Moran Committee in the UK (see footnote #3).

Linked to this is a recognition of the importance of making concerted efforts to create participation, dialogue and consensus building between local stakeholders involved in Cormorant-fisheries conflicts across Europe. This will require effective dissemination of relevant information at local, regional, national and international levels. Politicians and policy makers should also be included in such dissemination activities. There is a need for long-term studies to quantify the effectiveness of various measures to mitigate against Cormorant problems at fisheries. Similarly, there is a need for a practical pan-European Cormorant-fishery research programme that includes ecological study, collaboration between natural and social scientists and a strong conflict management element.

7.2.2 The scientific community

While social issues now feature strongly in the mind of natural scientists after the REDCAFE project, many in that community expressed clear needs to improve understanding of ecological issues. These include Cormorant physiology, biology and daily food intake, fish population dynamics and community structure, and Cormorant impacts on fish populations and catches in various aquatic habitats. There is also a need to explore means of reducing the carrying capacity of these habitats for Cormorants (see 6.5.2).

Scientists also realise the need to forge better links with others. Although scientific independence and rigour remain crucial, there is a need for scientists to apply their research results to real life cases (see 3.7.3 for discussion). Part of this process will involve wide dissemination of REDCAFE material but scientists also need to collaborate with other stakeholders and local people, for example in the development of local management plans. Such collaboration will require scientists to communicate practical information to others in a clear manner and to maintain dialogue with all interested parties. Natural and social scientists also need to forge closer links because, as discussed elsewhere (see 6.2), Cormorant-fisheries conflicts are situated in social and political contexts.

Scientists are aware that co-management (see 3.7.2.for discussion) should be more participatory rather than 'top down': they do not wish to tell people what to do. However, they must be involved in the management process: providing a better understanding of Cormorant-fisheries interactions and increasing their ability to predict the likely outcomes of particular management and mitigation scenarios. Related to this is the need for the scientific community to become more integrated into the decision-making process at regional, national and international levels.

7.2.3 *Looking forward: fisheries co-management*

While REDCAFE focused on Cormorant-fishery conflicts, other tensions were recognised by the project as influencing them. Addressing such broad fisheries conflict issues is not trivial and will take time and require trust between stakeholders. Furthermore, in order to avoid inadequate fisheries policies and management systems, that tend to treat the symptoms rather than address underlying problems, broader environmental and institutional factors should be taken into account and fundamental socio-cultural conditions must also be given high consideration. It has been suggested that participatory co-management in fisheries, where managers and local fishermen co-operate in drafting policy, may facilitate successful management while also offering the possibility of reducing public costs.

If natural resource management is to be sustainable in the long term, an understanding of human behaviour is vital and the need for collaborative links between natural and social scientists was recognised by REDCAFE. The fundamental challenge for fisheries management in this context is to find ways of expanding technical expertise whilst increasing collaboration amongst all stakeholders in decision-making processes. In the past there has been much co-operation between fishermen and scientists at the individual level but a more organised management structure is required to bring these, and other, groups together. REDCAFE's work established an area of co-operation between natural scientists, local environmental stakeholders (fishermen and conservationists) and policy makers which should form the basis for further dialogue and collaboration in the future.

7.2.4 Looking forward: future research

A major challenge for natural scientists will be to make their work more relevant and useful to stakeholders. It is clear that different stakeholders involved in Cormorant-fisheries conflicts have different values and perceptions over these issues. It is also clear from dialogue with other stakeholders that they also view scientists as having different values and perceptions. Thus, scientists should be considered as another stakeholder group involved in the issue of Cormorants and fisheries. Given the recognition that there is no single value or perception (i.e. 'reality') for all the different stakeholders groups within this conflict, it is unrealistic to expect a single method of collecting, analysing and interpreting useful scientific information. The development of a rigorous scientific research programme to address Cormorant conflict issues will have to maintain high scientific standards but will also have to be both relevant to and influential in the decision-making process.

There is a need for a practical pan-European Cormorant-fishery research programme that includes ecological study, collaboration between natural and social scientists and a strong conflict management element. Similarly, there is a need for long-term studies to quantify the effectiveness of various measures to mitigate against Cormorant problems at fisheries. Stakeholders have a long list of possible management actions against Cormorants but relatively little guidance on their likely effectiveness, practicability, acceptability or costs at a specific site. Therefore it seems likely that adopting 'new' techniques to reduce Cormorant impacts at feeding sites, in whatever habitat, is most likely to be a case of trial-and-error. Clearly, considerably more work is required to trial the use of techniques to reduce Cormorant impact at feeding sites.

Whatever framework future scientific research into Cormorant conflicts takes, it is clear that all stakeholders are concerned over the common issues of quality, health and status of biological resources in wetland systems. Dialogue with stakeholders highlighted several areas where major conflicts were currently poorly served by scientific literature (see 3.7.3). However, it must be stressed that such research should be undertaken with participation from stakeholders at all stages where possible. Ultimately, this should increase the useful knowledge of both scientists and other stakeholder groups whilst also increasing collaboration between all parties, but particularly local people, in the decision-making process with regard to Cormorant conflict issues across Europe.

7.3 Concluding remarks

Full information from REDCAFE should be disseminated as widely as possible so that the lessons learned from the project can be applied elsewhere. The establishment of a pan-European information exchange network would greatly facilitate the conflict resolution process and allow stakeholders to view their own particular situations in the broader continental context. Information must be exchanged at several levels: within and between disciplines of natural and social science, between scientists and other stakeholders, and between all interested parties and politicians, policy makers and the general public. There is also an urgent need for detailed information on the site-specific effectiveness, practicability, acceptability and costs of specific techniques to be disseminated as widely as possible to relevant stakeholders. Thus the formation of an information exchange network would be a very useful tool to facilitate the rapid transfer of ideas, experiences, techniques, their implementation and subsequent outcomes. It could also offer stakeholders opportunities for discussion and could provide them with clear information on the actual costs (both invested and saved) of specific techniques. The most important next step after dissemination is to build on the findings of REDCAFE so that local stakeholders can begin to develop effective site-specific strategies for resolving local conflicts.

The REDCAFE project is the most comprehensive attempt to address Cormorant-fishery conflicts at the pan-European scale, covering 25 countries. However, it is clear that the project is merely the first step of this process. Opportunities must now be explored to further develop the foundation framework that REDCAFE has developed in linking science with society and advancing processes of conflict management across a range of European contexts. The REDCAFE Cormorant-fisheries conflict synthesis demonstrated clearly that such conflicts are complex, in terms of both biology and equally important social and economic issues. This synthesis is an important first stage towards developing trust and collaborations between all those affected by Cormorant conflicts. These issues are as much a matter of human interests as they are of biology. It is hoped that this element of REDCAFE's work will indeed be the start of a management process for Cormorant-fisheries conflict issues and, by implication, for wider environmental issues affecting fisheries and aquatic conservation across Europe. A formal approach to applying REDCAFE philosophy to the thousands of other case studies across Europe is now needed. Moreover, the onus is currently on biologists to solve what are essentially people:people conflicts, professionals in other disciplines should be increasingly involved in these conflict management issues.

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