# Cormorant-fisheries conflicts in Carp pond areas in Europe and Israel

## an INTERCAFE overview

Photographs—INTERCAFE

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This publication has been produced by **INTERCAFE's** Carp Pond Sub-Group (part of Work Group Two, the 'Conflict Resolution and Management' group) which comprised seven Carp pond specialists each from an important Carp-producing country in Europe or beyond: the Czech Republic, France, Germany, Hungary, Israel, Latvia, and Poland (for details of these authors, please see Appendix Two).

This publication was written and edited by Kareen Seiche, Petr Musil, Tamir Strod, Oleg Nemenonoks, Ferenc Lévai, Robert Gwiazda, Daniel Gerdeaux and Dave Carss. Helpful information, comments and corrections on various drafts were provided by: Wolfgang Stiehler (GER), Gerd Füllner (GER), Damian Wiehle (Ornithological Association in Malopolska), Beata Orlowska (Ornithological Station in Ruda Milicka, Wroclaw University) and Simona Polakova (Daphne, Institute of Applied Ecology, Czech Republic) helped with the RDA analysis. A number of people also kindly provided photographs for inclusion and individual sources are acknowledged under each picture wherever possible. The 9 satellite images in the Appendix One were taken from Google Inc.'s Google Earth™.

Throughout the series of **INTERCAFE** meetings, numerous participants from the Action's other two Work Groups made contributions to the discussions on Carp ponds and these were also informed on occasions by discussions with invited experts and local stakeholders. Wherever appropriate, information from these sources has also been incorporated into **INTERCAFE's** overview of this highly important sector of European freshwater fisheries.

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# 1 PREFACE

D N Carss, M Marzano

This publication is supported by **COST**. It is one of the outputs of the **INTERCAFE COST** Action (635). **COST** (European Cooperation in Science and Technology) is the longest-running intergovernmental network for cooperation in research across Europe.

**INTERCAFE** — 'Conserving biodiversity: interdisciplinary initiative to reduce pan-European cormorant-fishery conflicts' — was awarded funding for four years (2004–2008). **COST** Actions are charged with directing European science and do not pay for researchers' time. Instead, funding was available for **INTERCAFE** to organise and run a series of international meetings, drawing together researchers from a number of disciplines (bird-related and broader ecology, fisheries science and management, sociology, social anthropology and international law) and other experts (very often connected with fisheries production, harvest and management, or to regional/national policy and decision-making). Under **INTERCAFE's** coordination, interested parties, from local stakeholders to international policy-makers, were thus offered a unique opportunity to address European cormorant-fisheries issues.

The main objective of **INTERCAFE** was to improve European scientific knowledge of cormorant-fisheries interactions in the context of the interdisciplinary management of human-wildlife conflicts at local to international levels across Europe. It also aimed at delivering a coordinated information exchange system and improved communication between stakeholders. To this end, **INTERCAFE** attempted to address:

i. the fundamental distrust between the main stakeholder groups which was compounded by the disparate and uncoordinated nature of available sources of information,
ii. the necessity of applying an integrated interdisciplinary research approach (biological, social, legal) to cormorant-fishery conflicts (as these are as much a matter of human interests as they are of biology or ecology), thus recognising the need for different perspectives in the development of collaborative strategies, and
iii. the lack of an integrated understanding of the interdisciplinary factors at the heart of cormorant-fisheries conflicts that precludes the provision of useful and practical information and advice to all interested/affected parties.

The **INTERCAFE** network comprised almost seventy researchers from all 27 EU Member States (except Luxemburg, Malta and Spain) and other countries in continental Europe (Georgia, Norway, Serbia) and the Middle East (Israel). In addition to these 28 countries, Ukraine and Croatia were also associated with the Action. **INTERCAFE** held a series of eight meetings, each themed around a topic particularly relevant to the host country:

1. Gdansk, Poland, April 2005 — *'Cormorant ecology, commercial fishing and stakeholder interaction'*
2. Saxony, Germany, September 2005 — *'Commercial Carp aquaculture'*
3. Hula Valley, Israel, January 2006 — *'Cormorant-fishery conflict management in the Hula Valley, Israel'*
4. Bohinj, Slovenia, October 2006 — *'Angling and EU legislation'*
5. Hanko, Finland, April 2007 — *'What to do when the cormorant comes'*
6. Po Delta, Italy, September 2007 — *'Extensive aquaculture systems and relationships between stakeholder perspectives and different spatial and institutional levels'*
7. South Bohemia, Czech Republic, April 2008 — *'Management practices in a complex habitat mosaic and at local, regional and national levels'*

8. Paris, France, September 2008 — *'The management of cormorant-fisheries conflicts in France and the wider European context'*

At each meeting, **INTERCAFE** participants worked in one of three Work Groups, covering the broad aims of the Action:-

- Work Group One — Ecological Databases and Analyses
- Work Group Two — Conflict Resolution and Management
- Work Group Three — Linking Science with Policy and Best Practice

Most meetings included a field visit to allow participants to see cormorant-fishery conflicts at first-hand. In addition, wherever possible the **INTERCAFE** budget was also used to invite appropriate local, regional, national or international experts to these meetings. Through these discussions and interactions, **INTERCAFE** participants tried to understand the diverse cormorant-fishery conflicts in Europe and beyond.

This publication is one of a series of **INTERCAFE** outputs aimed at providing readers with an overview of European cormorant-fishery conflicts and associated issues, which is as comprehensive as possible given the budgetary and time constraints on all of **INTERCAFE's** participants.

The **INTERCAFE** publications are:-

- Cormorants and the European Environment; exploring cormorant status and distribution on a continental scale. (ISBN 978-1-906698-07-2)
- The **INTERCAFE** Field Manual: research methods for cormorants, fishes, and the interactions between them. (ISBN 978-1-906698-08-9)
- The **INTERCAFE** European Cormorant Management Toolbox: methods for reducing cormorant problems at fisheries. (ISBN 978-1-906698-09-6)
- Cormorant-fisheries conflicts in Carp ponds areas in Europe and Israel — an **INTERCAFE** overview. (ISBN 978-1-906698-10-2)
- Essential social, cultural and legal perspectives on cormorant-fisheries conflicts. (ISBN 978-1-906698-11-9)

Highlights from these publications are available in **INTERCAFE**: an integrated synthesis (ISBN 978-1-906698-06-5) and are available at http://www.intercafeproject.net

Within the framework of **INTERCAFE** three working groups were organised. In Working Group 2, which was concerned with management problems, a special sub-group working on Cormorant conflicts in Carp Pond areas was set up. These conflicts are incommensurable with cormorant conflicts in natural habitats such as lakes or rivers. In some European countries the conflicts with Cormorants in Carp ponds are the main Cormorant-human conflicts at the national level.

Photograph — Shutterstock

Drawing on **INTERCAFE's** ability to develop a network of researchers and the Action's privileged opportunity to see and hear about cormorant-fishery issues across Europe and beyond, **INTERCAFE's** overview of Cormorant-fisheries conflicts at Carp ponds in Europe and Israel aims to: (1) introduce and discuss the importance of Carp pond areas, (2) analyse the situation of Cormorants in Carp pond habitats in relation to (seasonal) numbers and important associated environmental factors, (3) describe the damage caused by Cormorants at ponds, (4) provide an overview of the effects of management strategies on Cormorant-fishery conflicts under varying conditions, and (5) consider the possibilities of transfer of successful management strategies.

Besides the **INTERCAFE** meetings, the Carp Pond Sub-group held two additional smaller meetings in different Carp pond areas to get a better understanding of regional problems, to discuss issues with stakeholders and local experts, and to work on specific topics in relation to Cormorant conflicts in Carp pond areas. The additional meetings were held in:

1. France, west of Lyon (Forez) and east of Lyon (Dombes): 28 February–04 March 2007.
2. Hungary, Rétimajor: 06–10 March 2008.

# 2 INTRODUCTION

During the REDCAFE project Cormorant conflicts at European fisheries were examined in 24 countries and information was collated for 235 conflict cases from a wide variety of habitats and fishery types, including rivers, lakes, freshwater aquaculture ponds, coasts and coastal sites. Of these, freshwater aquaculture ponds (predominantly holding Carp *Cyprinus Carpio*) appeared to be a particularly interesting fishery sector, having considerable historical, cultural and environmental value and importance. Furthermore, although the surface area of fish ponds in Europe (27 Member States) is relatively small at some 340,000 ha[1], such pond fisheries are geographically very widespread across Europe and beyond and, in many instances, they are ecologically rather similar. The specific characteristics of Carp pond fisheries, and their intimate historical and traditional associations, clearly set them aside from many other types of European freshwater fisheries (whether commercial or recreational) in rivers and lakes and suggested that this fishery-type warranted detailed exploration.

Across European Member States, at least 29 species of fish are farmed commercially in aquaculture systems. Whilst some trout (*Salmo* and *Oncorhynchus* spp.) are farmed in freshwater (the remainder in salt or brackish waters), the most commonly produced freshwater fish in European States is the Carp, over 62,000 tonnes of which were produced in 2010 (FEAP 2011). In 2010, a further 5,172 tonnes of other Carp species and some 3,888 tones of other freshwater species were produced. Thus, the production of Carp dominates the freshwater production sector of European aquaculture and so Carp pond areas are of considerable importance.

This publication thus provides an overview of the cormorant-fisheries conflicts and associated issues in European Carp pond areas and, whilst not exhaustive, the areas covered are considered by the authors to be representative of the main Carp pond areas in Europe and Israel. To this end, a number of case study regions are examined: the Milicz and Zator complexes in South Poland (PL), the Jindřichův Hradec district of South Bohemia in the Czech Republic (CZ), the Upper Lusatia region of Saxony in Germany (GER), the Dombes and Forez regions of France (FR), the

[1] Introductory text by Prof. Bogusław Zdanowski, Head of Inland Fisheries Institute, Poland, for the International Carp Conference, 15–16 September 2011 Kazimierz Dolny, Poland.

Available at: http://www.aller-aqua.com/cms/front_content.php?idcat=561

This area of Carp ponds is equivalent to approximately 0.5% of the area of Germany, 1% of the area of France and 1.4% of the area of the United Kingdom. It is very similar in size to the area of the Romanian sector of the Danube Delta and about half of the area of the delta incorporated in UNESCO's Biosphere Reserve.

Hula Valley in Israel (ISR), and the Lubana wetland complex in Latvia (LV).

Here we briefly explore the importance of Carp pond areas from economic, social/cultural and biological perspectives and introduce a range of Case Study areas. For these areas we present numerical and seasonal information on Cormorant abundance, and temporal trends where information is available. Cormorant status and distribution in these areas is then analysed in relation to local environmental factors and assessments are made of Cormorant damage to Carp pond stocks. Examples of the different approaches to 'solving' Cormorant conflicts that have been adopted in the different Carp pond areas (and countries) and their effectiveness — or otherwise — is also explored. This publication ends with a summary chapter including concluding remarks.

**INTERCAFE's Carp Pond sub-Group.** Photos Kareen Seiche, Daniel Gerdeaux, Zuzana Musilova, **INTERCAFE**.

# 3 THE IMPORTANCE OF CARP POND AREAS

Fishponds and fishpond systems in the European landscape are the result of habitat modifications made by several generations often hundreds of years ago. Artificial production of Carp in freshwater ponds is common across much of central and eastern Europe and can be traced as a livelihood strategy back to medieval times or earlier.

Indeed, most of the fish ponds in Germany, Poland, France and the Czech Republic were constructed between the 12th and 15th centuries. European fish pond regions, particularly those specialising in Carp production, are now considered a vital part of the cultural heritage in the regions where they occur, having been an essential part of the landscape and a source of traditional livelihood and regional identity and pride for some 600–900 years. However, as this section describes, these pond farms are considerably more than just a local source of fresh fish.

**Common Carp *Cyprinus carpio*.**
Photo courtesy of Shutterstock.

## 3.1 Carp production

In recent years, Europe's Carp production has to considerable extent mirrored political changes within the European Union. Indeed, due to the Eastern European expansion of the EU in 2004, Carp production of the EU tripled from about 20,000 tonnes to 60,000 tonnes. In the 12 new EU Member States[2], aquaculture in freshwaters predominates and here Common Carp and other cyprinids represent 70% of annual production. The four largest Carp producing countries within the EU actually produce about 90% of all the EU's Carp production. The most important Carp producing countries in Europe are listed in Table 3.1. This shows the Carp production of different European countries and this as a percentage of the total national aquaculture production. In this instance, aquaculture means the captive breeding of fishes, bivalves and water plants/algae.

**Fishponds have had an important role in many landscapes for almost 1,000 years in many places, forming much-valued wetland mosaics.**
Photos courtesy of Jan Sevcik, Jan Pokorný, and Libor Pechar *et al.*[3]

Carp production in Germany, France, Latvia and Poland has decreased over recent years. For example in Germany production fell by around 88% between 1995 and 2006 (from 22,987 to 2,642 tonnes). Similarly, Poland's Carp production declined 34% between 2000 and 2007 and in 2009 Carp production amounted to 18,133 tonnes. Production is currently low in Germany and Poland because of a lack of Carp as a result of decreasing production caused by the Koi herpes virus (KHV or Cyprinid Herpes Virus 3) a viral disease known to be highly contagious to the Common Carp and its ornamental relatives.

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[2] These 12 Member States are Malta, Cyprus, Slovenia, Estonia, Latvia, Lithuania, Poland, the Czech Republic, the Slovak Republic, Hungary (all joined EU in 2004), Romania and Bulgaria (joined in 2007).

[3] Photograph taken from presentation 'The Role of Fishponds in the Landscape' by Jan Pokorný, Libor Pechar *et al.* (ENKI, Public Benefit Corporation, Dukelská 145, CZ-379 01, Třeboň and Institute of System Biology and Ecology, Academy of Sciences, Czech Republic. Email addresses: pokorny@enki.cz and lpechar@zf.jcu.cz, respectively).

Hradec region) export up to 75–80% of their production. The main export countries are Germany (about 45–50%) and Slovakia (about 25%), but Czech Carp are also exported to Belgium, Austria, France, Italy and Switzerland. Exports from the Czech Republic to Poland and Hungary are also increasing (Sächsische Landesanstalt für Landwirtschaft, 2005).

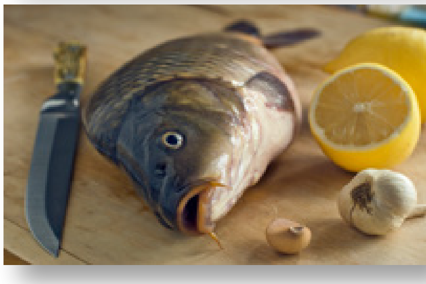
## 3.2 Market conditions

More than most other fish species, the Carp has had a special role as a traditional food in many European countries and it still does today. However the traditional role of Carp in the fish market has declined in recent years in many European

In contrast, Carp production in Hungary has been quite stable since 1999 with production around 900 kg/ha. Here, from a total pond area of 30,000 ha, around 85% (25,343 ha) are used for fish production (2003 survey), mainly of Carp. In the Czech Republic, data from 1990–2006 on international fish production (tonnes live weight) in inland waters show Czech production increased slightly, from 39,290–46,460 tonnes (Office for Official Publications of the European Communities, 2007). From a total pond area of 51,000 ha (24,000 ponds) in the Czech Republic, 42,000 ha (82%) are used for fish production and in 2003 the production of Carp was about 451 kg/ha of which 40%–50% went for export. However, some fishery companies (e.g. Rybářství Kardašova Řečice in Jindřichův

**Table 3.1** Carp production in Europe (data from FEAP, 2002; aus 'Ökonomie der Kapfenteichwirtschaft, Sächsische Landesanstalt für Landwirtschaft').

| Country | Annual Carp production (tonnes) | Proportion of total national aquaculture production |
|---|---|---|
| Poland | 18,000 | 59% |
| Czech Republic | 17,000 | 92% |
| Germany | 11,000 | 29% |
| Hungary | 8,000 | 67% |
| France | 6,000 | 10% |
| Belgium | 800 | 50% |
| Austria | 800 | 19% |



**Carp is an important traditional food in many European countries.**
Photos courtesy of Shutterstock.

**Carp harvest at Saxony fishpond.** Photo courtesy of Tamir Strod.

countries. Fish markets in Europe are changing due to changing circumstances and the growing complexity of the European market: consumer habits are changing with more and more exposure to new and different fish species and increasing demand for 'better' (i.e. low fat) fishes, mainly sea fishes. Other fish species on the market such as Atlantic Salmon (*Salmo salar*) and trout (*Salmo* and *Onchorynchus* spp.), catfishes (Siluriformes) and Shark Catfish (an Asian catfish species, *Wallago attu*) compete against Carp. Furthermore, relatively low prices for a variety of other fish species also affect Carp sales. Similarly, exposure to global fish markets is a problem for Carp production among others. This is because Carp is a regional product market-wise, and is generally sold not too far away from the fish ponds where it has been grown, using only ground-based transport to deliver Carp to retailers.

In addition, apart from a very small supply of 'ready to cook' products, Carp is not yet a very popular fish within the food processing industry and is thus sold mainly live or fresh. Indeed, several trials of Common Carp processing have been carried out in Europe, showing that live or freshly dressed fish are required by the market, and that processing increases the price of Carp to increasingly uncompetitive levels which would inevitably affect future demand for processed Carp products. Furthermore, the necessary transportation of live or fresh Carp is very costly compared to that of processed fish products.

Despite these issues, the trend for annual Carp production volume has started to increase over the last 5–10 years in some European

**Table 3.2** The production of Carp (and other cyprinids) in Europe from 2000–2009. (Source: FAO — Fisheries and Aquaculture Information and Statistics Service 29/2/2012).

| Production (1,000 tonnes) | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Common Carp | 137.5 | 142.8 | 144.6 | 146.0 | 146.9 | 153.0 | 124.7 | 148.0 | 153.6 | 157.2 |
| Carp, barbels and other cyprinids | 197.4 | 211.8 | 216.0 | 224.2 | 221.4 | 224.6 | 186.1 | 211.0 | 219.7 | 220.5 |

**Harvesting Carp and loading them for live transport.**
Photo courtesy of Petr Musil.

**Carp market at Christmas.** Photo courtesy of Shutterstock.

countries (first of all, eastern European countries), whilst at the European level as a whole it has stabilised (Table 3.2). Similarly, as the world trade expands and as a result of developing trade between EU countries, the former limited market for Carp 'fingerlings' (i.e. young-of-the-year fish) for restocking is evolving, with farmers in one country buying their 'raw material' for on-growing from fish farms in other countries (under limitations of the Epidemic Regulation of the EU from the 1st of January 2009).

As examples of changes in the markets for Carp, production of the species has declined in Poland, whilst production of Rainbow Trout (*Onchorhynchus mykiss*) has increased during the same time period.

Similarly, the changes in customer preferences for fast food over recent years in Germany has also affected the consumption of Carp, and less Carp is now eaten there. There are also other reasons for the market decline of Carp, including its 'muddy' flavour and that it has many bones and is considered difficult to prepare. Overall it is not considered a 'modern' fish and is rarely offered in current marketing. Additionally, the traditional custumers who used to buy Carp are getting older and there are far fewer young people that like to eat Carp.

Nevertheless, the Common Carp is still (and probably will remain) a commercially important species, consumed domestically in those areas where it has traditionally been produced. Whilst the market for Carp is likely to remain for live or freshly dressed fish, there is no guarantee of increasing demand. On the other hand production of 'bio Carp' has started in some areas. Here 'quality labelling' and an emphasis that the Carp is produced in extensive or semi-intensive systems with environment-friendly technologies may increase the acceptance of Common Carp by certain groups of consumers. In Germany there are intentions to produce 'organic Carp' (i.e. low density stocking, organic grain feed). However, because standard extensive Carp production is in effect very similar to such organic Carp production this is not really a

**Other freshwater and marine fishes are now becoming popular with many people.**
Photo courtesy of Shutterstock.

**The Carp harvest is celebrated with a local fish festival, Saxony.**
Photo courtesy of **INTERCAFE**.

this is not really a new product and so a higher market demand is probably unlikely. Similarly, fish farmers in several countries (i.e. in Germany, Poland, Czech Republic) have started to promote the Carp as a traditional fish species and a good, healthy dish at local festivals and on TV advertisments in an attempt to present the species as being a 'better' fish than others.

Recently, there has been a positive change in the marketing of Carp, by emphasising its use as a recreational sports fish rather than merely a food fish. A significant quantity of Carp is now stocked into natural waters and reservoirs for angling purposes. Since anglers prefer fish that are more active on the hook than the domestic Carp, wild Carp or hybrids of domestic and wild Carp strains are used for such stocking. Wild Carp are also required for re-stocking natural waters where rehabilitation or restoration programmes are carried out. Another significant and increasing trend in Carp ponds is to convert conventional pond farming to 'multi-functional fish pond farming' thus diversifying income sources from additional features such as the increased provision of angling, tourism and ecological services (e.g. Natura 2000).

## 3.3 The structure of Carp producers on a European level

There are two organisation of Carp producers in Europe: FEAP, the Federation of European Aquaculture Producers (see http://www.feap.info) and EAS the European Aquaculture Society (see http://www.easonline.org). FEAP is an international organisation comprising the National Aquaculture Associations of European Member States, as such it is primarily concerned with finfish production (though is not restricted to certain groups such as the Salmonids [Salmon-family] or Cyprinide [Carp-family]). The basic aims of the Federation are to develop and establish a common policy on questions relating to the production and the commercialisation of aquaculture species reared professionally and to to make these common policies known to the appropriate authorities. The European Aquaculture Society aims to bring together all those interested in the sustainable development of European aquaculture, to develop contacts and disseminate information and to promote multi-disciplinary research. To this end, the EAS organises international conferences and publishes the resulting Proceedings and numerous other publications as well as the peer-reviewed journal Aquaculture International.

As well as cross-border business connections, European Carp producers actively take part in these organisations. Relevant information about Carp fish farms and the associated fish trade can also be easily found on the internet. In the past a European Carp Conference was held, at the level of the fishery associations mostly in Austria, but this conference has not taken place in the last few years for financial reasons. Also operating at the international, trans-boundary level, a limitation for trading small stock Carp is contained in the EU's Fish Epidemic Regulation (operational since 1 January 2009) and it is now considered that trade with totally healthy fish is nearly impossible. Since the enlargement of the EU (particulary in 2004), it is hard to even estimate the fish trade that is going on between Member States because they are not obliged to produce any statistical data on this. Until 2011, each country compiled its own statistics (a job undertaken by local experts) but this information did not have to be sent to the EU. However, with enforcement of the act for aquaculture statistics (act Nr. 762 from 2008) the situation changed from 2012 onwards and all the countries have to provide their statistical data on their fish production to the EU.

However, it is current practice that whenever one country's local market is low for a specific type/age of fish, then they import it from another country if possible. For example, recently in Hungary there was apparently so much Cormorant damage done to stocks of 100–400 g Carp that fish had to be bought to fill ponds adequately. Since this was a problem throughout Hungary, fishermen had to look at other States to buy from, but often farmers in other countries were also facing similar problems. One-year old Carp in particular are exported by the Czech Republic to other European countries (including Germany, Poland, France, Belgium).

## 3.4 Pond fisheries — encouraging a profession for young people

There is a high degree of education and skill-transfer associated with Carp pond farming and this job should be seen as a profession rather than an old-fashioned, traditional job. Most of the young people joining the pond farming profession come either from families owning pond farms or have previous experience of working in fish ponds. In regions with a long history of pond fisheries, young people are attracted to work as fishermen and attend special fishery schools dedicated to fish pond farming. For example, in Königswartha, Saxony, there is a fishery department for training fishermen where students can specialise in pond or river fishery courses as well as ones in fish husbandry and fish farming, including both pond farming and trout farming. Over recent years there has been a decline in those studying sea or river fishery management but no decrease in those studying fish farming.

The recruitment of young Poles to pond farming was, up to 2009, through the Technical Fishery School and is actually from villages around pond areas. However, here, the numbers of recruits is declining. In Hungary it is also not easy to find adequate manpower for pond management and the workers here are mostly unskilled but recently universities have started to offer 2-year courses for fisheries and pond farming. In France there are several schools for aquaculture and these actually have more applicants than places, whilst there are also several secondary schools in the Czech Republic specialising in fisheries training (especially in the key regions of Vodňany and Třeboň). Fishery and fishpond management are also included in the education programmes of many natural science and environmental and agricultural faculties in Czech universities. In addition, the Faculty of Fisheries and Protection of Waters was established by the South Bohemian University in České Budějovice in 2009.

## 3.5 The importance of Carp ponds for nature protection

Whilst essentially man-made landscapes, many of Europe's pond areas have existed for so long and are managed in such a way that they have become semi-natural habitats. As such, they are often considered to be 'hotspots' of aquatic biodiversity. These ponds are also often considered to provide ecosystem services to the local area in the form of such things as flood prevention and water storage, and a variety of recreational and aesthetic pursuits. Despite being man-made, fishponds are now an integrated part of wetlands in the European countries in which they occur.

Pond areas and their surrounding landscapes show a variable mixture of forest, fields, meadows and water bodies, in each of **INTERCAFE's** Case Study regions (see chapter 4). Together with the natural components of the landscape, Carp ponds areas are very attractive in that they tend to hold high levels of biodiversity associated with diverse wetland mosaics in the form of aquatic and riparian vegetation, mammals, birds, amphibians, reptiles, fishes and invertebrates. Pond farms thus offer important foraging and/or breeding grounds for many bird species, especially waterbirds, including many rare and endangered species. Fishpond

**Nature diversity in Carp pond area, Saxony.** Photo courtesy of Robert Gwiazda.

**Public noticeboard explaining invertebrate diversity and life-cycles in Saxony fish pond region.** Photo courtesy of **INTERCAFE**.

landscapes are therefore considered to be important in maintaining species richness and biodiversity and, consequently, for nature protection. Indeed, most of Europe's fishpond regions are classified as Nature Reserves or National Park areas, many included in the Natura 2000 network [4]. For example, about 70% of the Milicz fish pond complex in Poland is a Natural Reserve and almost all the ponds are in the designated Natura 2000 area. In France almost all the Carp ponds areas are under Natura 2000 status or under a special French status of nature protection. Within current Natura 2000 designations, the lists of protected species in such pond farm areas include birds, mammals, reptiles, amphibians, fishes, insects, and plants.

The relative importance of fish ponds for nature conservation is often assessed by the numbers of breeding and migratory bird species they hold. For instance, 250 migratory bird species and 130 breeding species have been recorded in the Dombes pond region of France, whilst Latvia's Lubana wetland complex holds 186 breeding bird species, and over 26,000 waterfowl stop-over at the site during their spring migrations. Similarly, in Poland's Barycz valley with its fish ponds in Milicz, some 276 species visit and 166 species have been recorded breeding; 145 breeding bird species have been recorded in the pond farming area of Upper Lusatia in Germany, whilst the pond area of the Jindřichův Hradec district in the Czech Republic holds some 140 breeding bird species and 200 migratory ones. Finally, over 150 breeding and over 300 migrating species, have been recorded in Israel's Hula Valley, including 18 globally endangered species.

**Fishponds are often internationally-recognised sites for biodiversity.** Photo courtesy of Shutterstock.

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[4] The legal basis for Natura 2000 comes from the Birds Directive and the Habitats Directive which form the backbone of the EU's internal biodiversity policy. Over the last 25 years the EU has built up a network of over 26,000 protected areas in all Member States and covering an area of more than 850,000 km$^2$ (18% of the EU's land area). Known as Natura 2000, it is the largest network of protected areas in the world. For more details see http://www.ec.europa.eu/environment/nature/index_en.htm and also http://www.natura.org

**Fishponds are often internationally-recognised sites for birds, including White-tailed Eagle, Bittern and Black-winged Stilt.** Main photo courtesy of Petr Musil, inset photos — Shutterstock.

Besides Great Cormorants (*Phalacrocorax carbo*), several other fish-eating bird species are also commonly recorded in pond areas. For example, the Grey Heron (*Ardea cinerea*), Great White Egret (*Egretta alba*), Great Crested Grebe (*Podiceps cristatus*), terns (Common Tern *Sterna hirundo*, Whiskered Tern *Chlidonias hybrida* and Black Tern *C. niger*), large gulls (Herring Gull *Larus argentatus*, Caspian Gull *L. cachinnans*, Yellow-legged Gull *L. michahellis*), White-Tailed Eagle (*Haliaeetus albicilla*, Osprey (*Pandion haliaetus*) and Pygmy Cormorant (*P. pygmeus*). Furthermore, Carp ponds in Europe appear to be important refuges for rare species such as the Bittern (*Botaurus stellaris*), Little Bittern (*Ixobrychus minututs*), White-tailed Eagle, Little and Spotted Crake (*Porzana parva, P. porzana*) and are important breeding grounds for more common birds such as the Marsh Harrier (*Circus aeruginosus*), Greylag Goose (*Anser anser*), Night Heron (*Nycticorax nycticorax*), Purple Heron (*Ardea purpurea*), Squacco Heron (*Ardeola ralloides*), Little Egret (*Egretta garzetta*), Whiskered Tern, Avocet (*Recurvirostra avosetta*), Black-winged Stilt (*Himantopus himantopus*) and Hen Harrier (*Circus cyaneus*).

Overall, and specifically within the study sites described in chapter 4, pond farm areas are thus considered to be very important components of the best available habitats not only for commercial fish production but also for the conservation of the biodiversity in many European wetlands. There is however a complex relationship between the fish species stocked and grown for commercial fishery purposes and the other aquatic components of farm pond ecosystems.

These original pond constructions, and hundreds of years of naturalisation through sensitive management, have led to the development of shallow, eutrophic (nutrient rich) water bodies, often over-grown with marginal aquatic plants and thus highly suitable for breeding, resting or migrating waterfowl. Fishponds usually replaced original wetlands but often increased their diversity, thereby creating a complex mosaic of habitats which now often represent unique refuges for both plant and animal communities.

The grazing effect of fish, and especially Carp, has been recognised as an important factor affecting benthic (bottom-living) and planktonic communities, the extent of marginal vegetation, and consequently water transparency and chemistry. As a result, there is usually a greatly increased growth of phytoplankton, water turbidity (i.e. cloudiness) increases, and the light cannot penetrate to the deeper water layers where anaerobic conditions (i.e. life-processes in the absence of oxygen, often microbial) may occur (Broyer & Curtet 2011). The negative effects of high fish stock density on the density and reproductive output of several waterfowl species have thus been recorded in several fish pond regions in central Europe. For example, diving duck broods and Little Grebes (*Tachybaptus ruficolis*) have shown preference for fishponds with younger (presumably lower) fish stocks and higher water transparency in fish ponds in South Bohemia (Musil *et al*. 1997, Musil 2006).

In Saxony Little, Red-necked (*Podiceps grisegena*) and Black-necked (*P. nigricollis*) Grebes prefer shallow ponds stocked with fingerlings or one-summer Carp and a high water transparency (R. Schreyer pers. com.: Administration of Biosphere Reserve 'Upperlusation Heath- and Pond-Landscape'). In Poland densities of ducks and smaller grebes are strongly negatively associated with fish age/size gradient. Here, the

**The biodiversity value of fishponds includes a vast range of aquatic and riparian plants, as here at Spytkowice, Poland.** Photo courtesy of Robert Gwiazda.

**Mixed fish stock at fishponds can include Carp, Perch and Pike and Tench.** Photos courtesy of Shutterstock.

Great Crested Grebe was the only species that preferred ponds with medium-sized fish and that was positively associated with total fish biomass (Kloskowski *et al*. 2010).

Fish ponds with conditions most suitable for breeding waterbirds appear to be those with a fish stock density of less than 400 kg/ha and a water-depth transparency of more than 50 cm throughout the year. Generally, for ponds to be most attractive to birds, a typical stock of Carp should be replaced by a mixed fish stock including Tench (*Tinca tinca*) and Pike (*Esox lucius*) or Perch (*Perca fluviatilis*). The biomass of fish in such a mixed stock should also be lower in the first year of a two-year fish-growing cycle (at around 100–150 kg/ha). Fish pond systems should also include ponds with fry (i.e. fish-of-the-year) which can be very important for amphibians and for waterfowl broods which prefer habitats where there is less competition with fish over food and consequently a higher availability of invertebrate food.

# 4 CASE STUDY AREAS: AN INTRODUCTION

Participants in **INTERCAFE's** Carp Pond Sub-group have considerable practical experience in almost of the key Carp pond regions of Europe and Isreal. In order to provide the most comprehensive overview of Carp ponds and their associated Cormorant issues, this group selected nine regions as Case Study areas (Table 4.1).

These nine Case Study areas are centred in central/eastern Europe where Cormorants are considered a problem during the spring and autumn migration periods. However, they also include regions in France (to the west) and Israel (to the east) which are important wintering areas for birds (Figure 4.1). Roughly, the eight continental European Case Study areas are listed as they occur on a north-east to south-west axis from Latvia, through central Europe, to France.

**Latvian fishpond.** Photo courtesy of Oleg Nemononoks.

Full details of all nine Case Study areas are given in Appendix One where data have been collated from a variety of sources including the available results of local field research, regional management reports and information provided by local exports and stakeholders.

These Case Study areas are the focus of this and the next four chapters, being considered representative of fish pond aquaculture throughout Europe and Israel. Most of these areas support extensive fish farming systems using semi-natural, or

**Table 4.1** INTERCAFE's Carp pond Case Study areas in Europe and Israel.

| | Country | Case Study Area | Reference code |
|---|---|---|---|
| (1) | Latvia | Lubana wetland complex | LAT |
| (2) | Poland | Milicz complex | PL-M |
| (3) | Poland | Zator complex | PL-SZ |
| (4) | Hungary | Rétimajor | HUN |
| (5) | Czech Republic | Jindřichův Hradec district, South Bohemia | CZE |
| (6) | Germany | Upper Lusatia | GER-SAX |
| (7) | France | Dombes region | F-DOM |
| (8) | France | Forez region | F-FOR |
| (9) | Israel | Hula Valley | ISR |


**Figure 4.1** Location of the nine INTERCAFE Carp pond Case Study areas in Europe and Israel.

naturalised, ponds created centuries (but occasionally, decades) ago. However, the Case Study area in Israel differs in that it supports relatively high intensity fish production and the ponds in this dry region are obviously almost completely artificial.

**Fishponds in the Hula Valley, Israel.**
Photo courtesy of **INTERCAFE**.

The historical background, character, and use of Carp ponds in each of these Case Study areas are described in the rest of this chapter. The status and abundance of Cormorants in each area is then described (chapter 5), the geographic variation in the origin of Cormorants and possible relationships between environmental factors and Cormorant numbers and associated seasonal patterns for each Case Study area are investigated (chapter 6), the damage the birds are accused of causing at pond farms is also discussed (chapter 7), and associated Cormorant management issues, including legal frameworks, are reviewed (chapter 8). Comprehensive information and area-specific data and details are provided in Appendix One.

## 4.1 History and character of Carp pond areas in Europe and Israel

Most of the fish ponds in the Czech Republic, France, Germany and Poland were constructed between the 12th and 15th centuries. In these countries, such ancient fish ponds are an important part of the landscape and cultural heritage in regions such as Dombes and Forez (also Brenne) in France, Saxony's Upper Lusatia in Germany, and south Bohemia in the Czech Republic. Similarly, Carp ponds are

**Fishpond in Dombes, France.** Photo courtesy of Robert Gwiazda.

also a significant part of landscapes in the regions where they have been constructed more recently — at the beginning of the 20th century in Hungary and only 50 years ago in Latvia and in Israel.

There are varying degrees of watershed (catchment) modification in Case Study areas, depending both on their history and the patterns of land ownership. Some

**The Rožmberk Carp pond in the Czech Republic.**
Photo courtesy of Robert Gwiazda.

fish ponds are very large (e.g. the 489 ha or, including surrounding habitats 677 ha, Rožmberk pond in the Czech Republic) with big dams and have involved considerable excavation and reshaping of the watershed. In some areas, the dams and embankments of ponds are of considerable size and extent, giving fish farmers easy access (either on foot or in vehicles) along the whole perimeter of the pond regardless of its size. On the other hand, in areas such as Dombes in France, the dams and embankments are very low with very little slope, and access to much of the pond edge (even on foot) is difficult if not impossible.

Such differences in pond design are usually the result of regionally-specific local differences in land topography, soil type and available sources of water but they have several important consequences for the management of the ponds. For example, access to the bank of a fish pond in Dombes is often very difficult along much of its length whilst it is very easy to drain such a

**Fishpond in Rétimajor, Hungary.**
Photo courtesy of Robert Gwiazda.

pond and to use the exposed soil for agricultural crop production. Easy access to pond banks in other Case Study areas could be of importance for general management and Cormorant deterrence.

All the fish pond areas are located in the plains of river valleys or other low-lying areas and so their mean altitude differs from about 100 m in Latvia and Israel to about 500 m in the Czech Republic. The Case Study area of Rétimajor in Hungary is the smallest (total area 970 ha) examined here whilst the Upper Lusatia (Germany) area is the largest (total area 75,000 ha).

The average size of fish ponds also differs between study areas, from 5 ha in France to 38 ha in Poland. The variety of study areas is also apparent in relation to the number of ponds and their total size (surface

**Carp feeding on the bottom can disturb sediments.** Photo courtesy of Shutterstock.

**Frozen Carp fishpond in winter, Czech Republic.** Photo courtesy of Petr Musil.

area). For example, the Upper Lusatia area includes about 900 ponds with a total surface area of 5,500 ha whilst the Milicz complex in Poland includes 130 ponds with a total surface area of 6,400 ha.

Despite this diversity, several characteristics are similar in all nine pond Case Study areas. For instance all ponds are shallow with a mean depth of only about 1.5 m and all tend to have low water transparency (less than 0.1–1.0 m in Secchi depth) throughout the year. Water transparency is generally an indicator of eutrophication (nutrient enrichment) in deeper waters but in shallow waters transparency is often also reduced by the presence of disturbed sediments in the water column. Thus water transparency can be reduced as farm ponds due to 'bioturbation' caused by Carp feeding on the bottom and disturbing the sediments.

In general, all the Carp ponds are eutrophic ecosystems with concentrations of nitrogen ranging between 0.04–4.00 mg/l and of phosphorus from 0.01–0.25 mg/l. Except for the ponds in Israel which never freeze, most of those in the other Case Study areas are usually temporarily covered with ice during the winter period. These ponds are generally frozen between December and February/March, although this is a rare occurrence in the French Case Study areas which may only freeze over for a couple of weeks in January/February, if at all.

## 4.2 The use of ponds

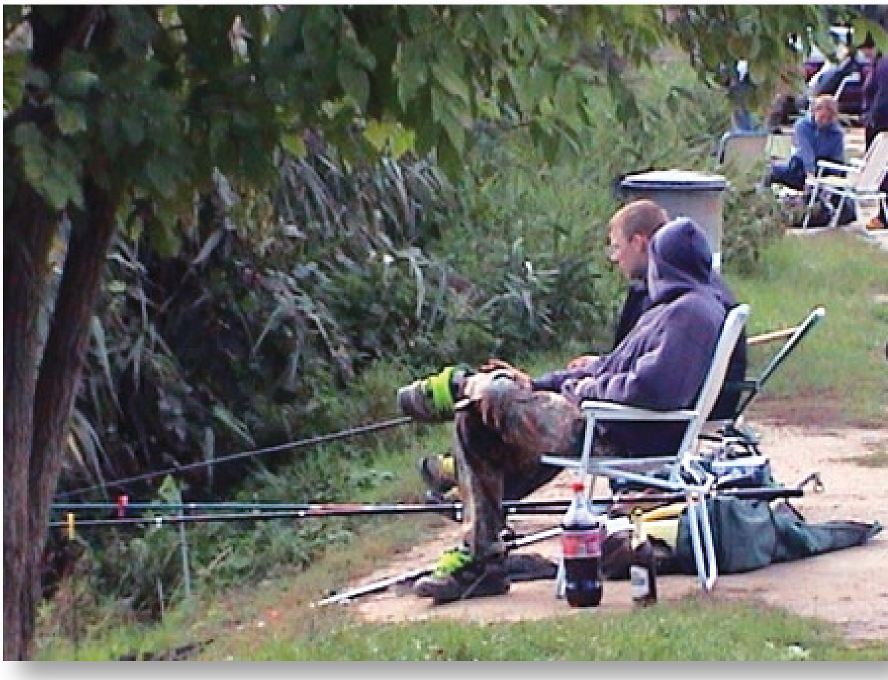
Today, fish farmers use over 85% (e.g. Dombes area in France) and often up to 100% (e.g. in south Bohemia) of their ponds for fish production. With the exception of Latvia and Israel, Carp ponds are also being used increasingly

**Waterfowl hunting is an essential activity in the preservation of French fishponds.** Photo courtesy of Shutterstock.

(although the shooting of Great Cormorants is permitted).

As all the fish ponds used for extensive fish production are located in the plains, they can also play an important part in the management of floods and droughts (particularly in South Bohemia) with water of a quality that is good enough not to affect the rest of the water in these regions. The exception is the more intensive system in Israel, where the water from fish ponds is very turbid (cloudy) and nutrient-rich because of the intensive feeding of Carp and from fish faeces and where flood management is not an issue.

for ecotourism and angling, as is the case in 20% of the Czech fish ponds or 5% or less of ponds in Germany and Poland. However, the most important subsidiary activity at fish ponds is the hunting of waterfowl which, with the exception of Hungary, is permitted on fish ponds in all of the other Case Study areas (e.g. on 29% of ponds in Latvia and up to 95% of ponds in France). Particularly in France, waterfowl hunting is a very important activity at pond farms, so much so that it is considered essential for maintaining pond areas there. Conversely, waterfowl hunting is prohibited throughout the year in the Hula Valley area of Israel



**Recreational anglers on the banks of a fishpond in Saxony.** Photo courtesy of **INTERCAFE**.

# 5 CORMORANT DATA FOR CASE STUDY AREAS

The Carp pond Case Study areas differ in many aspects affecting Cormorant numbers. For comparison, as well as breeding and wintering counts, an index of general Cormorant abundance (i.e. number of birds per 10 ha) is used here, taken from available data (sometimes on a monthly basis) from 2004–2007.

## 5.1 The seasonal abundance of Cormorants

Breeding Cormorant populations were found in three study areas: Dombes (France) 14 pairs, Milicz (Poland) over 100 pairs, and Latvia 150 pairs. These relatively small numbers emphasise that the major conflicts between Cormorants and Carp farmers are not with breeding birds but with those migrating or over-wintering in Case Study areas.

The general seasonal distribution of Cormorant abundance (2004–07) in six Case Study areas (Figure 5.1) shows relatively prominent peaks in the post-breeding period (July–October) as birds leave their breeding areas on autumn migration to the wintering grounds. In contrast, few spring migration (i.e. birds returning to breeding colonies) peaks in abundance are apparent, except for Forez in France where Cormorant numbers are high in January–March. In Israel's Hula Valley, Cormorant presence had a similar pattern to that observed in Forez in France but numbers increased in November (a month later) and had declined by March (a month earlier) and the overall number of birds was considerably larger. No comparable data were available for Dombes in France and Rétimajor in Hungary.

The potential 'predation pressure' of Cormorants — in terms of bird numbers per 10 ha — in the different pond areas is shown in Table 5.1. Here, two set of numbers are shown for the Hula Valley: one relating to before 2003 and the other to the period 2003–06, this is to demonstrate the the vast changes in Cormorant numbers resulting from an intensive programme of Cormorant management undertaken between 2001–2006 (for full details see 8.4.1 and Case Study No. 7 in Russell *et al*. 2012).

**Nesting Cormorants.** Photo courtesy of Josef Trauttmansdorff.

**Wintering Cormorants in Israel.** Photo courtesy of **INTERCAFE**.

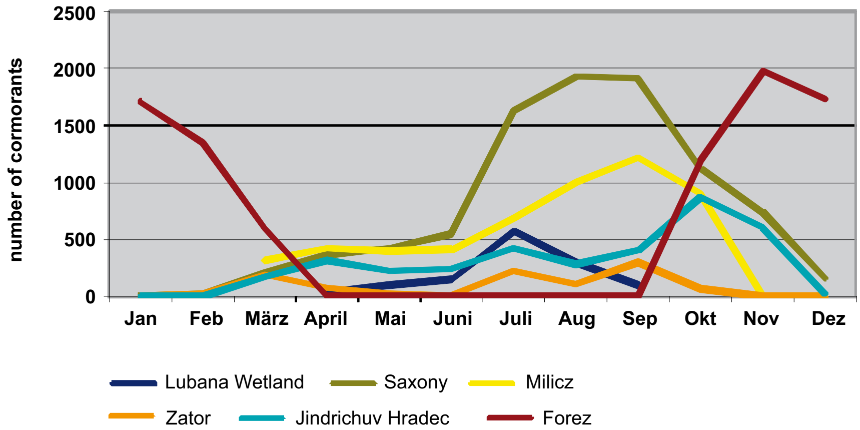



**Figure 5.1** Seasonal distribution of Cormorant abundance in six Case Study areas.

**Cormorants are highly mobile especially during spring and autumn migration periods.**
Photo courtesy of Josef Trauttmansdorff.

## 5.2 Spring migration period

In spring, Cormorants are focused on travelling north to reach their breeding grounds relatively quickly and so do not appear to take long breaks on the way. During the spring period, the highest density of migrating Cormorants (over 26 birds/10 ha) was estimated for the Hula Valley in Israel. This was not unexpected because of the large numbers of birds spending the winter in Israel. Excluding Israel, the highest estimated Cormorant densities during the spring migration within Europe were in the Forez area of France (4 birds/10 ha). Interestingly this was the highest estimated spring density in any of the European areas and was over five times greater than that estimated for the nearby Case Study area of Dombes. The reasons for such a difference are unclear but the areas appear to share similar geographical position and contain similar ponds. Overall, for the eight European areas, average Cormorant density during the spring migration period was estimated to be 1.3 birds/10 ha (range = 0.6–4.0 birds/10 ha).

## 5.3 Autumm migration period

Unlike the spring period, when Cormorants are probably migrating more or less directly to their breeding colonies in order to secure a nest site and a mate, birds migrating in autumn are presumably less constrained in their movements. Also, at this time of year, birds are presumably concentrating on feeding as much

**Table 5.1** Mean numbers of Cormorants per 10 ha of fish ponds in Case Study areas. The highest Cormorant densities during a season are highlighted.

| Case Study area | Mean no. of non-breeding birds/10 ha during breeding and post-breeding seasons | Mean no. of migrating birds/10 ha during spring migration | Mean no. of migrating birds/10 ha during autumn migration | Mean no. of wintering birds/10 ha |
|---|---|---|---|---|
| Lubana Wetland Complex (LV) | 0.2 | 1.1 | 3.0 | 0 |
| Milicz (PL) | 0.5 | 0.6 | 1.5 | 0 |
| Spytkowice and Zator (PL) | 0.2 | 1.3 | 2.0 | 0 |
| Rétimajor (HUN) | 0.4 | 1.1 | 1.7 | 1.9 |
| Jindřichův Hradec (CZ) | 0.7 | 0.9 | 2.3 | 0 |
| Upper Lusatia (GER) | 0.9 | 0.6 | 4.1 | 0 |
| Dombes (FR) | 0.01 | 0.7 | 2.1 | 2.3 |
| Forez (FR) | 0.07 | 4.0 | 10.0 | 10.0 |
| Hula Valley (ISR) | 0 | over 26 | 0 | Before 2003: 141<br>2003–06: 22 |

**Ice cover, particularly on still waters, severely restricts Cormorants' access to food and so fish are 'unavailable' at frozen foraging sites.** Photo courtesy of Shutterstock.

**During harvest operations, lowered water levels concentrate fish in fishponds — making them highly attractive to fish-eating birds, including Cormorants.** Photo courtesy of Robert Gwiazda.

as possible in order to build up body reserves for the oncoming winter. Cormorants migrating in autumn probably stage their movements to take advantage of any temporally abundant food supplies they encounter. Whilst ultimately affected by environmental conditions (particularly low temperatures causing waters to freeze) which tend to concentrate wintering Cormorants into southern and western Europe (see chapter 8 of van Eerden *et al*. 2012) it is likely that birds will take advantage of locally abundant sources of fish as long as they are available (i.e. waters are ice-free) and it is energetically efficient to do so. The relative 'availability' of fish to Cormorants will change dramatically as winter progresses.

In winter fish will become less active and agile as water temperatures fall and they become inactive. In more 'natural' waters, fish may seek shelter and cover and so be harder for birds to detect and catch. Conversely, as ambient temperature falls so too will the reaction time and swimming speed of fish and these individuals may be easier for predators to catch. Similarly, many pond farms harvest their stock in the autumn or overwinter them in specific ponds. At such times fish are often held (perhaps only for comparatively short periods) at relatively high densities and, as such, these concentrations of fish may be highly attractive to Cormorants.

The issues discussed above almost certainly contribute to the fact that average Cormorant density for the eight European Case Study areas during the autumn migration period was some 2.5 times higher than that estimated for spring. Overall, Cormorant density in autumn was estimated to be 3.3 birds/10 ha (range = 1.5–10.0 birds/10 ha). Almost certainly the counts of up to 4.1 Cormorants/10ha in the Upper Lusatia area in Saxony were a direct consequence of the fish harvesting operations in Carp ponds there in September and October and similar situations are likely to occur elsewhere.

**Drained fishpond after harvesting in Saxony.** Photo courtesy of **INTERCAFE**.

## 5.4 Roosting and non-breeding cormorants

Cormorant roosting sites within Case Study areas were recorded in most cases (see Appendix One): single roosts were reported in the Czech Republic, France (both areas), and Israel (1 roost in each), the Milicz complex in Poland (2 roosts), and in the Latvian

**Wintering Cormorants roosting in Israel.** Photo courtesy of **INTERCAFE**.

**Cormorants at a fishpond in Latvia.** Photo courtesy of Oleg Nemenonoks.

and Upper Lusatia Case Study areas (4–5 roosts in each). No local roosts were recorded in the Spytkowice and Zator (Poland) and Hungarian study areas. Where local roosts were present, the numbers of Cormorants varied from 150 in Dombes and Lubana to around 1,500–2,000 in the Milicz complex, Forez, and Upper Lusatia. Prior to management activities in 2003, the maximum number of locally roosting Cormorants in the Israeli Hula Valley case study area was 8,500 birds.

Furthermore, Cormorants may use roosting sites outside these study areas (perhaps up to 40 km distant) in most areas except for the Milicz complex (and the Hungarian area where no data are available). Thus additional Cormorants may have access to these sites during the year and, overall, this amounted to some 500–2,000 birds depending on the study area.

The maximum number of roosting Cormorants (in the continental Europe study areas) was found to change during the year and the seasonal distribution of birds probably depends mainly on geographical position. In Latvia, the most north-easterly Carp pond study area, maximum numbers of roosting Cormorants were recorded in July with a following decline until the end of September. Further south and west in the German and Czech areas, seasonal patterns differ but are rather similar to each other. In Upper Lusatia the number of roosting Cormorants increases slightly in March but rises more significantly in June and reaches its highest peaks in August and September before declining in October and November.

In the Czech Case Study area (Jindřichův Hradec), the number of roosting Cormorants increases until April, then falls slightly and increases again in July, followed by a decrease in late summer before increasing again and reaching a maximum in October. Thus the highest peak in roosting numbers in the Czech Republic is one month later than in Germany (September and October, respectively) and some 2–3 months later than the July peak in Latvia to the north-east. Farther south and west still in the French areas of Dombes and Forez, the highest peak in roosting numbers is later still — occuring some time between November and February.

**Drained fishpond in Dombes, France.** Photo courtesy of Robert Gwiazda.

Besides geographical position, habitat characteristics in the local landscape also seem to play an important role in the abundance of Cormorants during the year. It is interesting to see the differences between the two Polish study areas for instance. In the Milicz complex, the number of birds increases constantly until it reaches a peak in September before decreasing thereafter, while at the Spytkowice and Zator site there are three very similar peaks in numbers in March, July, and September. The relationship between environmental factors and the seasonal pattern of Cormorant numbers is explored in section 6.4.

The average number of non-breeding Cormorants in Case Study areas during the breeding

and post-breeding season (see Table 5.1) varied between zero and 0.9 birds/10 ha). As might be expected, no non-breeding birds were recorded in Israel (birds do not breed there at all) and so all records were from the continental European Case Study areas. The highest average numbers of non-breeding birds were recorded in the Upper Lusatia and Czech Republic areas with some 0.9 birds/10 ha and 0.7 birds/10 ha, respectively. Lower average numbers of non-breeders (range = 0.2–0.4 birds/10 ha) were recorded in other sites with the lowest numbers (0.01 and 0.07 birds/10 ha) being recorded at the two Case Study areas in France.

## 5.5 Winter period

In the middle of winter, it might be presumed (barring any severe cold weather events) that Cormorants are settled in their winter quarters, and that these offer perhaps the most important habitat requirement at this time of year, namely ready access to ice-free water (see chapter 8 of van Eerden *et al.* 2012). As might thus be predicted, no regularly wintering Cormorants were recorded in study areas in Latvia, Poland, the Czech Republic and Germany and, from the nine Case Study areas, over-wintering Cormorants were only recorded in the southernmost (i.e Israel and Hungary) and westernmost (i.e. France) of these. In Israel, freshwaters never freeze and the highest estimated densities of Cormorants in winter were recorded here. The highest estimated winter density of Cormorants recorded in the Hula Valley Case Study area was 141 birds/10 ha in years prior to 2003. Thereafter, estimated

**Juvenile — non-breeding — Cormorant in distinctive plumage.** Photo courtesy of Shutterstock.

**Severe cold weather events in winter very often force Cormorants to move to ice-free areas elsewhere.** Photo courtesy of Shutterstock.

**Fishpond in the Hula Valley Israel, the equipment shown aerates the water and increases oxygen levels.** Photo courtesy of **INTERCAFE**.

**Fishpond in Spytkowice, Poland.** Photo courtesy of Robert Gwiazda.

densities declined — by a factor of over six (to an estimated 22 birds/10ha) — as a result of management measures undertaken locally (see 8.4.1 for further details).

Nevertheless, even this lower estimated winter density in Israel's Case Study area is more than double that estimated for Forez in France (10 birds/10 ha). As in Israel, Cormorant presence (and presumably predation) at Carp ponds in the French Case Study areas is marked in the winter. The two French areas, to the west and south of Europe, are relatively mild and are generally ice-free for most, if not all, the winter. Once again it is interesting to compare the two French areas, where the estimated winter density of Cormorants at Forez is almost five times that estimated for nearby Dombes (2.3 birds/10 ha).

Though Cormorants are present in the Hungarian Case Study area in winter, estimated densities here are slightly lower (1.9 birds/10 ha) than in the Dombes area of France.

Clearly, as no Cormorants are present in other Case Study areas in winter, no important conflicts with Carp pond fisheries occur there at this time of year.

## 5.6 Trends in Cormorant numbers, 2004–2007

The available data for the Cormorant 'population' occurring over the whole region covered by the nine Case Study areas during 2004–2007 showed for most areas (e.g. Germany, Czech Republic, France - both, Poland - both) that bird numbers remained more or less stable during this period. The exceptions to this thus appeared to be the three Case Study areas to the extreme south-east — in Latvia, Hungary and Israel. Here, the overall Cormorant 'population'

**Large aggregation of Cormorants in Ķemeri National Park, Latvia.** Photo courtesy of Karlis Millers.

either increased during this period (slightly in Latvia, strongly in Hungary) presumably due to the continued natural expansion of the birds, or declined as in the Hula Valley (Israel) almost certainly as a result of coordinated management actions undertaken here after 2003.

## 5.7 Origin of Cormorants

Recoveries of Cormorants ringed as nestlings in their colony of birth, give some insight into the origin of birds occurring in Case Study areas. In Latvia in the far east, Cormorants originated from the generally north-eastern territories of Estonia, Poland and Russia whilst in France in the far west, they originated from the generally north-western territories of Great Britain, Germany, Denmark and Sweden. Ringed Cormorants recovered in Hungary (a relatively southern Case Study area) originated in colonies in countries to the north. Those found in the Czech Republic had been ringed in colonies mainly in northern and eastern countries — Sweden, Finland and Estonia whilst in Germany, ringed cormorants came mainly from Denmark but also from east (Poland), west (Netherlands), north (Sweden) and central Europe (Czech Republic and Hungary).

A similar tendency for birds from very different directions to occur in single Case Study areas was also recorded in Poland. The ringed Cormorants recovered in the Israeli study area almost certainly belong to a different 'population' to those in other areas: all the recoveries from the Hula Valley were of birds originating in the Ukraine (see also Nemtzov 2008) but to some extent this may well be due to the lack of Cormorant-ringing effort in other countries (see also section 6.2 in Carss *et al*. 2012).

Thus, whilst considering each of the Case Study areas as specific sites, it is important to consider that the Cormorants that visit them may often originate from colonies (and presumably commute to and from them as breeding birds) in numerous countries, often considerable distances away. Whilst the recoveries of ringed Cormorants demonstrate relative constancy in the general pattern of the migratory fly-ways used by birds (at the 'population' level at least — see also van Eerden *et al*. 1995), site-specific differences in both the timing and numbers of birds at the peak of migration suggests that individual birds are flexible in their movements and foraging-site selection (within the broader confines of Europe's winter temperature regime of course).

The geographic magnitude of such migratory movements via 'traditional' pathways and the attractiveness of Carp ponds along the way as relatively predictable sources of food, coupled with the undoubted subtleties of foraging- site selection in individual birds, means both that Carp ponds are likely to suffer predation losses to migratory and/or over-wintering Cormorants in particular but also that this situation will be complex and not necessarily simple to overcome.

**Ringed Cormorants recovered at fishponds provide information on their country or origin.** Photo courtesy of **INTERCAFE**.

**Fish ponds — like this one in Saxony — can offer Cormorants a relatively predictable source of accessible food in autumn and spring.** Photo courtesy of **INTERCAFE**.

# 6 EFFECTS OF HABITAT VARIABLES ON CORMORANTS: A MULTIFACTORIAL ANALYSIS

**INTERCAFE's** nine Carp pond farm Case Study areas differ in many interrelated variables concerning their geographic location, topography, climate, wetland and adjacent landscape habitat(s), biology, and management practices. Hereafter, for ease, this set of variables will be referred to as 'environmental' variables. Importantly, each of these variables (seperately, and in combination with others) is likely to affect the presence of Cormorants at particular Carp pond farming areas to some degree. The aim of this chapter is thus to explore statistically which subset(s) of these variables best explains the Cormorant-environment relationship found in the Carp pond Case Study areas.

Specifically, we explore the relationships between environmental variables and both (a) Cormorant numbers and (b) seasonal changes in Cormorant numbers in these areas. In addition, we explore the origin of Cormorants occurring in the Carp pond farm Case Study areas by examining recovery data from ringed birds. Throughout, we use so-called 'redundancy analysis' (RDA — program CANOCO 4.5) as the tool for exploring our data.

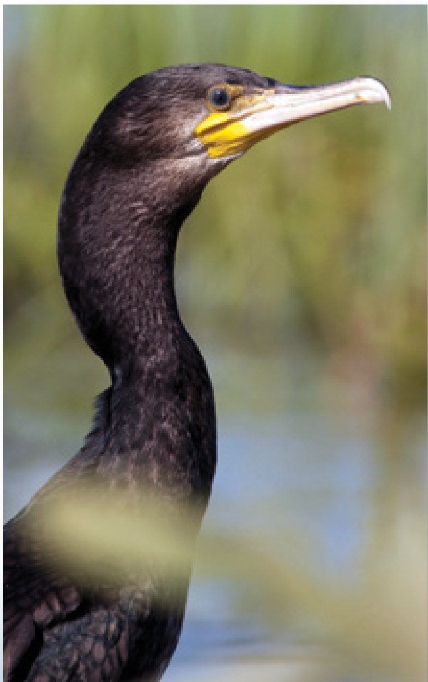
## 6.1 Datasets and analyses

Throughout the remainder of this chapter, the nine Carp pond Case Study areas included in the anayses are referred to by their reference codes (i.e. LAT, PL-M, PL-SZ, HUN, CZE, SAX, F-DOM, F-FOR, ISR) as detailed in Table 4.1.

### Environmental variables

The following suite of environmental variables was collated for each of the nine Case Study areas:

- **Latitude**
- **Longitude**
- **Altitude** — metres above see level
- **Total area** — total area of the fishpond region
- **Mean fish pond size** — mean water surface area fish ponds
- **Number of ponds** — total number of fish ponds in the area
- **Total size of ponds** — total water surface area of all fish ponds



**Cormorants undoubtedly respond to a variety of environmental variables.** Photo courtesy of Shutterstock.

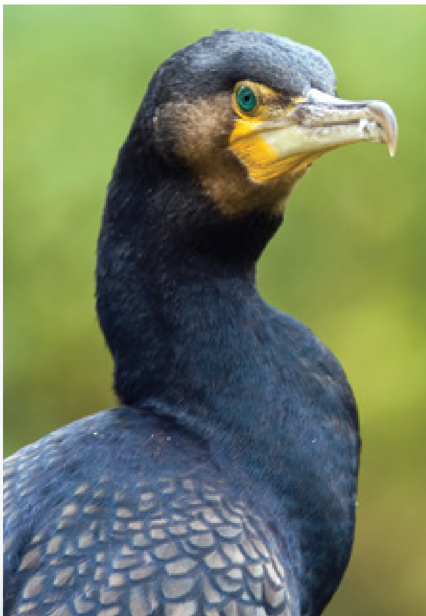
**Czech fishpond landscape area.** Photo courtesy of Petr Musil.

- **Ice cover** — duration of ice cover in a 'normal' winter
- **Landscape mosaic** — level of landscape mosaic, ranging from highly heterogenous landscape (score = 1) to large and almost homogenous patches of habitat (3)
- **Waterfowl hunting** — percentage of fish ponds used for waterfowl hunting as a disturbance factor affecting birds
- **Littoral vegetation** — percentage of total pond surface covered by littoral vegetation
- **Submerged vegetation** — percentage of fish ponds with large extent (i.e. more than 10 % of water surface) of submerged vegetation
- **Fish production** — mean fish production (kg per ha)
- **Number of shot Cormorants** — annual number of shot Cormorants in the area
- **Number of employed people** — number of people employed by the fishery companies in the area
- **Number of owners** — number of owners of fishery companies in the area

## Cormorant data

To give the best possible overview of the Cormorant situation in the Case Study areas, the following data were collated for each one:

- **Maximum numbers** — maximum numbers recorded during the whole year
- **Breeding pairs** — number of breeding pairs in the area
- **Cormorant season** — length of season with Cormorant occurrence (months).
- **Spring numbers** — mean number of Cormorants occurring during spring migration.
- **Breeding numbers** — mean number of Cormorants occurring during breeding season.
- **Autumn numbers** — mean number of Cormorants occurring during autumn migration.
- **Wintering numbers** — mean number of Cormorants occurring during winter season.
- **Cormorant days** — number of Cormorants multiplied by they number of days spent in the area (this value expresses the intensity of Cormorant presence/predation during the whole year).



**Cormorant numbers, seasonality, presence, and numbers at different times of year were investigated at fishpond Case Study areas.**
Photo courtesy of Shutterstock.

In addition, Cormorant 'recovery data' were available and included in our analyses. These data referred to the numbers of Cormorants ringed as chicks in particular European countries (= origin of birds), which were later recorded in one of the Case Study areas. Such information was available from CZE, SAX, PL-M and ISR. For the remaining five Case Study areas (i.e. F-FOR, F-DOM, PL-SZ, LAT, HUN), we could only find information about the origin of ringed birds without data on the proportion of ringing countries amongst those birds. For further analysis, here we assumed equal proportions of these 'origin countries' for these Case Study areas. For example, Cormorants from Denmark, Poland and Estonia were recorded in Rétimajor (Hungary) but in unknown proportions from these three countries, therefore we used a proportion of 33% for each of these origin countries.

## Analyses

Our datasets were used to explore three specific issues for the Case Study areas:

- the geographical variation in the origin of ringed Cormorants recorded,

- the effect of environmental variables on Cormorant numbers, and
- the effect of environmental variables on the seasonal pattern of Cormorant numbers.

The fish pond areas investigated included all those with large numbers of birds (more than 100) occurring during the breeding season. These included areas which contained their own Cormorant breeding colony (SAX, PL-M, LAT) and one without a colony but clearly affected by a neighbouring one (CZE). Lower numbers of Cormorants (i.e. <100 birds) were also recorded during the breeding season in four areas (F-DOM, F-FOR, PL-SZ, HUN).

Maximum numbers of Cormorants occurred during either the autumn migration (September to November in CZE, SAX, PL-M, PL-SZ, LAT) or in the winter (F-FOR, F-DOM, HUN, ISR). Spring migration represented a second peak in Cormorant numbers in CZE, PL-M (early April) and PL-SZ.

Winter was the most important season for Cormorants in four areas (F-FOR, F-DOM, HUN, ISR). Nevertheless, the timing of peak Cormorant wintering numbers in these places ranged from November (F-FOR) to December-January (F-DOM, HUN, ISR). Furthermore, wintering Cormorant numbers in fish pond regions in northern countries were known to increase in mild winters (e.g. in CZE, SAX).

Overviews of Cormorant occurrence in relation to the suite of environmental variables at Carp pond Case Study areas were generated here through a

**Cormorant breeding colony, Czech Republic.** Photo courtesy of Jan Sevcik.

redundancy analysis (Jongman *et al*., 1995, ter Braak & Šmilauer, 1998). Essentially, this analysis distils all the information described above into simple interpretative diagrams that show the strongest relationships between factors recorded in the original datasets. In such 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. The redundancy analysis is thus very useful for providing an overall view of the data.

## 6.2 Geographical variation in the origin of Cormorants recorded in Carp pond Case Study areas

All the available information on Cormorant recovery data from the Case Study areas can be distilled into a simple interpretative diagram (Figure 6.1) that shows the

**Fishpond in Spytkowice, Poland.** Photo courtesy of Robert Gwiazda.

relationships between the country of origin of ringed Cormorants and specific Case Study areas.

Here in Figure 6.1, the country names are represented by their first 2 or 3 letters (except DK = Denmark, NL=Netherlands, GB=Great Britain, PL=Poland). Regular fonts are used to identify the Case Study areas and italic fonts identify the country of origin for Cormorants. The red arrows show the relevant geographical variables (only latitude and longitude were used in this data analysis). The blue arrows and letters in italics are 'species scores', denoting the origin of Cormorants from particular countries and the circles with letters in normal font are 'sample scores', denoting the Case Study fish pond areas.

**Cormorant ringed in Finland recovered at a fishpond in the Czech Republic.**
Photo courtesy of Petr Musil.

The origin of Cormorants in particular fishpond regions is dependent on the geographical position of the Carp pond Case Study areas. However, it has to be remembered that the intensity of Cormorant ringing (usually when the birds are chicks in the nest) varies greatly in different countries and does not occur at all in some. Thus the origin of birds recovered later in life is dictated by the relative amount of ringing undertaken in their natal countries and so a country of origin can not be represented in ringing recovery data if no birds (or very few) are actually ringed there.

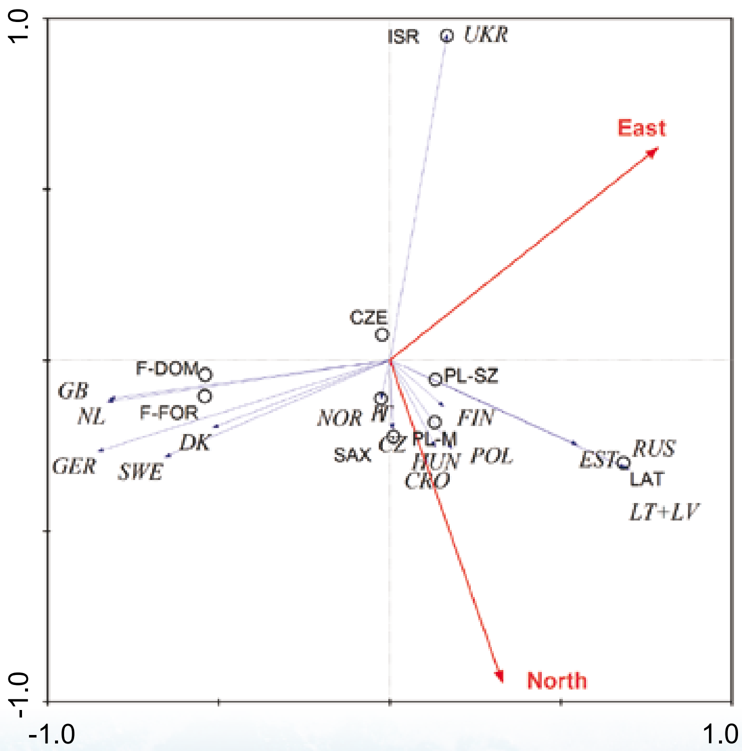



**Figure 6.1** The relationship between the country of origin of ringed Cormorants and specific Case Study areas where they were recovered (Redundancy Analysis, Canoco version 4.52). The 1st and the 2nd RDA axes explain 37.0% of recovery data variance. The 1st ordination axis was statistically significant (Monte-Carlo permutation test: F= 1.717, P= 0.024).

Here, the available data show that Cormorants originally ringed in Ukraine prevailed in ISR (though very few birds that may winter in ISR are actually ringed in any other country than Ukraine, thus biasing the recoveries in ISR), whilst only birds from north-west Europe were recorded in F-FOR and F-DOM and only birds from the Baltic States and Russia were recorded in LAT. The five Carp fish pond areas in Central Europe (CZE, SAX, PL-M, PL-SZ and HUN) are located on a crossing-point of Cormorant migration routes, and so birds recovered in these areas originated in several countries primarily on a North-South axis travelled by migrating birds but also including post-breeding birds moving from the south and Central Europe to the Baltic Sea region.

## 6.3 Effect of environmental factors on Cormorant numbers in Case Study areas

The environmental variables of particular fish pond areas were found to be strongly inter-correlated. Therefore, a standard statistical technique called ‘forward variable selection’ was used to determine the best sub-set of variables to explain the ‘Cormorant–environment’ relationship at Carp pond farm Case Study areas. As a result of this selection, the following 8 variables (see 6.1 for original list of 16) were used ultimately in the analysis: latitude, longitude, mean fish pond size, number of ponds, ice cover, number of shot Cormorants, number of employed people, number of owners.

The RDA analysis of selected environmental variables in relation to associated Cormorant data for the nine Carp pond farm Case Study areas, discriminated three separate groups of Cormorant data (Figure 6.2).

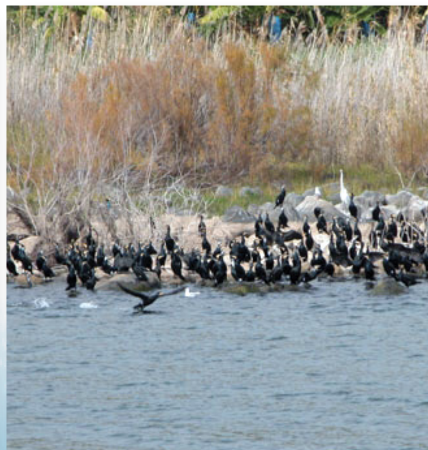
Here, in Figure 6.2, the red arrows show the pre-selected (using forward variable selection) environmental variables whilst the blue arrows and legends in italics show the ‘species scores’ indicating those variables expressing Cormorant numbers during the whole year, and the circles and legends in normal font show the ‘sample scores’ expressing fish pond Case Study areas. This simple interpretative diagram does not show every relationship but focusses on the main ones emerging from the analysis. It thus gives a general picture of the strongest relationships between environmental variables and Cormorant numbers at Carp pond farm Case Study areas.

**Carp fishpond employees harvesting fish in the Czech Republic.**
Photo courtesy of Petr Musil.

The RDA analysis discriminated three separate groups of Cormorant data (Figure 6.2). The first group of Cormorant data represents (a) numbers of breeding pairs, (b) total number of birds occurring during the breeding season, and (c) duration of Cormorant season — the length of time the birds are present in the Case Study area. Each of these (Figure 6.2 top) are related to north and east geographic locations, periods of longer ice cover, and particularly to the larger fish ponds (mean pond size). These Cormorant data variables were associated with fish pond Case Study areas in CZE, SAX, PL-M, PL-SZ and LAT (Figure 6.2 bottom), where breeding colonies are within the fish pond areas or occur nearby.

The second group of Cormorant data, comprising the number of migrating Cormorants (spring numbers, autumn numbers), were correlated with the maximum number of Cormorants and the number of Cormorant days in the Case Study areas. This second group was associated with number of ponds (Figure 6.2 top), suggesting

**Foraging Cormorant.**
Photo courtesy of Shutterstock.

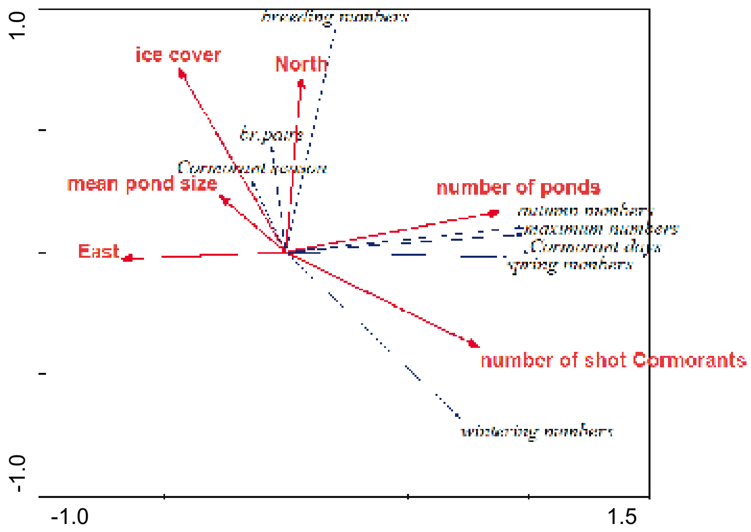


**Wintering Cormorants in Israel.**
Photo courtesy of **INTERCAFE**.

that fish pond areas across Europe should regarded as 'hot-spots' for Cormorants. The numbers of Cormorants using such fish pond habitats are strongly affected by size of the area, expressed by the number of available ponds. Cormorant numbers during the migration periods, as well as Cormorant data expressing whole-year Cormorant presence and predation (Cormorant days), seem not to be effected by the other environmental variables investigated.

The third group of Cormorant data comprises the wintering numbers of birds (Figure 6.2 top). It is closely related to Case Study areas where Cormorants commonly over-winter (F-DOM, F-FOR, ISR and HUN, Figure 6.2 bottom). These areas are strongly related to the most intensive shooting of Cormorants.

Interestingly, fish production in Carp pond Case Study areas was not selected as a factor explaining variation in data concerning Cormorant numbers. Presumably, the levels of fish production are relatively very high in all fish pond areas but have no effect on Cormorant numbers in specific ones.



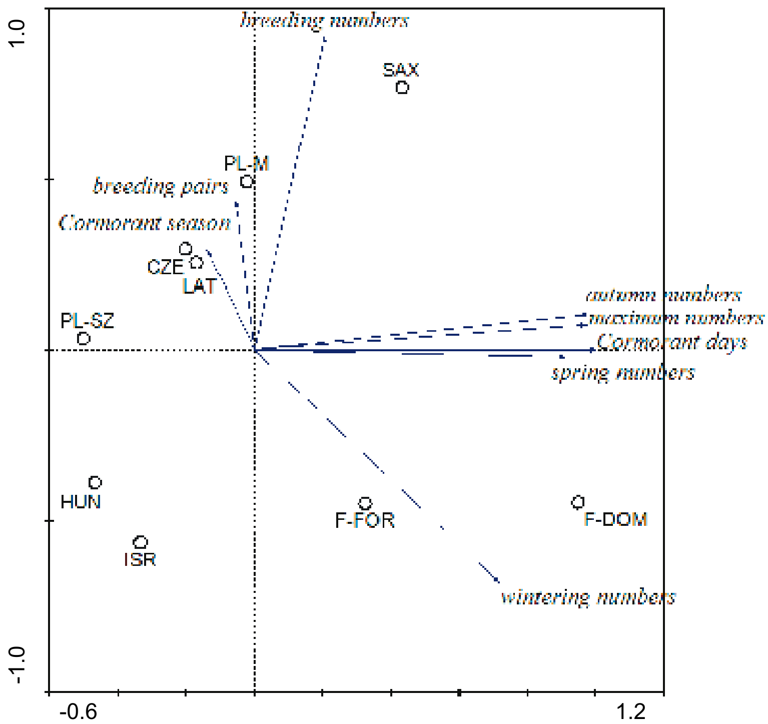




**Figure 6.2** The relationship between Cormorant numbers (in three groups, see text) for Case Study areas and the most important associated environmental variables (top plot) and the same groups of Cormorant number data in relation to each of the Case Study areas (bottom plot). (Redundancy Analysis, Canoco version 4.52). The 1st and the 2nd RDA Axis explained 83.7% of Cormorant number-recovery data variation. The 1st ordination axis was statistically significant (Monte-Carlo permutation test: F= 2.667, P= 0.034).

## 6.4 Effect of environmental factors on the seasonal patterns of Cormorant numbers in Case Study areas

The environmental variables of particular fish pond regions were found to be strongly inter-correlated. Therefore, a standard statistical technique called 'forward variable selection' was used to determine the best sub-set of variables to explain the 'Cormorant–environment' relationship at Carp pond farm Case Study areas. As a result of this selection, the following 7 variables (see 6.1 for original list of 16) were used ultimately in the analysis: latitude, mean fish pond size, number of ponds, total size of ponds, ice cover, fish production, number of shot Cormorants.

**Burning reeds around fishponds, Nagli, Latvia.** Photo courtesy of Karlis Millers.

**Fishpond system in Saxony.** Photo courtesy of **INTERCAFE**.

The RDA analysis of selected environmental variables in relation to associated Cormorant data for the nine Carp pond farm Case Study areas in relation to seasonal patterns in Cormorant numbers there, discriminated two separate groups of Cormorant data (Figure 6.3).

Here, in Figure 6.3, the red arrows show the pre-selected (using forward variable selection) environmental variables whilst the blue arrows and legends in italics show the 'species scores' indicating those variables expressing Cormorant numbers in specific months, and the circles and legends in normal font show the 'sample scores' expressing fish pond Case Study areas. This simple interpretative diagram does not show every relationship but focusses on the main ones emerging from the analysis. It thus gives a general picture of the strongest relationships between environmental variables and the seasonal patters of Cormorant numbers at Carp pond farm Case Study areas.

The RDA analysis discriminated two separate seasonal groups of Cormorant data (Figure 6.3). In the first group, higher Cormorant numbers during the breeding period in spring and summer (April to September) were closely associated with the Case Study areas at more northerly latitudes where there is usually a longer period of ice cover (Figure 6.3 top). Specifically, these fish pond regions were SAX, PL-M and particularly CZE and LAT (Figure 6.3 bottom).

The second group identified higher Cormorant numbers during the non-breeding season. Cormorant migration peaked in either autumn (October) or spring (March), when higher numbers of birds were associated with larger fish pond

**Large fishpond in the Czech Republic.** Photo courtesy of Petr Musil.

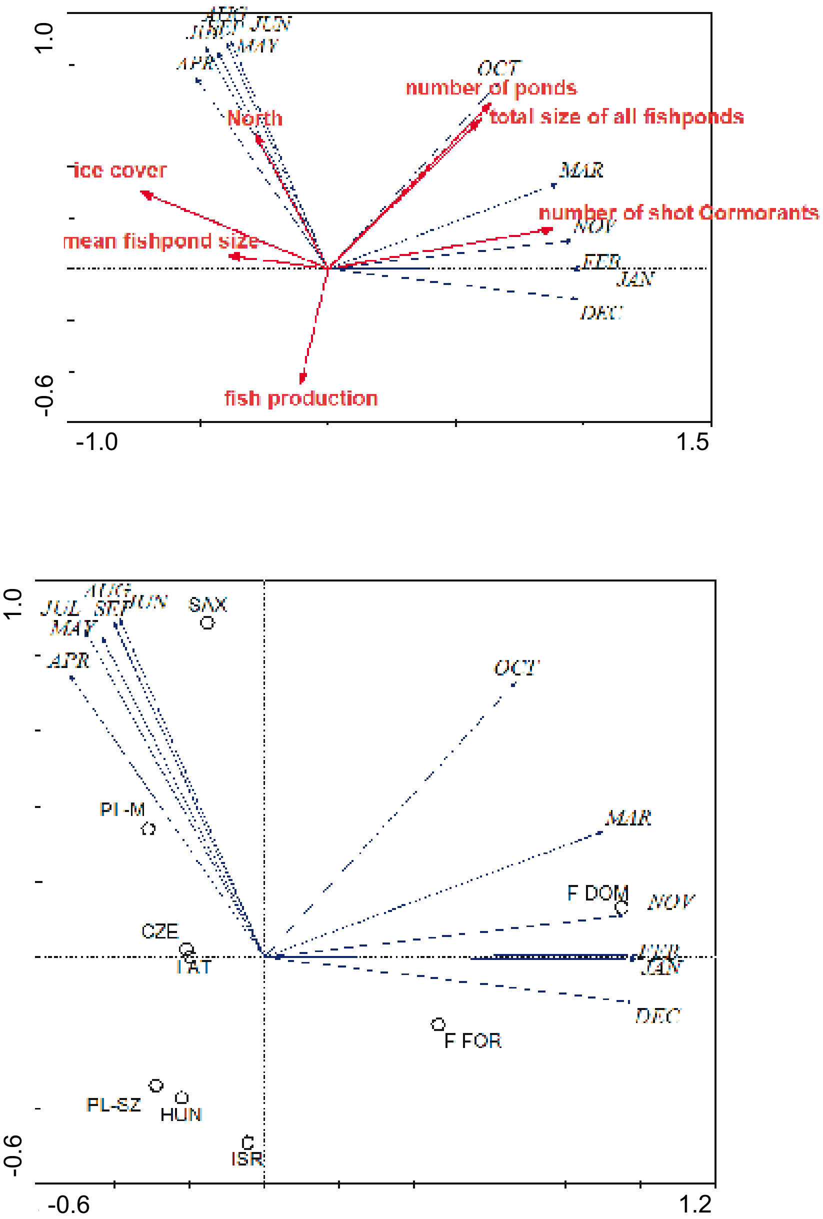



**Figure 6.3** The relationship between Cormorant numbers (in two seasonal groups, see text) for Case Study areas and the most important associated environmental variables (top plot) and the same groups of Cormorant number data in relation to each of the Case Study areas (bottom plot). (Redundancy Analysis, Canoco version 4.52). The 1st and the 2nd RDA Axis explained 89.3% of Cormorant number-recovery data variation. The Monte-Carlo permutation test of significance of the 1st ordination axis : F= 7.424, P= 0.062).

areas (as indicated the number of ponds and total size of all fish ponds variables, see Figure 6.3 top). Over the non-breeding period, the highest numbers of Cormorants in late autumn and winter months (November to February) were recorded in the French Case Study areas (F-DOM, F-FOR, see Figure 6.3 bottom) which were also closely associated with the highest numbers of shot Cormorants (Figure 6.3 top).

Of all the Carp pond farm Case Study areas, the highest fish production was found in PL-SZ, HUN and ISR (Figure 6.3). Remarkably however, the fish production levels do not affect the numbers of Cormorants recorded in any month. This is presumably because the levels of fish production are relatively very high in all fish pond areas and so it is not an important factor affecting seasonal Cormorants numbers in particular region.

As all fish pond areas offer very high fish densities, the size of the Carp farm area (number of ponds and total size of all ponds) seems to be only limiting factor for migratory birds at the peaks of the migration season in October and March.

## 6.5 Conclusions from the redundancy analysis

Data from **INTERCAFE's** nine Carp fish farm pond Case Study areas across Europe and Israel were analysed. Differences were found in the origin of ringed Cormorants, the numbers of birds and the seasonal patterns of Cormorant numbers at Carp pond farms in relation to specific environmental variables. The most important findings are summarised below:

1. The largest numbers of Cormorants (and breeding pairs) during the breeding season were recorded at fish pond areas in northern latitudes, with longer periods of ice-cover and with larger mean fish pond size.
2. At Carp ponds, the numbers of migrating Cormorants as well as the number of 'Cormorant days' (a value expressing Cormorant presence/predation throughout

**The number and total size of fishponds are probably the most influential factors for migratory Cormorants in terms of site-choice.** Photo courtesy of Jan Sevcik.

the year) correlated with the number of available fish ponds.

3. The effect of several environmental variables, including the intensity of fish production at farms, was not significant in affecting Cormorant numbers in fish pond Case Study areas.
4. The intensity of shooting Cormorants was correlated with the numbers of wintering birds. In other words, Cormorants are mostly shot on wintering grounds where they are numerous. Nevertheless, these management activities had no observable effect on Cormorant numbers in particular Carp farming areas.
5. The level of fish production was probably relatively very high in all fish pond regions and so it was not shown to be an important factor affecting Cormorant numbers in particular areas. Except in a few situations (e.g. Saxony), all fish pond areas offer very high fish density and so, generally, it is likely that the size of the Carp farming area (by number of ponds and total size of all ponds) is probably the only limiting factor for migratory birds at the peaks of their migration season in October and March.

# 7 ASSESSING CORMORANT DAMAGE TO POND FARM FISH STOCKS

Rigorously assessing the damage caused by Cormorants to fish stocks in ponds is notoriously difficult because there are numerous parameters with a strong influence on fish growth and mortality of Carp and also because the 'pathway' from Cormorant attack to some form of fish loss may be complex and incompletely understood. Fish farmers generally know the amount of fish that they stock and later harvest but cannot see underwater between these events. Consequently, they do not usually know exactly the reasons for their losses or when these losses occurred. The most important parameters affecting fish production are water quality, weather conditions, pond management, fish diseases and parasites, as well as predation.

Many of these parameters are inter-related and so the influence of any single one is very difficult to calculate. For instance, poor water quality or adverse weather conditions may make fish more vulnerable to other sources of lowered production or mortality such as disease or predation. However sometimes fish mortality is not noticed or the impact of poor water quality or disease is hard to quantify at the time despite the fact that subsequent

**Fishpond harvesting and management in the Czech Republic.** Photo courtesy of Petr Musil.

**Pikeperch *Sander lucioperca* — a predatory fish found in many Carp fishponds.** Photo courtesy of Shutterstock.

**Otter *Lutra lutra* — a predatory mammal found throughout several Carp fishpond areas.**
Photo courtesy of Shutterstock.

damage can be very high. Nevertheless, since 2003, Carp production in Poland and Saxony is thought to have decreased by about one third as a result of KHV — the Koi Herpes Virus (see also 3.1).

Similarly, fish are vulnerable to numerous predators, including fishes such as Northern Pike (*Esox lucius*) and Pikeperch (*Sander lucioperca*), birds such as Cormorants (*Phalacrocoridae*), Herons and Egrets (*Ardeidae*), Grebes (*Podicipedidae*) and Osprey (*Pandion haliaetus*) and mammals such as the Eurasian Otter (*Lutra lutra*). Except for the case of Otters that may leave the uneaten remains of prey on the banks of ponds, much of this predation probably goes unseen and can not necessarily be apportioned to a specific predator such as the Cormorant.

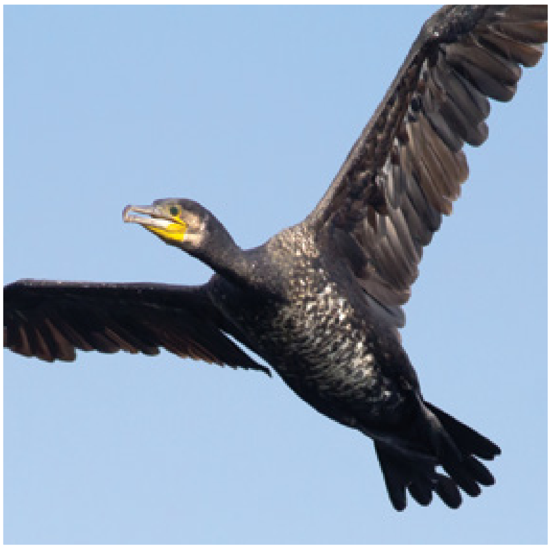
Similarly, although Cormorants may feed at pond farms, these ponds seldom hold a monoculture and so at least the possibility that some of the fish taken by the birds are not highly-prized Carp but some species of lesser (or no) commercial value has to be considered. The process of predation is also complex and includes considerably more than the mere capture and consumption of a prey item. Some fish may evade capture by Cormorants only to be left uneaten but damaged by the attack (see chapter 8 of Carss *et al.* 2012).

**Carp showing the characteristic beak marks ('damage') made by Cormorants.**
Photo courtesy of Daniel Gerdeaux.

Such damaged fish will undoubtedly be stressed from their ordeal and may subsequently die as a direct result of the attack or indirectly through infection of any wounds sustained during it. Even if they do not die, such fish may grow more slowly that others and in many cases fishermen cannot sell the wounded and scarred fish on the market and thus Cormorant predation contributes indirectly to reduced productivity. Similarly, many believe that the presence of feeding predators such as Cormorants affects the behaviour of fish both stressing them and/or forcing them to seek cover and shelter. Again it is possible that if such behaviour is sustained then fish may have reduced feeding or growth rates and associated increased vulnerability to disease and parasitism and/or reduced productivity.

Whilst many of these aspects are likely to apply to fish held in pond farms, it is extremely difficult to apportion specific losses to such things as Cormorant predation (see chapter 9 of Carss *et al*. 2012) . As a result, rigorous assessments of the scale of fish losses to Cormorants are seldom available to farm managers. Of course, this is not to say that predation (or subsequent indirect losses to stock or reduced production) have not occurred, merely that it is extremely difficult to quantify.

Nevertheless, pond farmers are often in a position where they see relatively large numbers of



**Cormorants are often very conspicuous in fishpond landscapes.** Photo courtesy of Shutterstock.

**Many Carp fishermen calculate Cormorant damage to their fishery when their harvests are lower than expected.** Photo courtesy of Robert Gwiazda.

Cormorants feeding on the stock in their ponds — regardless of the potential indirect losses of fish discussed above (though not trivialising its potential magnitude), at the very least these birds are likely to be eating large numbers of economically valuable farmed fish, particularly Carp. Despite the biological complexities that mitigate against any easy quantification of fish losses to Cormorants at ponds, the presence of birds there is invariably the foundation for both concerns over resulting fish predation and the necessarily 'semi-quantitative' attempts to quantify it.

**Counting Cormorants can be an important element of any calculation of damage the birds have done to fish stocks in ponds.** Photo courtesy of Shutterstock.

There is a high natural mortality of Carp in ponds depending on the age of the fish. However, this mortality is reasonably well quantified and is incorporated into productivity (and final yield) calculations for individual pond farm systems. For example in the Upper Lusatian Case Study area, the mortality of K1 Carp is about 70–80% on average, of K2 Carp 20–30%, and of K3 Carp about 10%. The mortality rates in the other Case Study areas are thought to be similar to these.

As most fishermen do, Carp pond farmers tend to calculate the damage caused by Cormorants as the difference between expected and actual fish harvest. However, such a calculation does not discriminate between various causes of fish losses and consequently tends to overestimate the losses caused specifically by Cormorants. Slightly more refined alternative calculations of the amount of fish consumed can be made by multiplying the numbers of Cormorants observed at the site by the number of days they stay and feed there (to estimate 'Cormorant days' — see section 2.4 of Carss *et al*. 2012 for more details) and by their estimated daily food intake. Such calculations clearly require good background data on Cormorant presence at a site and so careful monitoring of both Cormorant numbers and length of stay is an essential prerequisite.

Wherever possible we have attempted to summarise the best estimates of annual fish pond losses for Carp to Cormorants (2004–2007) from the different pond study areas (Table 7.1). For two Case Study areas, Dombes and Forez (FR), there are no comparable data available. In France the loss of fish could not be calculated because the predation pressure depends a lot on the weather during winter. In a cold winter the Cormorants hunt on rivers, if the winter is mild they stay on ponds and shallow reservoirs. This is the reason why no estimation of loss is accepted in France.

The basic data for the individual calculations differ from area to area as described below. The data presented were those normally used for management decisions. There are very few attempts to calculate the damage cause by Cormorants using accurate data derived quantitatively in the field.

The information collated in Table 7.1 suggests that, financially, estimated fish losses to Cormorants are high in all Carp pond regions and are in the order of tens, if not hundreds, of thousands of euro per year. Estimated financial losses are especially high in Upper Lusatia and Israel's Hula Valley at around 900–1,500 euro per 10 ha of ponds.

In the Polish study areas and the one in Saxony calculations of financial losses to Cormorants made by ornithologists are based on the mean number of Cormorants for the whole Case Study area, counted in a certain time period (i.e. counted at sites every two weeks in Poland or monthly in Saxony), the daily food consumption rate of the birds, estimates of the proportions of Carp and other fish species in the birds' diet taken from the scientific literature, and the fish market price of fish. The calculated market price of fish in Saxony is the average price from two-summer Carp and three-summer Carp. This way of calculating financial loss tends to result in a rough evaluation of damage in relation to direct losses. Indirect losses to stress because of predation pressure by Cormorants, for instance, are not included.

Besides this method for damage assessment the fishermen in Saxony also calculate the damage by a so-called 'amount of coverage' method. This equates to the difference between the expected harvest (including losses due to the normal mortality of fish in ponds) and the effective (i.e. the 'actual') harvest. This means in Saxony there are two kinds of damage assessment and Table 7.1 shows the range between them: the lower calculated value comes normally from ornithological data.

In the Czech Republic, calculations are based on the numbers of birds

**Table 7.1** Calculated financial losses due to Cormorant damage to fish stocks in Case Study areas per year (based on data from 2004–2007).

| Case study region | Total calculated damages per year (1,000 €) | Calculated damages per year (€ per 10 ha) |
|---|---|---|
| Upper Lusatia (GER) | 500–800 | 909–1,455 |
| Jindřichův Hradec (CZ) | 147–288 | 491–963 |
| Milicz Complex (PL) | 94.5 | 145 |
| Spytkowice and Zator Complex (PL) | 45.4 | 303 |
| Lubana Wetland Complex (LV) | 40–47 | 148–174 |
| Hula Valley (ISR) | 35–55 | 921–1,447 |
| Rétimajor (HUN) | 39–45 | 410–473 |


**In some places, financial compensation for Cormorant damage can be related to the market price of fish.** Photo courtesy of **INTERCAFE**.

**Scanning the Krvavý Carp fishpond for Cormorants in the Czech Republic.** Photo courtesy of Zuzana Musilova.

recorded on a particular pond by regular census (at least 8 visits to each pond per month), their period of presence there, their expected daily fish consumption rate (from the literature), and the mean market price of the fish cohort/species stocked in that particular pond. In the Hula Valley fish farmers used to complain (in the period 1994-2001) about 'severe Cormorant damage', assessed annually to be 300 tonnes of direct losses and another 300 tonnes through indirect damage (e.g. loss of 'raw material', insufficient growth rate) by merely multiplying 'Cormorant days' by daily food intake. However, more refined assessments of Cormorant damage to fish stocks were later calculated (2001–2004) with the help of local fish farmers (see also Case Study No. 7 in Russell *et al*. 2012). More accurate data were used than before, including the numbers of Cormorants on ponds, the number of days the birds were present, the Carp stocks in ponds, and an analysis of the stomach contents of Cormorants feeding there. As a result, these new estimates of damage were 10% or less than the original estimates. This large, 90% difference was due to a number of things: accurate Cormorant numbers in Carp ponds instead of merely counts of Cormorants in the area; taking into account Cormorant predation on non-commercial fishes; the identification of disease in the Carp ponds; separation of Cormorant

**Fishpond in the Hula Valley, Israel.** Photo courtesy of **INTERCAFE**.

**Carp fishpond, Ženich, Třeboňsko, Czech Republic.**
Photo courtesy of Robert Gwiazda.

damage from other known causes such as those related to harvesting procedures for instance. In the past, the old (and ineffective) management measure of shooting Cormorants at ponds cost around 200,000–300,000 NIS (some 40,000–60,000 euro) per year. More elaborate estimates of losses showed that the direct damage was about 18 tonnes in the 2001–02 winter, less than 10 tonnes later on, and decreasing further thereafter. Any claims for indirect damage to fish stocks by the birds (requiring time-consuming and costly management measures to reduce losses to Cormorants) were no longer made because fish farmers lost their feeling of having big losses to the birds.

As a result of these changes in estimated losses to Cormorants and the associated management of birds at pond farms, the costs of managing the birds were reduced to 60,000 NIS (about 12,100 euro) and could be even less with improving cooperation in management activities. The numbers and figures given above have either been provided by the fish farmers themselves or have their agreement.

In the Rétimajor Case Study area in Hungary there are no data about losses to Cormorants. In Hungary, pond farmers consider that the problem of fish losses due to Cormorants is ever increasing and that they are more affected by Cormorant predation each year. Pond farmers estimate that the cost of predation is increasing between 10–20% each year. This is largely due to the increasing number of birds on fish farming sites, which could be the result of increasing population size or the shift of the existing population from natural rivers and lakes with diminishing fish stocks to fish farming sites. However, at the same time, the cost of defending the farming sites from predation is also increasing at a steady pace, as the price of such things as fuel, ammunition and labour, rise.

This does not necessarily mean that every pond has fewer fish as a result but that fishermen have to spend a lot more money (and time/manpower) on deterring the birds. In Hungarian fishpond culture there are no hard statistics available for the whole sector, but there are data for several individual farms. On

**Cormorants at Ķemeri National Park, Latvia.** Photo courtesy of Karlis Millers.

**Table 7.2** Estimated damage assessment in Latvia at Nagli fish farms.

| Pond Number | Area (ha) | Stocked in Spring (numbers) | Harvested in Autumn (numbers) | Output (%) |
|---|---|---|---|---|
| 3. | 104.7 | 114,000 | 21,000 | 18.4 |
| 4. | 81 | 146,000 | 42,100 | 28.8 |
| 9. | 96.2 | 98,000 | 21,200 | 21.6 |
| Total | 259.9 | 358,000 | 84,300 | 23.5 |

average, it now costs 20–25 euro/ha to try to protect fishponds in the Rétimajor Case Study area (e.g. manpower, ammunition, fuel). By comparison, this cost was only 5–10 euro/ha in 2004. Moreover, these costs do not include either the direct losses of fish to the birds or the indirect damage they cause to stock. As mentioned earlier (3.3), there was apparently so much Cormorant damage to stocks of 100–400g Carp that fish had to be bought to fill ponds adequately. As this was a problem throughout Hungary, fishermen had to try to buy fish from other countries but often farmers there were facing similar problems too. The damage caused by Cormorants in the Rétimajor Case Study area continues to grow and the owner has found no useful and effective methods to reduce it.

In Latvia, an example of the economic damage Cormorants cause to fish farmers is provided by the example of the production registration of two-year old Carp (average weight 200 grams) at Nagli fish farm (Table 7.2).

As can be seen, the calculated output (amount of fish registered in the autumn as a proportion of that registered in spring) from these three fish ponds was very low. There were no fish diseases recorded during the period in question but a lot of Cormorants and other fish-eating birds were noticed at the ponds by fish farmers. According to the accepted standards, the yield of Common Carp of this age for this region when harvested in autumn should be around 80% of the fish stocked in spring in terms of numbers. In this particular case it could thus be assumed that the total amount of two-year old Carp harvested in autumn from these three ponds should be around 286,400 individuals according to the standards, with an average weight of 200g per fish. Instead what was harvested in reality was 84,300 fish with the same average weight. It was thus calculated that the 'lost' harvest was 202,100 fish which is 40,420 kg of two-year old Carp (202,100 individuals multiplied by 0.2 kg, the average weight per individual). The most significant factor for this lost harvest was thought to be the presence of about 500 Cormorants at Nagli fish farm during the period May to October according to the observations of local ornithologists and fish farm workers.

# 8 CORMORANT MANAGEMENT IN CARP POND AREAS

## 8.1 Cormorant management techniques

There is a very diverse variety of management techniques that can be applied, to both Cormorants and fishes, in an attempt to reduce the problems the birds cause at European fisheries. All of these techniques are explored and discussed in detail in 'The **INTERCAFE** Cormorant Management Toolbox — methods for reducing Cormorant problems at European fisheries' by Russell *et al*. (2012). Indeed, given the relatively high vulnerability of Carp ponds to Cormorant presence/predation — through a combination of their location in relation to the migratory pathways of the birds, their obvious attractiveness as feeding sites (relatively high densities of fish, shallow water, little cover for fish), shallow water, and their proximity (or lack of it) to other wetland areas — a wide range of management techniques discussed by Russell *et al*. (2012) are directly relevant to the Carp pond situations. Furthermore these techniques cover a wide range of practical actions that have been shown to reduce Cormorant problems, at least in particular situations and at certain times of year.

**Cormorants at Ķemeri National Park, Latvia.** Photo courtesy of Karlis Millers.

As reviewed and synthesised by Russell *et al*. (2012), limiting the interaction between Cormorants and fish can be achieved in a number of ways, each falling into one of four broad categories of action:

1. Scaring Cormorants away from a fishery.
2. Protecting the fish — by preventing Cormorants from reaching them.
3. Altering fish availability to Cormorants — by making a fishery less attractive as a foraging site.
4. Reducing overall Cormorant numbers — for example by killing Cormorants locally to reinforce scaring at specific sites, killing them more intensively, or reducing their reproductive efficiency.

In addition, under some circumstances Cormorant-fishery conflicts can be addressed through the use of financial or other compensation measures.

In relation to Carp ponds, the effectiveness of different techniques and their cost (obviously an issue of vital concern but one which is seldom quantified — publically at least) are ultimately dependent on the size of the ponds, accessibility to their whole perimeter, the number of ponds and their distribution within larger geographic areas.

Readers interested in further details (including reports of practical

**Cormoshop™ auditory deterrent used at some fishponds, Dombes, France.** Photo courtesy of Robert Gwiazda.

cases where the so-called 'tools' have been used successfully) of Cormorant management techniques are urged to consult Russell *et al*. (2012). Here we give an overview of the management techniques (and associated legislative restrictions) most frequently applied in the Carp pond regions under consideration in this publication (see Table 8.1). These include shooting, and other 'active' techniques as well as several 'passive' ones alongside a short description of their efficiency. Importantly, the information provided in the Table shows that, at the moment at least, there is no appropriate scaring technique with a long-term effect for Carp pond fisheries.

### 8.1.1 Active management techniques in pond areas

None of the static management — deterring — techniques were found to be effective over a long time period in Case Study areas. In this respect it was found to be very important to combine several such techniques and change their locations frequently. Although this strategy was considerably more

**Visual deterrents used at some fishponds: 'kites' and flags painted with large eyes.** Photos courtesy of Paul Butt.

**Table 8.1** Management techniques used to reduce Cormorant-fishery interactions at Carp ponds in INTERCAFE's Case Study regions. ('Free' indicates that the activity can be undertaken without licence/permission.'Cormoshop'™ is an auditory deterrent).

| Country | Czech Republic | France | | Germany | Poland | | Latvia | Hungary | Israel |
|---|---|---|---|---|---|---|---|---|---|
| Case Study region | Jindřichův Hradec | Forez | Dombes | Upper Lusatia | Milicz | Spytkowice and Zator | Lubana Wetland | Rétimajor | Hula Valley |
| Shooting (Not Allowed, Licence required, Free) | Licence | Licence | Licence | Licences only during breeding season (since 2006) | Licence | Licence | Licence | Licence | Licence, virtually Free |
| Lethal Shooting carried out at: (A) Night Roosts, (B) Day Roosts, (C) Feeding Habitats, (D) New breeding colony to prevent settlement | (C) | (A)<br>(B)<br>(C) | (A)<br>(B)<br>(C)<br>(D - illegally in 2008) | (A)<br>(B)<br>(C)<br>(D - illegally) | (C) | (C) | None | None | (C) |
| Number of shot Cormorants per year | 300 | 950 | 4,000 | 600–800 | a few | 30 | 10 | 700–1000 | 2003–2006: about 50, before 2003: 600–1,000 |
| Management techniques (Not Allowed, Licence required, Free) | Free or Licence | Allowed | Allowed | Free, but Licences required in protected areas | Licence | Free | Free | Free | Free |
| 'Active' management techniques | Gas Cannons, Shooting, Human Disturbance | | | | | | | | Fireworks, Shooting |
| | Non-lethal Shooting | Laser gun, Cormoshop™ | Laser gun, Cormoshop™ | Laser gun | None | None | None | None | |
| 'Passive' management techniques | Scarecrows | Scarecrows, Netting (partly, but rare) | Scarecrows, Netting (partly, but rare) | Scarecrows, Netting (partly, but rare) | None | None | Scarecrows | None | Scarecrows |
| Efficiency of management techniques | Non-lethal shooting effective up to 300 m | Low, but not efficient in long-term | Low, but not efficient in long-term | Gas cannons (effective for a few weeks, if their position is changed frequently), Shooting (days) | Gas cannons (days) | Gas cannons (days) | Low | Low | Fireworks — very effective if incorporated with small amount of shooting |

labour-intensive than using a single technique in the same position, it was found to be considerably more effective — although its effects were not 'permanent'.

In Saxony/Upper Lusatia the ultrasound technique 'Seeadler K1'™ is used quite often and nearly every fish farm owns such equipment, which can be floated offshore and produces a 360° spread of noise. It is very often used in combination with other deterring techniques such as the Razzo-Triplex™ (a pole-mounted 'kite' — often painted with large eyes — which is launched up the length of the pole on a timing device) and others. However, some of the auditory scaring systems are considered to be too loud for use next to human settlements. In practice the laser gun is used only very seldomly at fish ponds in Saxony because it works only at twilight or in the dark. Here shooting was also considered ineffective because it did not cause a reduction in the Cormorant population. The number of shot Cormorants has increased from about 1,200 (in 2006) to over 2,400 birds the following year when the so-called 'Cormorant Regulation' came into effect in January 2007. However, despite more than doubling the numbers of birds shot, there has been no recorded reduction in the Cormorant population to date — although 'population reduction' as such was not the aim of the Cormorant Regulation.

Fishermen do consider that shooting shifts the problems of Cormorant-related damage to other locations, but no regional reduction in such damage has occured overall. Only in site-specific cases is it thought that shooting might help but, very importantly, this is highly dependent on specific circumstances such as the location and size of the pond concerned.

In the Czech Republic, the Great Cormorant is a fully protected species and so 'flushing' (i.e. disturbing or scaring) and/or shooting is only possible under a special licence (i.e. an exemption from species protection). However, in breeding localities, shooting is usually allowed apart from during the actual breeding season (from the end of April to mid-July). The numbers of Cormorants shot in the Czech Republic increased between 1980–2000 and then over the 1999–2007 period the numbers of shot birds has fluctuated between 2,000–3,200 birds each year. Some fishery companies stimulate the shooting and killing of Cormorants by the payment of a 'bounty' to hunters, paying about 300 CZK — or around 11 euro — for every bird they kill.

The most intensive shooting of Cormorants was undertaken in the districts of Jindřichův Hradec and Břeclav, in areas up to 30 km from the nearest breeding colony. In these districts about 66% (according to hunting bags) or 75% (according to recoveries of ringed individuals) of the locally breeding birds were actually shot. In fact the vast majority of Cormorants shot in so-called 'breeding districts' (i.e. areas within 30 km of a breeding colony) are from Czech breeding colonies. In total, 104 of the 111 recoveries (94%) of Cormorants ringed in Czech colonies were later reported dead within the Czech Republic, having been killed in these breeding districts. Originally, the shooting of Cormorants was actually aimed at the migratory Cormorants visiting the Czech Republic from elsewhere. However, ring recovery data show that this shooting probably has an important effect on the local breeding population in the shooting areas, presumably due to the birds' fidelity or philopatric relationships to the breeding area.

In Latvia the majority of the six biggest pond areas (the smallest

**Shot Cormorant at fishpond in the Czech Republic.** Photo courtesy of Petr Musil.

**Gas cannon.** Photo courtesy of Thomas Keller.

pond is 5 ha, the largest 127 ha) are situated in NATURA 2000 sites and other protected areas. Therefore the killing of Cormorants is prohibited and even their disturbance was prohibited until recently. The technical mitigation measures which are used at these fish farms are gas cannons and scarecrows, the latter being ineffective. Similarly for gas cannons, because the size of ponds is quite big, prohibitively large numbers of cannons are needed to surround the area. In terms of effectiveness, whilst fish farmers admit that these cannons are better than nothing, they see that Cormorants quickly get used to the noise cannons make and observe that the birds fly in and forage for fish in the ponds between the ‘shots’ from them. This behaviour was particularly well documented in one case when cannons were installed on small winter ponds at one of the farms. Clearly the use of noise deterrents, here in the form of gas cannons, is not a solution to the Cormorant problem on its own. At Latvian farms the use of scaring devices such as gas cannons must therefore be consolidated with a financial damage compensation scheme, where the implementation of such technical mitigation measures on site is a compulsory condition for fish farmers to be eligible for compensation.

In Hungary Carp pond farmers found that the most effective, but also the most costly, deterring technique for Cormorant was shooting. Gas cannons were used in different areas but their effect is limited in time and so they need to be moved often. Recently in Hungary, fish farmers have discovered that the efficiency of deterrence can be increased by applying different techniques (e.g. shooting and gas cannons) in combination very early in the morning. This is the time when the first flocks of Cormorants start to visit farm ponds. However, if these ‘early birds’ are not allowed to settle and feed they will usually leave the area and not come back again until the next morning.

In Poland gas cannons are also commonly used at Carp ponds but, generally, the number used is often too small in relation to the surface area of the pond they are used to protect. Furthermore, the ‘shots’ from the gas cannons are usually at a regular frequency and so birds quickly become used (‘habituated’) to them. As a result of these practical problems, the efficiency of gas cannons is not considered to be good.

In Israel (Hula Valley) active deterrence techniques, notably the use of fireworks and shooting of foraging birds, are used to scare Cormorants from fish ponds. In combination, these techniques are

**Multi-directional noise generator, Saxony fishponds.**
Photo courtesy of Thomas Keller.

**Pyrotechnics, including fireworks and rockets are used at some fishponds.** Photo courtesy of Paul Butt.

considered to be very effective, when used as part of a Cormorant scaring strategy and co-ordinated on a relatively large scale (for more detailed discussion, see 8.4). Indeed, as such a programme developed in the Hula Valley the necessity to kill Cormorants decreased dramatically (see Table 7.1).

## 8.1.2 Passive management techniques in pond areas

Carp are most vulnerable to Cormorant predation during their first two years of life. During the first few months they can be bred and held in small hatcheries and ponds and are relatively easy to protect from predation than they are when older (larger). However this careful rearing and protection of very young (small) fish is costly when compared to natural breeding in larger ponds as it requires the juvenile fish to be artificially reared and fed.

In ponds the risk of predation is highest during the end of the first year and throughout the second year of the fishes' lives. Fish farmers in France can delay the introduction of one-year old Carp to large ponds in the spring after overwintering Cormorants have departed to their breeding areas. However, this delay both reduces the duration of the Carp's growth period in the pond and also increases the cost of production. When Carp are in large ponds (1 ha or more), fish farmers can try to protect them from predation by creating some form of artificial refuges, sometimes as submerged wire cages. In Dombes, the soil is cultivated every 3–4 years often with maize which farmers harvest leaving the rooted stalks in the field. These stalks make very good refuges but there is an associated risk of oxygen depletion within the pond as the organic matter of the stalks consumes a lot of oxygen in summer. It has been found that the good management of macrophytes within ponds and around their edges can also create good refuges for small fish, offering them some protection from predation.

**Very young fish ('fingerlings') can be kept in hatcheries as here in Hungary but this is expensive.** Photo courtesy of Robert Gwiazda.

The best method for reducing Cormorant predation at small ponds is to span them with some form of net. However, such passive protection outside and above the water (e.g. nets or wires) is considered to be too expensive for large ponds. Costs also increase with increasing pond area because additional infrastructure is necessary to keep the nets or wires in place.

## 8.2 New methods of fish pond management to minimise Cormorant damage in ponds

In Saxony, two tests of Cormorant-proof small stock fish production are running next to the traditional pond management systems. The first is a 'warm water fish breeding system' (operated by the Kreba-Fisch GmbH company) and the second is a 'pond-in-pond system' (a research project by the Fishery Authorities in the municipality of Königswartha).

**Nets and wires can reduce Cormorant predation at small ponds but are often impractical for larger ones.** Photo courtesy of Bruno Broughton.

### 8.2.1 Warm-water fish breeding system

The basic idea of Kreba-Fisch's warm water fish breeding system is to produce at least a proportion of the young Carp (one- and two-summer fish, so-called K1 and K2 fish) that are especially vulnerable to Cormorant predation under protected and very productive conditions. These fish are only finally released into the more traditional 'normal' fish ponds at the beginning of their third summer.

**Cut maize stalks can provide additional cover for fish in some fishponds when they are re-flooded.**
Photos courtesy of Shutterstock.

This system uses the cooling water from the lignite-fired power plant 'Schwarze Pumpe' (Figure 8.1). The water temperature here is 23–24°C and it runs into a round basin (Figure 8.2) which is oxygenated and holds both one- and two-summer Carp.

This warm-water 'breeding complex' is controlled remotely which reduces the necessary manpower. Indeed, it only takes a single person to run the system. One big problem associated with such a fish-rearing facility concerns the provision of the 'waste' cooling water that is used. If it were necessary for fish farmers to pay for such water, the technique might become too expensive. The system outlined here costs about one million euro, which is prohibitively expensive for many fish farms, particularly the smaller ones.

In the Kreba Fisch GmbH situation, a grant of 60% of the costs was made available but for the company the remaining 40% contribution to costs was still a considerable investment. Ultimately, the crucial problem for Carp pond farmers with all expensive investments is that Carp production and subsequent marketing does not bring in enough money to cover the costs. Nevertheless, for Kreba Fisch GmbH, this innovative project saved the company and allowed it to survive in 2008, according to W. Stiehler the Management Director of this fish company.

## 8.2.2 Pond-in-pond system

This system was tested in Saxony in the municipality of Königswartha in special test ponds and also in Brandenburg at the Petkamsberg fish farm Peitz (see Gottschalk *et al*., 2008). The pond-in-pond system was funded by the FIAF, a project devoted to the development of for the so-called 'Cormorant-safe' breeding of Carp. This system works with aquatic chambers for the young Carp held within a larger pond (Figure 8.3) and was tested for breeding first-summer (K1) fish. Due to its size, this system would be suitable for small pond farms but because it uses 'compound' feeds for the fish, the method can only be used outside FFH areas as this practice is forbidden within them. FFH areas are designated for

**Figure 8.1** Warm-water fish breeding system which uses cooling water from the nearby Schwarze Pumpe power plant in Saxony. Photo courtesy of W Stiehler.

**Figure 8.2** The fish basins of the warm-water fish breeding system in Saxony which are oxygenated and are used for one-and two-summer Carp production. Photo courtesy of W Stiehler.

nature conservation under EEC's Flora Fauna Habitats Directive and are designated alongside European Birds Directive sites with the aim of creating the European protected area system NATURA 2000.

Tests in Königswartha showed that the pond-in-pond system did not appear to be practical because not enough Carp could be produced. However, a similar test — but on a larger scale — was undertaken in Petkamsberg (Figure 8.4) with more success than the Köniswartha trial. Second-summer (K2) Carp were produced at the Königswartha site with a computerised husbandry system. The system was expensive, especially the aeration system and the emergency generator, but overall this new method of juvenile Carp production was cheaper than the warm water fish breeding system desribed above and this trial was considered to have worked successfully.

**Figure 8.3** Pond-in-pond Carp rearing system in Saxony. Photo courtesy of Archiv Königswartha.

**Figure 8.4** Pond-in-pond Carp farming system being trialled in Petkamsberg.


**Financial compensation is paid for 'Cormorant damage' to fishpond stocks in some places.** Photo courtesy of Shutterstock.

## 8.3 Financial assistance

### 8.3.1 Compensation for damage caused by Cormorants

In 2006 a questionnaire on financial compensation or subsidy schemes in relation to Cormorant-fisheries conflict was distributed among **INTERCAFE** participants (by Michal Adamec, Slovakia). Experts from 22 countries responded and, at the time, there were financial compensation schemes for the damage caused by Cormorants to fisheries operating in several countries. These were Belgium (Waloon), Finland, Romania, Czech Republic, Slovakia and Germany (Saxony), whilst a compensation system was established later in Latvia.

There were different definitions of what instances were eligible for compensation. In some cases, the compensation was only for fish stocks on fish farms, fish hatcheries, or fish-breeding and keeping facilities. In some places only the value of the missing, dead (i.e eaten) fish was compensated for, in others fish injured by Cormorant attacks could attract compensation, and in some cases related expenses (e.g. safe destruction of carcasses, veterinary fees) could also be covered by compensation payments. However, it was clear from the survey that, in most European countries, there was no financial help for the damage to fisheries caused by Cormorants.

**Carp pond management in the Czech Republic.** Photo courtesy of Petr Musil.

In relation to the study cases of Carp ponds reported here, fish farmers in Saxony, in the Lubana Wetland Complex in Latvia and in the Jindřichův Hradec district of the Czech Republic can get compensation for Cormorant damage to their fisheries but other fish farmers — those in Forez and Dombes in France, Millicz, Spytkowice and Zator in Poland, and in Case Study areas in Hungary and Israel — cannot apply for any form of financial compensation.

Interestingly, the financial compensation schemes and procedures for obtaining compensation are very different between the Saxony, Czech Republic and Latvian situations, as described below.

#### Damage compensation in Saxony

The fishermen in Saxony calculate the damage by a so-called 'amount of coverage' method. This equates to the difference between the expected harvest (including losses due to the normal mortality of fish in pond) and the effective (i.e. the 'actual') harvest. However, as

**Carp harvesting, Saxony.** Photo courtesy of **INTERCAFE**.

these calculations are carried out 'in-house' and with no independent observer, there is scope for the fishermen to exaggerate the damage caused by Cormorants. Indeed, some of the damage calculations done by fishermen result in loss figures that are three times as high as the potential losses calculated from counts of the local Cormorant population and knowledge of their average daily fish consumption. Farmers know that only a certain percentage of any calculated damage can be covered through compensation payments. Thus fishermen calculate higher damage figures because they know that the amount of compensation ultimately paid will be reduced anyway.

Financial help to fish farmers for hardship cases as a result of the damage caused by Cormorants will only be paid in very limited cases as a consequence of the 'Cormorant Regulation'. With commencement of the 'Cormorant Regulation', pond farmers in Saxony can make an application for damage compensation claims (so-called damage equalisation claims) only for the ponds where deterrence techniques are prohibited due to nature conservation reasons. As long as the Cormorants are allowed to be shot, no compensation is paid. Where the nature conservation authorithy prohibits shooting (i.e. in special areas like nature conservation areas), it is possible to apply for a compensation payment. Furthermore, another big problem is that possible financial help can be only supplied in the context of the *de minimis* regulation of the European Union. In the European Union, *de minimis* 'state aid' regulation allows for aid of up to a certain maximum amount to be provided from public funds to any business enterprise over a period of three years. Under this regulation, compensation payments for Cormorant damage to fish stocks up to a maximum of 30,000 € over three years can be paid. In Saxony hardship cases are liable to the *de minimis* regulation and so the system of compensation payments for hardship cases, in terms of the Cormorant, has become unattractive. As a consequence, only a few such applications have been filed in recent years.

## Damage compensation in the Czech Republic

As has already been noted, the Great Cormorant is a fully protected species in the Czech Republic and flushing (i.e disturbance or scaring) and/or shooting is only possible under a special licence. Moreover, the Act No. 115/2000 Coll. entitled *'Compensation of damages caused by selected especially protected species'* was issued in the 5th April 2000. The following species are included in this Act: European Beaver (*Castor fiber*), Otter (*Lutra lutra*), Great Cormorant (*Phalocrocorax carbo*), Moose (*Alces alces*), Brown Bear (*Ursus arctos*), Lynx (*Lynx lynx*), and Wolf (*Canis lupus*). In the case of Cormorants, this Act recently covers the damage caused to fishes stocked for economical purposes in fishponds, fish farms, fish hatcheries etc. during any time of year. Requests for compensation have to be addressed to the Department of Nature Conservation of the Regional Government or to the Landscape Protected Area/ Nature Park Authorities no later than six months after the start of the damage. All such requests for compensation have then to be confirmed by an 'expert review'.

In this way, the damage is calculated as product of (A) the number of recorded foraging Cormorants x (B) the average mass of consumed fishes (i.e. Daily Food Intake) x (C) the mean actual market price of the consumed fishes.

**Fish pond in Latvia.** Photo courtesy of Oleg Nemononoks.

**Freshly harvested Carp, Latvia.** Photo courtesy of Oleg Nemononoks.

In 2000, the total amount of compensation paid by the Government for damage caused by Cormorants was about 610,000 CZK (24,223 €), and was 1,586,000 CZK (62,980 €) in 2001, when this compensation process covered only the Cormorant breeding population. In the following year (2002), the total amount of Government compensation exceeded 8,600,000 CZK (341,509 €) because the compensation procedure was applied all year round, especially on fishponds. The total amount of financial compensation paid out is still increasing and reached 21,327,000 CZK (846,762 €) in 2005 and 23,579,000 CZK (936,175 €) in 2006. The corresponding figures in euros (€) above are based on the (exchange ratio: 1 € = 25.19 CZK).

Usually, the requests for financial compensation relate mostly to the larger Czech fishpond regions located in South Bohemia and South Moravia. Where the amount of compensation paid out has reached 85% of total amount used for compensation in the whole country.

## Damage compensation in Latvia

In November 2007, a new Regulation was passed by the Latvian Cabinet under which fish pond farmers are eligible to receive financial compensation — under certain conditions — for stock losses arising from the activities of protected fish-eating birds, including Cormorants. In the Latvian case, counts of Cormorants breeding on the fish ponds are carried out and, on this basis, the damage to fish stocks is calculated. Importantly, in addition, fish framers claiming for damage compensation must carry out all possible measures for damage mitigation.

According to the Regulation, the main conditions under which pond farms must act are as follows: fish pond farmers should implement bird-scaring devices at the farm and in some cases eliminate a certain number of Cormorants according to official permission granted by the Regional Environment Authority (REA) and issued on an individual basis. Not more than 10 days after damage has been identified, the claimant of the compensation must submit a completed application form to the REA. The REA then creates a 'Commission' consisting of experts from other public authorities, the REA itself, and independent ornithologists. The Commission then evaluates the damage not later than 10 days after receiving the completed application form from the claimant.

On reciept of an application, the Commission makes a calculation of the damage in monetary terms using the formula approved in the Regulation. The Regional Environment Authority then draws up a report stating the size of the damage in monetary terms if all conditions of the Regulation are fulfilled, and sends this to the Latvian Environmental Protection Fund. Then, the Fund's administration decides within a one month period whether or not to compensate for the damage on the basis of the claim being in accordance with the Regulations.

In reality, the Regulation actually started to work in 2008, because it was only passed in November 2007, and so the first fish-breeding season after that was from spring 2008. In 2008 the total amount paid in compensation to Latvian fish pond farmers was 171,000 euro. According to the Latvian Ministry of Environment and the Ministry of Agriculture, the number of complaints from fish pond farmers — as well as complaints from environmentalists about the illegal shooting of protected birds — was reduced to zero in 2008 because of this Regulation on financial compensation. Therefore people in Latvia believed that this scheme was the most appropriate measure for conflict reconciliation between protected fish-eating birds and fish pond farms. However, the Regulation on a financial compensation mechanism for damage caused by protected animals and birds described above was repealed at the end of 2009 by the Latvian Parliament because of the financial crisis and the need to reduce an increasing budget deficit by cutting costs. It has not been in force since then despite the objections of stakeholders (farmers including fish farmers and environmentalists including ornithologists). Instead of allocating an appropriate (but comparatively insignificant) amount of finance in the national budget for compensation purposes, the Latvian authorities chose either to issue permission for the elimination of larger numbers of Cormorants at fish farms or to allocate more finances for mitigation measures and compensation (not applicable to fish farms), where possible from European financial instruments.

## 8.3.2 Financial advancement to maintain ponds

In Saxony, as well as the money available for compensation for fish losses (see 8.3.1), it is also possible to get financial help for pond management and maintainence that is in accordance with nature protection. In 2007, about 140 fishery companies, as well as angling and nature conservation organisations and associations, got financial support according to RL AuW/2007, Part A Range T *'Pond preservation and nature conservation conformed pond management'* or RL 73/2000 (or rather RL 73/2007) Part E/ *'Nature conservation and preservation of the cultural landscape'* (NAK). The water surface area supported by this financial help comprised some 7,668 ha of ponds and 2,002,800 euro was paid in financial support. Thus the average total amount of financial support for pond preservation and nature conservation-based pond management was 261 € per ha in 2007.

In 2010 fishery companies, as well as angling and nature conservation organisations and associations, received financial support according to RL AuW/2010, Part 1 Range T *'Pond preservation and nature conservation conformed pond management'*. Table 8.2 shows the actual amount paid out in financial support.

Thus in 2010, the average total amount of financial help for pond preservation and nature conservation-based pond management in Saxony was 241 € per ha and amounted to over 2.1 million euro.

## 8.3.3 European Fishery Fund (EFF)

Other financial support may indirectly help to overcome the conflict between Cormorants and fisheries interests at pond farms. Such financial support is available within

**Table 8.2** Financial support paid in Saxony according to RL AuW/2010, Part 1 Range T (AuW- agricultural environmental task). * Note: the total surface area receiving financial support comprises the total surface of ponds including reeds.

| Financial Support regulation | Water surface area* (ha) supported financially | Amount of financial support (€) |
|---|---|---|
| AuW measures T 1 Pond preservation | 1,695 | 206,035 |
| AuW measure T 2 (including the determination of stocking intensity) | 225 | 36,376 |
| AuW measure T 3 (including the determination of stocking intensity and protection measures for species and/or the biotic community) | 2,022 | 713,647 |
| AuW measure T 4a (including protection measures for species and/or the biotic community and the stocking of excluded fish species) | 3,765 | 896,199 |
| AuW measure T 4b (including protection measures for species and/or the biotic community and additional stocking) | | |
| AuW measure T 5 (maintenance of pond biotopes without production) | 318 | 150,577 |
| Total | 8,895 ha | 2,146,119 € |

**Financial support can be available in Saxony for fishpond management if it is in accordance with nature protection.** Photo courtesy of Shutterstock.

the European Fisheries Fund (EFF), under the framework of the European Common Fisheries Policy. This money is financed by the European Union budget and is available to every Member State of the EU in compliance with Council Regulation (EC) No. 1198/2006 of 27 July 2006 on the European Fisheries Fund (EC Reg. on the EFF).

The aqua-environmental measures included in the EFF aim to promote aquaculture production methods which help to protect and improve the environment and to conserve nature. They cover four different types of measures:

- forms of aquaculture comprising protection and enhancement of the environment
- participation in EMAS (The EU Eco-Management and Audit Scheme, which is a management tool for companies and other organisations to evaluate, report and improve their environmental performance.)
- organic aquaculture
- sustainable aquaculture comparible with NATURA 2000 (the Europe-wide network of sites tasked with the preservation of natural heritage, see Footnote 4)

These measures are new for most Member States, although some measures have been funded under the AGRI programmes under the framework of the Common Agricultural Policy (e.g. the protection of aquatic biotopes/ extensive fish ponds).

Compensation payments provided under Article 30(2)(a) of the EFF are especially high for such things as frequent maintenance costs of farming structures, losses due to predation by protected wild species, and lack of revenue due to the low farming densities. Furthermore, issues related to the calculation of compensation payments will also be addressed.

In conclusion, the scope of the EFF programme's 'aqua-environmental measures' (applied in certain countries e.g. CZ, LT, DE, PL) clearly overlaps with the Cormorant-fish pond farms conflict and can contribute to its reduction/resolution. However, this support stopped in 2009. In some countries, similar support is available from the EFF but it is not available in Hungary for instance.

**Some forms of indirect financial support for fishpond systems are available through the European Commission in Brussels.** Photo courtesy of Shutterstock.

It can be summarised that, under these EU financial support programmes, Carp pond fish farms are eligible for a payment per hectare of the fish pond area on an annual basis if farm managers fulfil certain environmental criteria by which favourable conditions for the existence of waterfowl (including the Cormorant) are created along with other factors which enhance biodiversity and nature protection. The amount per hectare payable to fish pond farms is calculated in accordance with an assessment of the state of current fish pond farming in each Member State. This should be made in respect of Article 30 of the EC Regulation of the EFF, taking into account socio-economic and mainly environmental aspects. There will obviously be variation from country to country, but — crucially — the concept of the financial support programme should remain the same for all. Furthermore, there are plans for similar programmes to be implemented in the Czech Republic, Poland, and Lithuania — and most probably in Latvia too. However, it is very important to state that fish farmers in general would like to continue their professtion — therefore financial compensation is only a tool for relief and not a solution.

Finally, under Article 29 of EC Regulation of the EFF, financial support can also be provided to support investments for the purchase of equipment aimed at protecting fish pond farms from wild predators (of course, only where it is applicable). However, the main problem for fish farmers is not the cost of the equipment (e.g. gas cannons, shotguns) but the labour cost of operating it. Our current information suggests that finding some form of co-financing for these necessarily high amounts of investment is a really big problem for most of the farms.

**Fishpond in the Czech Republic.** Photo courtesy of Petr Musil.

## 8.4 Technology transfer: possible or not?

It is clear that in all of the **INTERCAFE** Carp pond farm Case Study regions — chosen carefully to represent the breadth, diversity and complexity of this 'fishery type' across Europe and Israel — serious attempts have been made to reduce the effects of Cormorants (see chapter 7). However, what is also clear is that in most cases these attempts — whether they involve active or passive deterrence techniques — have largely failed to solve the problems caused by Cormorant presence and predation at pond fish farms for periods longer than perhaps a few weeks. Whilst some other management techniques, such as various systems developed to protect the especially vulnerable first-and second-summer Carp and the provision of financial compensation for 'damage', are

**Netting over relatively small fishpond in the Hula Valley, Israel.**
Photo courtesy of Ian Russell.

promising, such approaches are necessarily very expensive, and certainly beyond the financial means of smaller fish farms.

However, in one Carp pond region, the Hula Valley in Israel, there has been a very effective programme of Cormorant management (see Carss & Marzano 2005, pp.180–187). This raises the very obvious question of whether this programme could be a candidate for technology transfer to other Carp pond farm regions in Europe. Here, drawing heavily on other **INTERCAFE** publications, we briefly summarise the Hula Valley situation before considering the practicalities of technology transfer (as well as of 'philosophy transfer') and also the implications for important Carp pond farming regions in Europe.

## 8.4.1 Co-ordinated Cormorant management at pond fish farms in the Hula Valley, Israel

The Hula Valley Cormorant management programme is highlighted in The **INTERCAFE** Cormorant Management Toolbox (Russell *et al*. 2012) as a case study of co-ordinated Cormorant management on a relatively large scale. This section briefly describes the Hula Valley programme in northern Israel, borrowing heavily from Russell *et al*. (2012).

In the Hula Valley about 8,000–9,000 Cormorants used to overwinter annually and the birds caused major conflicts at fish pond farms. Hundreds of Cormorants were shot every winter over a 7-year period but the intensity of the problem remained essentially unchanged. Furthermore, shooting was costly, largely ineffective and the resulting lead shot and bird carcases polluted the environment.

In response to this 'failure', a collaborative partnership involving biologists, fish farmers and NGOs developed a co-operative management scheme that operated between the winters of 2001–2 and 2004–5. Deterring Cormorants from fish ponds was organised in a co-ordinated manner and was informed by the best available science and up-to-date information on both the fish stocks and wintering Cormorant numbers at foraging sites. Scaring in the area commenced as soon as birds arrived (late October) and continued every morning when the first Cormorants started to feed at fish ponds. The scaring

**Shooting Cormorants at fishponds in the Hula Valley was expensive and damaging to the environment.**
Main photo — Shutterstock, inset courtesy of **INTERCAFE**.

team comprised three professional hunters (from early December-late February), with additional help from up to three fish farmers as necessary. Under the programmme, shooting to scare and the use of different types of fireworks and pyrotechnic devices, largely replaced lethal shooting. All ammunition and fireworks were bought collectively and monitored to reduce expenses (considered a major part of the conflict).

As a result of these management measures over three consecutive winters, the peak seasonal numbers of Cormorants feeding at the fish ponds declined from about 3,600 birds (December 2001) to around 200–300 (December 2004), while peak seasonal numbers roosting in the Hula Valley declined from 8,150 to 1,250, respectively. Cormorants moved to other foraging/roosting sites well away from the aquaculture production areas and losses of fish from the fish ponds declined markedly. Moreover, the operating costs (e.g. staff time, ammunition) for the fish farmers also declined by about 80%. Consequently, the conflict with the Cormorants was perceived as less of an issue each year.

Coupled with the availability of alternative foraging sites for Cormorants, the key to the success of the Hula Valley scheme was:-

- **Organisation** — co-ordinating interest/expert groups, manpower and resources. All actions were pre-arranged, co-ordinated and monitored over the whole region to avoid simply scaring the birds from one fish farm to another. Monitoring was carried out on a daily/weekly basis to ensure rapid feedback and effective targeting of activities.
- **Information** — decisions were based on knowledge of Cormorant physiology/

**Mobile gas cannon — auditory deterrent — in use at Israeli fishponds.**
Photo courtesy of Ian Russell.

ecology, actual bird numbers and movements, fish stock assessments, and damage assessments. Thus actions were focused at 'hotspots' — those fish ponds particularly attractive to Cormorants or very sensitive to damage — instead of over a wider area.

- **Timing** — actions started as soon as the Cormorants first appeared in the region and were carried out every morning from the moment birds first arrived at ponds.

Interestingly by late winter 2005, as a result of the perception that the Cormorant problem was relatively low (coupled with personnel changes amongst the area's fish farmers), co-operation between farmers and co-ordination of the management programme became less effective. Consequently, roosting and foraging Cormorant numbers increased in the following two winters. Crucially, this highlights the importance of continued vigilance and communication, and of ensuring that the use of deterrents is both sustained and co-ordinated.

### 8.4.2 Barriers and opportunities for transferring Hula Valley experiences

**INTERCAFE** participants met for a Case Study meeting in Israel's Hula Valley in January 2006 and full details of this meeting are reported in Marzano & Carss (2006). Part of the work at this meeting was to explore the wide range of issues discussed, looking specifically at (a) what worked well in the Hula Valley and might be worth considering elsewhere, (b) what did not work so well, (c) what barriers there might be for disseminating success in the Hula Valley to other places, and (d) additional general points of interest and several key issues that emerged from the Hula Valley Case Study that have wider relevance for policy and strategy. For a complete discussion of these issues, readers are urged to consult the original Case Study report (Marzano & Carss, 2006). In this section we focus on the technology and philosophy of the Hula Valley Cormorant management programme and the concept of transferring these experiences to other extensive pond fish farm areas using text only modifed slightly from Marzano & Carss (2006).

There was a relationship between scale and the goals of the Hula Valley programme when considering 'success'. Most people felt that the programme had been successful on several levels at the local scale. The first success was actually achieving effective co-operation between fish farmers and scientists. Indeed, some fishermen accepted the programme because they had had direct involvement in developing it. Also, getting agreement on the

**Netting suspended over fishpond in the Hula Valley, Israel.** Photo courtesy of Thomas Keller.

**Cranes *Grus grus* overwintering in the Hula Valley, Israel.**
Photo courtesy of Shutterstock.

same agenda within INPA (the Israel Nature and Parks Authority) and then INPA subsequently cooperating with fish farmers were also considered to be successes. There were acknowledged problems with transferring knowledge beyond the Hula Valley because stakeholders from adjacent regions were not involved in the same way that locals had been and this appeared to create an obstacle to the acceptance of such a management programme and its implementation elsewhere in Israel. However, it is impossible to see how those involved could have stretched their resources even further to lead and manage stakeholder engagement across such a broad area beyond the Hula Valley. So, one important reason for the apparent difficulties in transferring the Hula Valley programme elsewhere may simply have been down to a lack of resources. Crucially, it seems important to consider 'success' and 'lessons learned' in a spirit of collegial support, recognising that many people demonstrated great commitment and skill locally and perhaps showed some of the way forward for scaling-up from the Hula Valley to elsewhere.

### (i) What has worked well?

1. **Establishing and building trust, and agreeing common goals.** The Hula Valley case was solution-oriented, stakeholder-friendly and demonstrated a considerable amount of mutual trust.
2. **Building and maintaining effective communications, information exchange, coordination, monitoring and organisation among stakeholders.** Co-ordinated efforts were key to success. The programme was flexible, growing out of the local context where people were allowed to express their opinions openly, and participants have had a standing in local communities. Its management depended on local agreements which naturally varied from site to site, even if they shared common elements.
3. **Experience with scaring strategies.** The cost of the scaring effort was reduced progressively as people got better every year at doing the job of scaring (e.g. timing, location). Intensive scaring with good coordination between intensity (especially of fireworks), timing and location worked well at reducing Cormorant numbers in the Hula Valley. Properly managed scaring proved a success at the local scale as measured by pond owners as a practical option for addressing their problem.

**Wetland habitat in the Hula Valley, Israel.** Photo courtesy of Shutterstock.

### (ii) What has worked less well?

1. **Scaling up.** It is not easy in the Hula Valley, as with so many other areas of Cormorant-fisheries conflict, to generate lessons and learning that can actually be applied at different scales. Some think that while the programme may have solved the local problem in the Hula Valley it has just shifted it elsewhere and so the Hula Valley model is not a solution. Local collaboration has proved broadly successful, regional collaboration is developing and, overall, an international dimension is required.
2. **Adverse publicity.** There is an example of fishermen being embarrassed by a media article on the use of trash fish to feed Pelicans. Another example concerns a newspaper article that reported parasite transmission by birds which had a very bad outcome because the market was severely impaired and the report caused bad relationships among some stakeholders.

### (iii) Barriers and opportunities for disseminating Hula Valley 'success' elsewhere

1. Scaling-up to a larger area with diverse fishery and habitat types will not be easy given the need for effective communication and coordination of deterrents as used in the Hula Valley.
2. Unless the policy is to kill birds, they have to feed somewhere and cannot be endlessly relocated. Clearly, birds need access to 'alternative' feeding sites. It is probable that the birds will locate these sites themselves (athough their 'choice' of site probably can not be predicted in advance). The effectiveness of any programme will depend on geographic location and the availability of alternative foraging sites, which may not be options for all fish-growing sites.
3. Trying to regulate a migrating Cormorant population is very difficult. Reducing the size of the population that reaches a pond farming region in winter would require outside involvement, usually from other countries. There are also concerns that Cormorants currently spending the winter in pond farm regions will soon become established as breeding birds there.
4. Water policies and water availability are fundamental issues underpinning decisions on such things as fisheries and agriculture. Thus national water policies, as they are expressed regionally, can have diverse effects on fisheries management in the various fish-growing regions of concern here.

## 8.4.3 Implications for other Carp pond farming areas

As discussed here and also by Marzano & Carss (2012, chapter 12), rising Cormorant populations and the numbers of them roosting in high density fish-production sites are linked to 'excessive predation' and 'economic damage'. Moreover, efforts to scare birds away from pond farms contribute to increased time and monetary costs. This is undoubtedly true but as the Hula Valley programme clearly demonstrated, these costs can decline markedly through time as a co-ordinated Cormorant management (i.e. fisheries protection) programme becames established and increasingly efficient.

To date there has been no attempt to adopt some of the conclusions from the Hula Valley experience to Europe (or elsewhere in Israel). Indeed many currently believe that the solution in Hula Valley can not be transfered directly to Carp pond areas in European countries. Clearly the 'Hula solution' would need significant modifications to other areas. Many feel that the technology and philosophy from the Hula Valley could not be transferred from Israel to Europe because of the significant habitat and ecological differences between these places. In this respect, the most obvious differences appear to be the fact that the value of European farm ponds for nature ('biodiversity') protection is considerably higher than it seems to be in Israel and the perception that there are far fewer water bodies available as alternative feeding sites in Europe compared to the Hula Valley situation.

However, without investing in, and developing and testing, a relatively long-term, co-ordinated management programme based (however closely) on that from

**The nature ('biodiversity') protection value of Carp fishponds is thought to be considerably higher in many regions of Europe than it is in Israel.**
Photos courtesy of Shutterstock.

the Hula Valley, it is perhaps impossible to predict how Cormorants would respond to the need to find alternative foraging sites if part (or all) of any pond farming region was made unavailable to them. Clearly such a programme would also have to take into account the evident high biodiversity value of the farm ponds in the region.

Nevertheless, as discussed earlier in this chapter, the Hula Valley situation shows the big importance of close local cooperation and the use of ecological understanding of Cormorant behaviour. In the Hula Valley the problem of Cormorant predation at pond farms could actually be reduced for a period of at least several years. Such time-scales are far in excess of those achieved by many of the other techniques currently tried-out, and used, in European Carp pond farming regions (see Table 7.1).

Importantly, Israeli fish farmers are now increasingly looking to other countries in continental Europe for solutions to help address the problems caused by Cormorants visiting their country on migration. This is a highly relevant issue for Cormorant-fishery conflicts in European Carp pond fish farm areas too — where problems are caused in winter by birds that actually breed in other countries often thousands of kilometres distant.

**Cormorant breeding colonies are often the 'source' of birds that cause problems at fishponds that can be thousands of kilometres away.**
Photo courtesy of Stef van Rijn.

# 9 GENERAL SUMMARY AND CONCLUDING REMARKS

Here we summarise the key issues raised throughout this document: the issue of Cormorant-fishery conflicts at Carp ponds in Europe and Israel is a complex, long-term one. Moreover, there are numerous social, cultural, economic and ecological benefits of this traditional form of fish culture. Consequently it is necessary to consider the 'bigger picture' of Carp pond farming and this may also help in framing possible solutions to Cormorant (and other) issues facing this important fishery sector. Many of these issues are also described and discussed in Marzano and Carss (2012, chapter 12) and some of the (sometimes slightly modified) text from that publication is reproduced in this chapter and the 8 relevant paragraphs are indicated at the start by an asterisk *.

## 9.1 Carp ponds — unique water/landscapes and attractive habitats

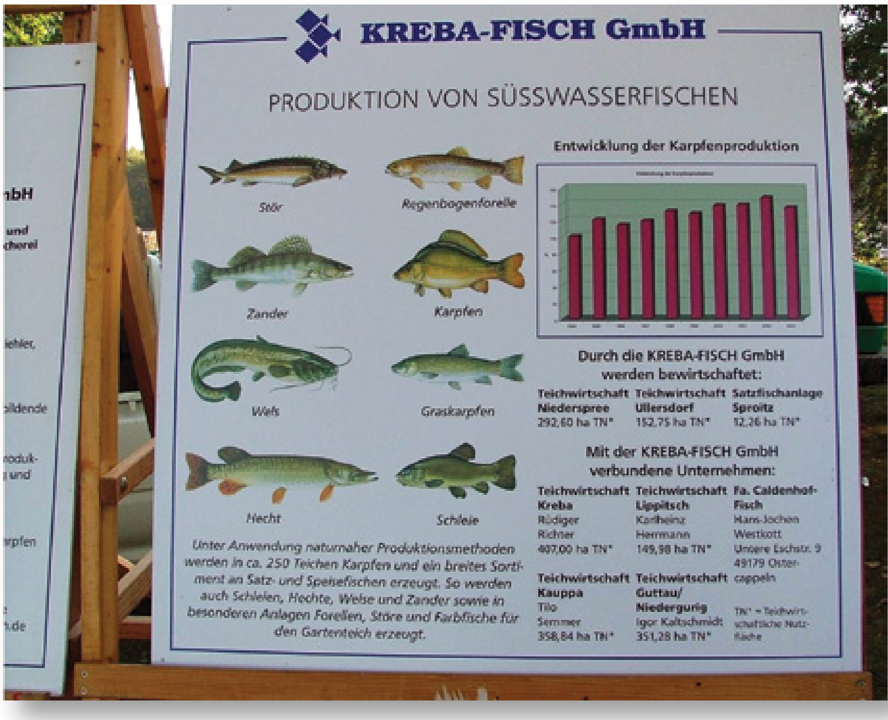
### Variability and representativeness of Case Study areas

The nine Carp pond Case Study areas (see detailed information in Appendix One) comprised a total of 3,320 km$^2$ and individual areas varied from over 70,000 ha (SAX, CZE) to 9,000 ha (ISR), 5,000 ha (POL-SZ) and 970 ha (HUN).

All areas comprised mosaics of different habitats, predominantly forest, crops, low quality agriculture and both natural and artificial meadows. Within these mosaics, the total surface area of fish ponds (totalling 339 km$^2$) varied by one or two orders of magnitude from 380 ha (ISR) and 810 ha (HUN) to 6,400 ha (POL-MIL) and 12,100 ha (FR-DOMBES). In all cases, Carp was by far the most dominant fish species in farm ponds and proportions of non-commercial fishes generally varied between <1% and 5%, except in the ISR Case Study area where this proportion reached 5–20%. Most pond farms (7/9 = 78%) were privately owned with only the two Polish cases being state-owned. Whilst the number of private owners per area varied from one (HUN) to over 100 (FR-DOMBES), overall the number of owners was usually between 10–20. Usually, some 20–50 people were employed at pond farms in each study area (not necessarily full-time in the French areas) but over 100 people were employed at the POL-MIL farm.

Whilst there was obviously considerable variation between study areas, this was clearly an advantage in the present work. As such, the nine Case Study areas described here are considered to be fairly representative of Carp pond farming activities across Europe and Israel.

**Common Carp — a highly regarded fish across much of Europe.**
Photo courtesy of Shutterstock.




**Carp fishponds often hold several other species of fishes.**
Photo courtesy of Tamir Strod.

## Habitat characteristics

Case Study area pond farms were generally 'low input' systems with some additional feeding (usually in the form of grain) ocurring in all areas (though rarely in the two French ones) and generally low levels of added fertiliser (see Appendix One). Such aquaculture is clearly 'sustainable' in the sense that most of the ponds in Case Study areas were established some 600–900 years ago, the remainder being 100 years old or less (HUN established in 1900, ISR in 1954, LAT in 1960). The proportion of natural shore around farm ponds generally varied between 50–80% being highest in CZE and FR-DOMBES, whilst natural shoreline was very low (<5%) around ponds in ISR. Similarly, 30% of ponds in the ISR Case Study area contained submerged vegetation but none had littoral vegetation, whilst those elsewhere tended to vary with 10–40% of ponds having submerged vegetation and a 10–40% coverage of littoral vegetation around ponds.

* Whilst initially, pond construction involved sometimes massive habitat modification, in most study cases centuries of naturalisation and management have turned these heavily modified areas into a mosaic of interconnected semi-natural wetlands. This new landscape has subsequently become both familiar to local people over generations and a regional symbol of their long history of fishing and water management and the unique skills associated with these activities that is easily recognisable and acknowledged by outsiders. This is also generally true for the 'younger' pond farm areas too. As is the fact that these unique wetland mosaics are generally visually highly attractive and aesthetically pleasing and so, coupled with tradition and history, the areas are highly regarded by tourists and visitors.

Most Carp pond farms were generally 'extensive', at least in terms of numbers of ponds, their average size, and their yields of fish. All areas except for HUN (30 ponds) and ISR (70–80 ponds)

**Carp fishponds are often surrounded, in part at least, by rich littoral vegetation.** Photo courtesy of Robert Gwiazda.

**Carp fishponds are often highly regarded by tourists and visitors as attractive wetlands.** Photo courtesy of Robert Gwiazda.

**Freshly harvested fishpond Carp.** Photo courtesy of Shutterstock.

contained at least 100 ponds with some having 300–400 and SAX and FR-DOMBES having 900 and 1,100 ponds, respectively. Median pond size varied between 5–38 ha, being largest in HUN (25 ha) and POL-MIL (38 ha) and fish yield was generally between 400–600 kg/ha, though up to 700 kg/ha in the HUN Case Study area. Fish yield was however considerably higher in both LAT and especially ISR (360–1,000 kg/ha–5,000–20,000 kg/ha, respectively). Again (with the exception of ISR), the variation described above for **INTERCAFE's** Carp pond farm Case Study areas was considered to be representative of Carp pond farming in general across Europe.

### Why are Cormorants here?

Few breeding Cormorants are present in the nine Case Study areas (see Appendix One) and breeding was only recorded in FR-FOREZ (1 pair), FR-DOMBES (14 pairs), POL-MIL (100 pairs) and LAT (150 pairs). Similarly, the number of non-breeding birds present either during the breeding or non-breeding seasons was relativley small with only a few tens of birds recorded in most areas except CZE (210 birds), POL-MIL (300 birds) and SAX (500 birds). Thus, most Cormorants were recorded in Case Study areas in the non-breeding season during the winter and the autumn and spring migration periods (Table 9.1).

Generally, Cormorant numbers in Case Study areas were relatively low during the winter, except in relatively southern areas (ISR, HUN) and western ones (SAX, the two FR areas). Overall, mean Cormorant numbers during the autumn migration were higher than those during the spring migration (Table 9.1). Mean autumn numbers were highest (1,100–2,500 birds) in FR-DOMBES, SAX, FR-FOREZ and POL-MIL and mean spring numbers were highest (600–900 birds) in the two French Case Study areas.

Clearly, Cormorants find Carp pond farms to be attractive sites to visit. This is presumably a consequence of the relatively large numbers of closely-spaced ponds in such areas, the high surface area of water they offer, and their relative lack of submerged and littoral vegetation offering little cover to fishes. Similarly, all farm ponds are shallow with a mean depth of some 1.2–2.0 m (average for all areas is approximately 1.5 m) and so the energetic constraints encountered by the birds when diving in farm ponds are fairly minimal.

* The central Cormorant issues in most European pond farming regions are thus associated with a trend towards stable/increasing numbers of migrating or over-wintering birds outside the breeding season. There is a general feeling that these birds are 'outsiders' and this often leads to both the

**There are relatively few Cormorant breeding colonies in most Carp fishpond regions.** Photo courtesy of Petr Musil.

problem (too many birds) and the desired solution (a reduction in their numbers) being considered an international, European issue. In most regions there is also an associated trend towards birds remaining in an area throughout the year and often starting to establish breeding colonies. In some places there is thus also an increasing number of 'home-grown' Cormorants to deal with and problems are no longer confined to outside the breeding season but are occuring increasingly throughout the year. Similarly, Cormorants no longer appear in small numbers in reasonably predictable times and places but are often present in relatively large numbers throughout a region, or even a country (in the case of France).

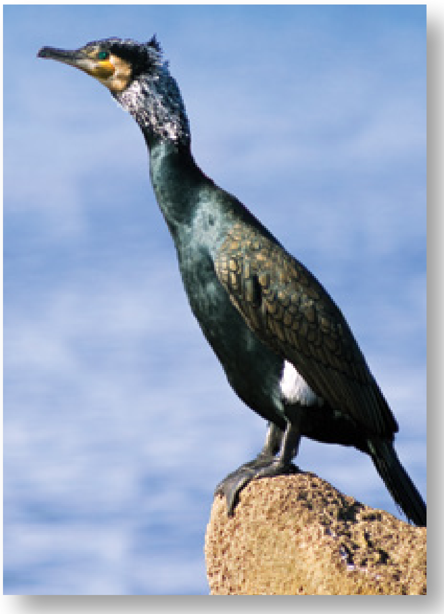
## 9.2 Cormorants — presence, predation and management

### What cormorants do — eat fish, damage others

Clearly, relatively large numbers of Cormorants are attracted to congregate at Carp pond farm areas,

**Table 9.1** The mean numbers of Cormorants reported during the non-breeding season (autumn, winter, spring) at INTERCAFE's Carp fish pond Case Study areas. Notes: *this number reached about 400 in the winter of 2007, **these figures are for the period of active Cormorant management in the area (2003–2006), the corresponding number prior to 2003 was 5,350 birds.

| Case Study Area | Mean Number of Cormorants per Day During Seasonal Counts | | |
|---|---|---|---|
| | Autumn Migration | Winter | Spring Migration |
| (1) LAT | 100 | 0 | 100 |
| (2) POL — MIL | 1,100 | 0 | 400 |
| (3) POL — SZ | 300 | 0 | 100 |
| (4) HUN | 120–150 | 180 (50–300) | 80–100 |
| (5) CZE | 700 | 0 | 260 |
| (6) GER-SAX | 2,300 | 20–30 normally* | 300–400 |
| (7) FR-DOMBES | 2,500 | 2,750 | 900 |
| (8) FR-FOREZ | 1,500 | 1,600 | 600 |
| (9) ISR | 400 | 850** | 100 |



**Great Cormorant.**
Photo courtesy of Shutterstock.

at some times of year at least. In all areas (except ISR), the trend in Cormorant numbers (2004–2008) was considered either stable or increasing, with the birds' 'use' of ponds estimated (for all areas except ISR) at a mean of some 150,800 'bird days' (range = 43,190–282,008 bird days). Whilst there is no comparable information about Cormorant use of other waters besides Carp pond farms, nor about the extent to which birds may move between the two, the potential for Cormorants to consume large numbers of commercially-valuable fish is high at pond farms. Whilst Carp are the most 'important' fish in these circumstances, several other species inhabit farm ponds too and only a very small proportion of them (usually no more that 5%, see Appendix One) are classified as having no commercial value to farmers.

*At Carp ponds the main Cormorant-related problem is the consumption of young (1–2 year-old) Carp and an associated decline in fish yields at harvest. Associated, indirect, problems are related to increased stress levels in fish due to the presence of Cormorants and the increased mortality of others that are damaged by unsuccessful Cormorant attacks.

In some cases there are other indirect economic consequences of Cormorant predation. For instance in France, the delaying of the re-stocking of angling waters (until the main period of Cormorant presence is over) results in farmers having to keep fish stock longer than they would normally do with associated husbandry costs and increased fish-diesease risks. As such, Cormorant presence and predation at the levels currently experienced are thought of as causing severe and direct financial losses to pond fish farming. In addition, valuable time and resources are often spent on scaring and/or shooting Cormorants and trying to manage them locally. This is all being played out against the background whereby excessive, selective Cormorant predation on juvenile Carp — the foundation of the whole fishery — is considered to be severely threatening the industry at the European scale. For example the Czech Republic looks to other European countries now apparently no longer able to supply a reliable source of young Carp as a result of Cormorant predation. Persecution and disturbance from fishermen often prevent colonisation and so Cormorants tend not to breed in many pond farm areas.

## What people do — management activities, 'compensation' and scaling-up

As discussed in chapter 8, in relation to Carp ponds, the effectiveness of different techniques and their cost (obviously an issue of vital concern but one which is seldom quantified — publically at least) are ultimately dependent on the size of the ponds, accessibility to their whole perimeter, the number of ponds and their distribution within larger geographic areas.

**Cormorant damage to fishpond Carp.**
Photo courtesy of Robert Gwiazda.

None of the static management — deterring — techniques (see Table 8.1) were found to be effective over a long time period at Case Study pond farms. However, combining several such techniques and changing their locations frequently did improve matters although this strategy was considerably more labour-intensive than using a single technique in the same position and its effects were not 'permanent'. Carp are most vulnerable to Cormorant predation during their first two years of life but the careful rearing and protection of very young (small) fish is costly when compared to natural breeding in larger ponds as it requires the juvenile fish to be artificially reared and fed. Some farmers in France

**Wires positioned over a German fishpond in an attempt to prevent Cormorants foraging there.** Photo courtesy of Thomas Keller.

**Gas cannon used to scare Cormorants from fishponds.** Photo courtesy of Thomas Keller.

delay the introduction of one-year old Carp to large ponds in the spring after the departure of overwintering Cormorants. However, this delay both reduces growing time for the fish and also increases the cost of production. The best method for reducing Cormorant predation at small ponds is to span them with some form of net or wires but such passive protection outside and above the water is considered to be too expensive for large ponds.

Costs also increase with increasing pond area because additional infrastructure is necessary to keep the nets or wires in place. Clearly, given the size and number, of ponds involved in many fish farm areas (see above), such a technique is particularly limited. Protecting fish from Cormorant predation requires the development of novel techniques. For instance, two tests of Cormorant-proof small stock fish production have been tried in Saxony: a 'warm water fish breeding system' (operated by the Kreba-Fisch GmbH company) and a 'pond-in-pond system' (a research project by the Fishery Authorities in the municipality of Königswartha).

**INTERCAFE** found that there were financial compensation schemes for the damage caused by Cormorants to fisheries operating in several countries, including the Czech Republic, Saxony, and Latvia. Each system used different definitions of what instances were eligible for compensation and each used different methods to calculate the value of actual payments.

However, there is no financial help for the damage to fisheries caused by Cormorants across most of Europe despite — in some sitations and regardless of how it is calculated — such compensation being considered very helpful to Carp pond farmers.

There is no doubting that the commonly used methods (and ways they are used) are not efficient enough to reduce Cormorant problems at Carp pond farms. Only in the Hula Valley in Israel have Cormorant problems at fish ponds been reduced greatly for relatively long periods of time (several years in this case) and the associated management costs similarly declined.

## 9.3 A highly-valued 'ecosystem' under threat

Carp pond farms and the wetland habitats they provide clearly have great 'value'. This value is both social and cultural, encapsulates landscape and biodiversity, as well as being economic. The high value

**Many Carp fishponds are considered very important for biodiversity conservation.** Photo courtesy of Shutterstock.

**Carp pond fishermen harvesting their stock, Saxony.**
Photo courtesy of Kareen Seiche.

of Carp pond farming should thus not be underestimated. Whilst this form of fish culture is perhaps not economically viable at the 'global' scale, it is extremely important for local livelihoods and sometimes also at the regional level. Even where pond fish farming is a relatively young practice, it can be an important element of a diversified suite of local income generation.

* Many traditional fish farming countries in mainland Europe report that pond aquaculture is considered to be very important, both in cultural and in biodiversity conservation contexts. The fact that all nine **INTERCAFE** Carp pond Case Study areas are Natura 2000 sites (at least in part), as well as being designated under other national and international conservation legislation is clear testimony to the latter. Most of the fish ponds in Germany, Poland, France and the Czech Republic were constructed between the 12th and 15th centuries and they are considered a vital part of the cultural heritage there, having been an essential part of the landscape and a source of livelihood, regional identity and pride for some 600–900 years. Many local communities in these fish pond regions take great pride in them and voice a strong sense of stewardship towards them. These wetlands are the product of many generations of careful management and, as custodians of the ponds, fish farmers feel that they have a strong responsibility to continue this long tradition.

* Whilst essentially man-made landscapes, very many pond areas have existed for so long, and are managed in such a way, that they have become semi-natural habitats. As such, they are often considered to be hotspots of aquatic biodiversity, supporting populations and communities of aquatic and riparian plants, reptiles, amphibians, fishes, birds and mammals that rely on them for their existence. In relation to biodiversity and ecological issues,

**Carp pond fishermen are regarded by many as local custodians with a long tradition of skillful wetland management.**
Photo courtesy of **INTERCAFE**.

such wetland mosaics also provide crucial ecosystem services to the local area in the form of such things as a variety of recreational and aesthetic pursuits, flood prevention, water storage and maintainance of the water table. Pond fish farming practices can also recover and recycle agricultural wastes and use relatively low-quality resources in the production of animal protein. Carp pond fish farm systems are considered to play a useful role in integrating agricultural production, recycling wastes and by-products, and contribute to biodiversity maintenance and conservation at a landscape level.

**Fresh Carp for the table.** Photo courtesy of Shutterstock.

**Some pond farmers and owners can supplement their income through waterfowl hunting.** Photo courtesy of Shutterstock.

* The maintainance of Carp fish pond landscapes clearly requires dedicated, skilled management without which, the ponds would fall into disrepair, many would become silted and disappear and the habitats be lost forever. The disappearance of these pond landscapes would also quickly lead to the disappearence of these distinct and unique oases of wetland biodiversity. Whilst in most regions or countries, pond farming is the main source of livelihood for some hundreds of fishermen (though some tens of thousands of private owners rely to some extent on pond fish production in France), these numbers are relatively small in comparison with other jobs, businesses and livelihood strategies. Although locally very important, pond farming is probably a minority occupation when viewed at a broader scale. Nevertheless, local fishermen are often given considerable authority as a popular professional group maintaining a long tradition. However, this duty of stewardship appears threatened, not only by the presence of Cormorants but by the failing economics of fish — primarily Carp — production and a related trend away from Carp as a prime culinary species to others that are now more available and cheaper than before. In some areas there are also demographical problems as young people move away from pond farm regions to more prosperous towns and cities. Associated with this is the increasing problem of finding younger people to learn the skills and continue the jobs associated with pond farming.

*Given this suite of pressures, although there is potential for diversification into tourism or even eco-tourism businesses of some sort, pond farmers feel threatened. Indeed there seemed little evidence (see Appendix One) that pond farmers in Case Study areas currently derived much (if any) income from activities other than fish production, this providing 90–100% of income in most cases. Ecotourism accounted for less that 5% of income in SAX but none elsewhere and waterfowl hunting provided 5% of the income to farmers in LAT and an unknown amount to farmers in the two French areas. Here, although the level of financial income from waterfowling was unknown, this activity was deemed important for maintaining the ponds in their current condition. Consequently, here and in the other study areas, we recorded the view that if ponds are not maintained for fish production there is a grave risk that they will be converted into more profitable agricultural land. This would have all the likely associated losses in biodiversity and ecosystem services. A traditional way of life may be lost — perhaps within a generation and once lost, the situation may well be irreversible.

## 9.4 Towards large-scale collaborative and adaptive management

Overall, we detected a strong feeling that traditional Carp pond farming activities were vulnerable to a number of related threats. This vulnerability is related to the traditional, and unique, character of Carp farming and its obvious ecological, social and cultural 'benefits'. There is a strong feeling that pond farms constitute a unique landscape, albeit one that is generally undervalued (by those outside the industry at least) and also that this landscape could soon be lost without urgent action. Realistically, Carp pond farming is certainly not threatened solely by Cormorant presence or predation, but this is a serious additional burden to farmers. The Cormorant problem can also be seen as an issue which unites the industry and, because it is a threat, causes us to seriously consider the much wider value of Carp pond farming.

* While fish farmers do not want to abandon this traditional form of livelihood, there are increasingly some economic opportunities to be made from nature-based tourism here. Although not common, Marzano & Carss (2012) detected an increasing trend within the pond farm industry to diversify somewhat. This was not in the means of fish production but in terms of seeking financial opportunities through proactively attracting tourists to pond farm regions. Here, visitors can see for themselves the traditional skills of fish famers but also appreciate the aesthetic qualities of these wetlands and the biodiversity they support.

Indeed, along similar lines, there seems an urgent need to enter a much wider public debate to acknowledge the multiple values of Carp pond landscapes and their maintenance. Intimately related to this is a similar public debate on how to protect such valuable heritage over a wide swathe of continental Europe. Clearly, it would be helpful if these debates were political ones too.

**Migrating birds in the Hula Valley, Israel.**
Photo courtesy of Shutterstock.

The Hula Valley programme in Israel demonstrated that both predation and management costs can decline markedly through time as a co-ordinated Cormorant management (i.e. fisheries protection) programme (using an array of commonly-used methods) becames established and increasingly efficient. It is interesting to note that there has been no attempt to date to adopt some of the conclusions from this experience to Europe (or elsewhere in Israel). Indeed many currently believe that the solution in Hula Valley can not

resources such as people, time, and ultimately money, in order to facilitate and enhance more large-scale, coordinated (and adaptive) management activities. Associated with this, further scientific understanding of the predator-prey relationships between Cormorants and fish in Carp ponds would be extremely valuable. This would be so, not only in terms of understanding how the birds and fish interact, but also in documenting more precisely the nature and scale of Cormorant predation at ponds. Similarly, it may be necessary to more realistically explore ecomonic issues to best balance the cost-effectiveness of any measures taken. In addition, closer collaboration between those in regions favoured by overwintering Cormorants and those in the countries where these birds breed could be insightful. Perhaps the desire for people in the latter countries to reduce overall Cormorant numbers in

be transfered directly to Carp pond areas in European countries. Clearly this solution might need significant modifications for other areas but perhaps some larger-scale, coordinated management programme — adopting the Hula valley philosophy of 'organisation, information, and timing', incorporating financial assistance where necessary, and involving dialogue with some of the countries 'exporting' Cormorants during the winter could be considered seriously.

Of course, this would require the specific provision (perhaps independently from fish farmers themselves) of additional

**Most Cormorants visiting Carp fishpond areas are winter visitors or passing-through on their autumn and spring migrations.** Photo courtesy of Petr Musil.

**Sustainable Carp pond farming, as here at Nagli fishponds in Latvia, could be a very useful tool to manage landscapes, biodiversity conservation, and the maintenance of ecosystem services.** Photo - unknown source.

order to reduce the problems for those fishery interests in the former regions in unrealistic but clear dialogue and a mutual understanding of the issues would surely be welcome.

Another important issue to consider is that, certainly in most Carp pond areas, there are many important strands to the position that fish farmers find themselves in, including increased production costs and falling demand. When losses through Cormorant predation are added to this precarious background, the plight of Carp pond farming — with its intimately linked and highly valued, biodiversity conservation and social-cultural relationships at local, regional and national scales — is starkly framed and threatened. Overall, there seems an urgent need to stem this decline — and indeed, to enhance — the profitablility of Carp pond farming regions. It would be timely for both the conservation/ecological and agricultural/fisheries strands of government ministries to work more closely together over adopting such strategies, and developing others (perhaps including further targetted financial aid and support). Ultimately, it should be possible to use sustainable Carp pond farming as a tool to manage landscapes, biodiversity conservation, and the maintenance of some ecosystem services. This might be through the focused delivery of evidence-based programmes to support local (generally rural) economies and skills, traditional Carp pond farm regimes and all their associated social, cultural and ecological/ ecosystem benefits.

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# 11 APPENDIX ONE: FULL DETAILS OF INTERCAFE'S CARP POND FARM CASE STUDY AREAS

**(1) LATVIA** The total area of fish ponds in Latvia is approximately 4,000 ha. Some of the fish ponds (30%) were constructed in the 19th Century but the majority were built during the middle of the 20th Century. All of the Latvian pond farms are situated in low-quality agricultural land but as wetlands they make a major contribution to the current landscape management and to the nature conservation objectives that are strongly associated with it. As a consequence, almost all of the fish pond locations (90%) and their surroundings are designated as nature protection areas of different national and European status (e.g. Natura 2000).

| Case Study area | Lubana Wetland Complex | | |
|---|---|---|---|
| Status of Protection | Natura 2000 (80%) | | |
| Mean latitude | 56.4 | Mean altitude | 93 m |
| Mean longitude | 26.5 | Total area | 48,000 ha |

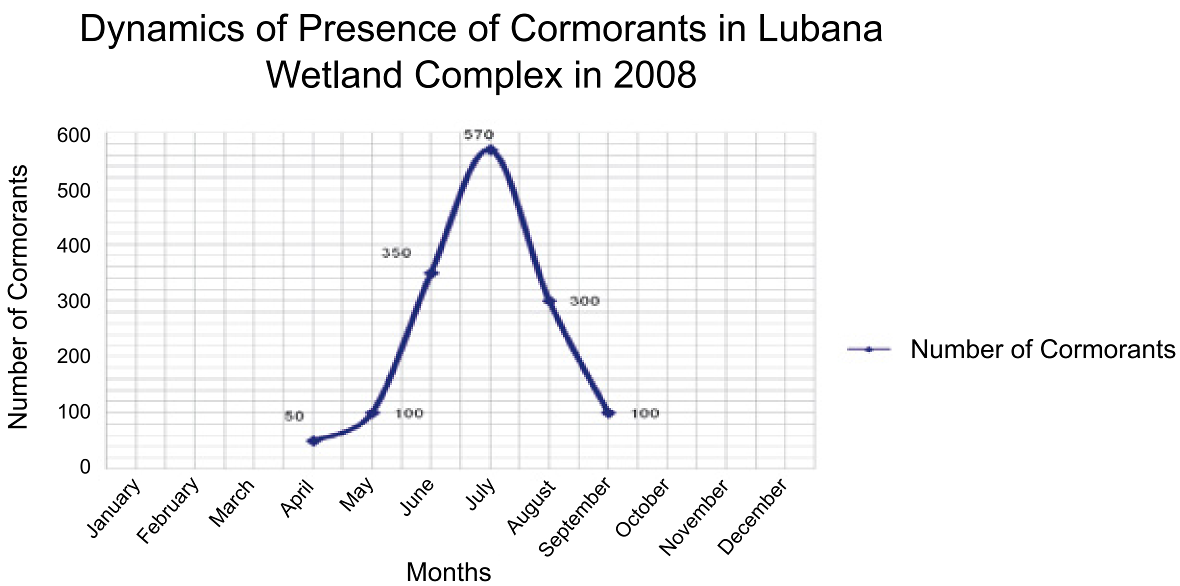
The Lubana Wetland Complex in the Madona, Rezekne, Balvi and Gulbene administrative regions is a nature reserve and the largest wetland in Latvia, with a shallow freshwater lake, seven raised and transitional bogs and fens, inundated grasslands, fish ponds and wet forests. In total this unique area contains 15 protected habitats of European importance. The site is important for maintaining bog-specific and rare bird species and characteristic wetland plant species and communities. More than 26,000 waterfowl birds rest in the area during the spring migration, especially large flocks of Bewick's Swan, Whooper Swan and Pintail, and the site supports some particularly protected bird species like White-tailed Eagle, Spotted Eagle, Great Snipe, Corncrake and protected mammals such as Beaver, European Otter, Wolf, Brown Bear and Lynx. Maintenance of fish production (fish pond farming) is a very important activity for the maintenance of the area at favourable conservation status at the landscape level and creates favourable conditions for the existence of many species of fauna and flora.

**(2) LATVIA**

| Case Study area | Lubana Wetland Complex | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | Since 1960 |
| | Median size of ponds | 17 ha |
| | Number of ponds | 158 |
| | Total surface area of ponds | 2,700 ha |
| | Natural shore line | 20% |
| | Mean water depth | 1.5 m |
| | Mean water transparency in July | 0.2–0.5 m |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 10% |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 20% |
| | Concentration of Nitrogen | 0.04–1.6 mg/l |
| | Concentration of Phosphorous | 0.09–0.14 mg/l |
| | Ice cover in normal winter | Dec–March |
| Pond management data | Main fish species | Carp (90%), Pike (8%),<br>Tench (2%) |
| | Cycle of production | 3 years |
| | Yield | 360–1,000 kg/ha |
| | Total production per year | 8,100 tonnes |
| | Percentage on non-commercial fish | <2% |
| | Seperated age classes of Carp | K1, K2, K3 |
| | Additional feeding | Grain |
| | Fertilisation | Yes |
| Fishery company data | Number of employees | 54 |
| | Owner(s) | Private |
| | Number of owners | Up to 10 |
| | Proportion of income from fish production | 95% |
| | Proportion of income from ecotourism | 0 |
| | Proportion of income from waterfowl hunting | 5% |
| | Price per kg Carp | K1 = 4.00 euro/kg<br>K2 = 2.50 euro/kg<br>K3 (wholesale, 70-80%) =<br>1.70–2.10 euro/kg<br>K3 (direct marketing (15–20%)<br>= 2.70–3.00 euro/kg |
| | Price development in the last 5–10 years | Increase by 50% |

### (1) LATVIA

| Case Study area | Lubana Wetland Complex | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 150 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 50 |
| | Mean no. of migrating birds — spring | 100 |
| | Mean no. of migrating birds — autumn | 100 |
| | Mean number of wintering birds | 0 |
| | Cormorant days (Cormorant numbers x no. of days) | 46,000 |
| | Trend in numbers, 2004–2008 | Slight increase |
| | Seasonal peak in numbers (month) | Jun–Aug/Sept |
| | Seasonal peak in numbers (numbers) | 670[1] |
| | Number of roosting sites inside area | 5[1] |
| | Roosting Cormorants (maximum number) inside area | 150[1] |
| | Roosting Cormorants (month of max number) inside area | Jun/Aug |
| | Number of roosting sites outside area (within 40 km) | Big increase |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 2,000[1] |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | Oct/Nov |
| | Origin of birds (from ringing recoveries) | LAT, EST, RUS |

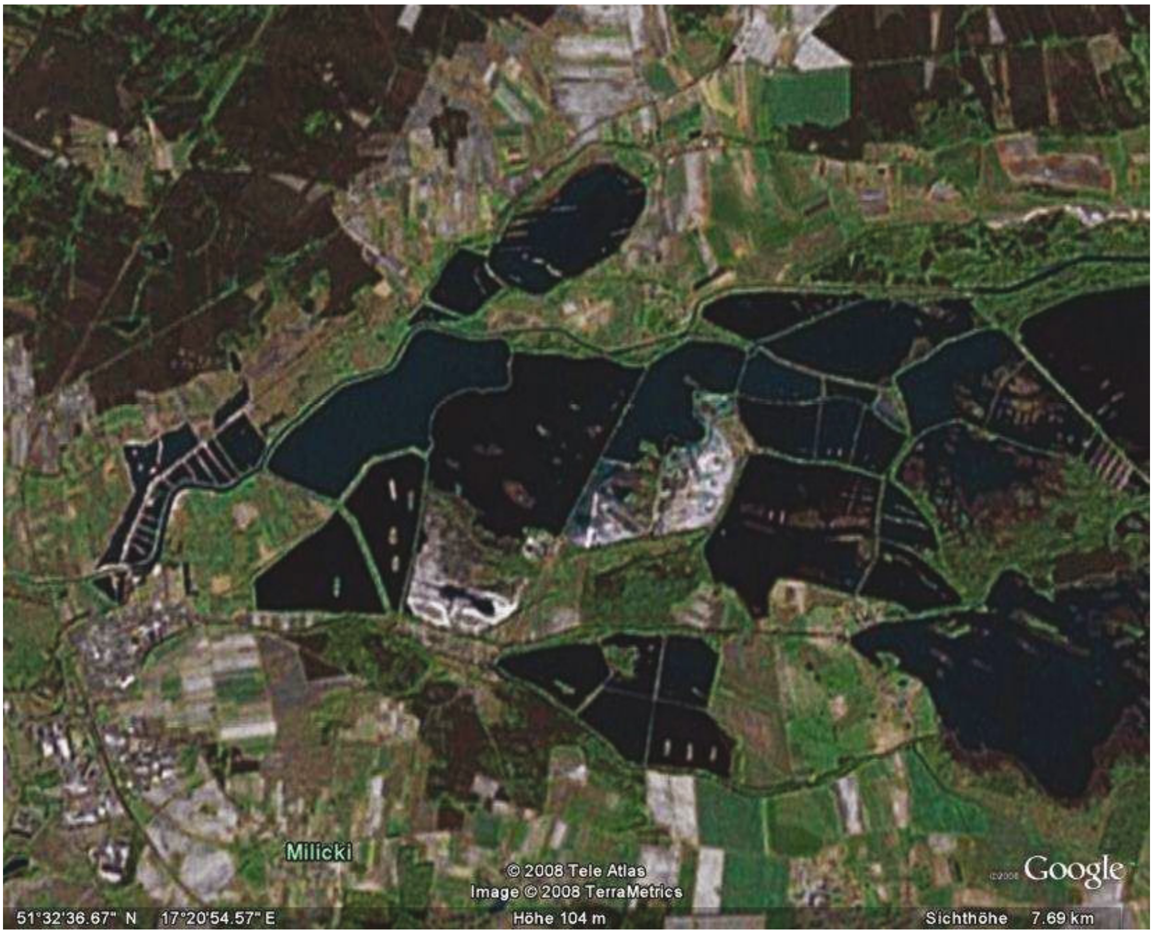



[1] Janis Baumanis 'Cormorants *Phalacrocorax carbo* Protection Plan in Relation to The Damage It Causes to Fish Pond Farming 1999 [Latvian reference: JūraskraukĜa *Phalacrocorax carbo* aizsardzības plāns sakarā ar tā nodarītajiem zaudējumiem dīe·saimniecībā' 1999].

**(2) POLAND** There are approximately 750 fish ponds in Poland with a total surface area of 47,900 ha in the 2000s. The distribution of Polish fish ponds is uneven, most of them are located in the south of the country. Fish ponds in Poland were established in the Middle Ages and more than 40,000 ha (80%) belong to the state, the rest belonging to private owners.

| Case Study area | Milicz complex | | |
|---|---|---|---|
| Status of Protection | Natura 2000 (98% of ponds) | | |
| Mean latitude | 51.3 | Mean altitude | 102 m |
| Mean longitude | 17.2 | Total area | 40,000 ha |

The fish ponds of the Milicz complex are situated in south-west Poland in the Barycz valley and the Barycz river is no more than 0.1–0.9 km away from them. The Milicz complex itself covers some 6,400 ha and includes over 130 ponds.These ponds are mainly surrounded by forests (38%), fields and meadows. About 70% of the Milicz fish pond complex is a designated Natural Reserve and almost all ponds lie within a designated Natura 2000 area. In total, 276 bird species (including 166 breeding ones) have been recorded in the Milicz complex. Fish ponds play a very important role as a sanctuary for endangered bird species in Poland. The most interesting and rare species occurring on fish ponds are: Bittern, Little Bittern, Black Stork, Great Egret, Bewick Swan, Greylag Goose, Ferruginous Duck, Marsh Harrier, Black Kite, Red Kite, White-tailed Eagle, Crane, Little and Spotted Crake, Whiskered Tern, Black Tern.

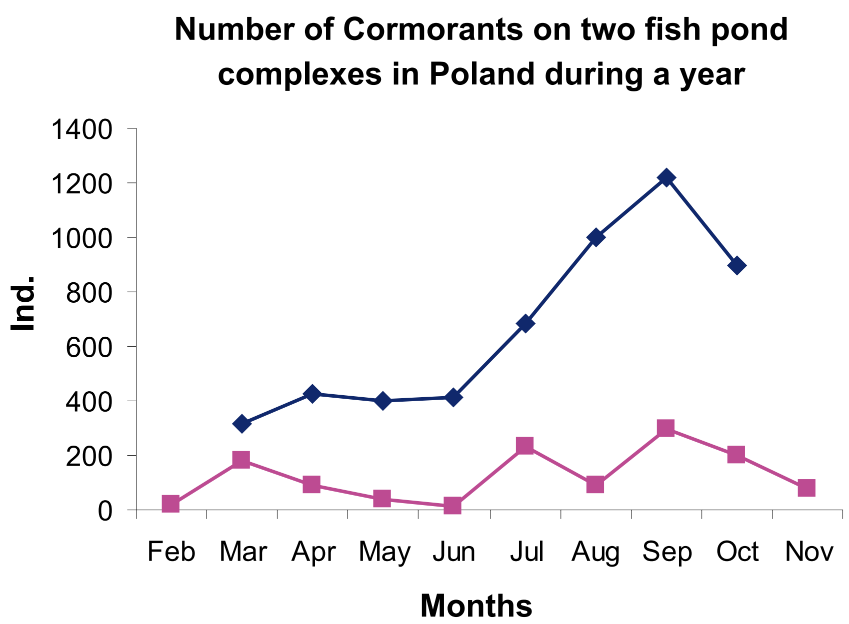


### (2) POLAND

| Case Study area | Milicz complex | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | Since the 12th Century |
| | Median size of ponds | 38 ha |
| | Number of ponds | 130 |
| | Total surface area of ponds | 6,400 ha |
| | Natural shore line | 50% |
| | Mean water depth | 1.5–2.0 m |
| | Mean water transparency in July | 0.3 m |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 10% of ponds |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 20–25% |
| | Concentration of Nitrogen | <0.5 ml/l |
| | Concentration of Phosphorous | <1.00 mg/l (usually 0.25 mg/l) |
| | Ice cover in normal winter | Dec–Feb |
| Pond management data | Main fish species | Carp (90%), Grass and Silver Carp, Goldfish, Bighead Carp *Hypophthalmichthys nobilis,* Tench, Pike, Pikeperch, Catfish |
| | Cycle of production | 3 years |
| | Yield | 500 kg/ha |
| | Total production per year | 1,500–2,000 tonnes |
| | Percentage on non-commercial fish | 1% |
| | Seperated age classes of Carp | K1, K2, K3 |
| | Additional feeding | Grain |
| | Fertilisation | Low |
| Fishery company data | Number of employees | >100 |
| | Owner(s) | State |
| | Number of owners | 1 |
| | Proportion of income from fish production | 100% |
| | Proportion of income from ecotourism | 0 |
| | Proportion of income from waterfowl hunting | 0 |
| | Price per kg Carp | K1 = 3.0–3.5 euro/kg<br>K2 = 2.5–3.0 euro/kg<br>K3 = 2.0 euro/kg |
| | Price development in the last 5–10 years | Stable |

**(1) POLAND**

| Case Study area | Milicz complex | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 100 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 300 |
| | Mean no. of migrating birds — spring | 400 |
| | Mean no. of migrating birds — autumn | 1,100 |
| | Mean number of wintering birds | 0 |
| | Cormorant days (Cormorant numbers x no. of days) | 152,300 |
| | Trend in numbers, 2004–2008 | Stable |
| | Seasonal peak in numbers (month) | Sept/Oct |
| | Seasonal peak in numbers (numbers) | 2,000 |
| | Number of roosting sites inside area | 2 |
| | Roosting Cormorants (maximum number) inside area | 1,500 |
| | Roosting Cormorants (month of max number) inside area | Sept |
| | Number of roosting sites outside area (within 40 km) | 0 |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 0 |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | Unknown |
| | Origin of birds (from ringing recoveries) | POL (mainly), GER, CZE, HUN, RUS, EST, FIN, SWE, CRO |



**(3) POLAND**

| Case Study area | Zator complex | | |
|---|---|---|---|
| Status of Protection | Natura 2000 (all of the ponds) | | |
| Mean latitude | 49.8 | Mean altitude | 240 m |
| Mean longitude | 19.2 | Total area | 5,000 ha |

The ponds of the Zator complex are situated in southern Poland. They are surrounded by fields and meadows. The Zator complex in the upper Vistula valley covers 1,525 ha (with over 100 ponds). The ponds belong to the designated Natura 2000 area. In total, 211 bird species (including 123 breeding bird species) have been recorded in the Zator complex. Here the fish ponds are both breeding and feeding places for many rare and endangered bird species in Poland: Bittern, Little Bittern, Night Heron, Greylag Goose, Ferruginous Duck, Marsh Harrier, Little and Spotted Crake, Mediterranean Gull, Common Tern, Whiskered Tern, Black Tern, In this area, the preservation of its value for nature protection is closely connected with the maintenance of fish production.

**(3) POLAND**

| Case Study area | Spytkowice and Zator | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | Since the 13th Century |
| | Median size of ponds | 14 ha |
| | Number of ponds | 109 |
| | Total surface area of ponds | 1,525 ha |
| | Natural shore line | 50% |
| | Mean water depth | 1.5 m |
| | Mean water transparency in July | 0.3m |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 30–40% of ponds |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 10% |
| | Concentration of Nitrogen | <0.5 ml/l |
| | Concentration of Phosphorous | <1.0 ml/l (usually 0.25 mg/l) |
| | Ice cover in normal winter | Dec–Mar |
| Pond management data | Main fish species | Carp (95%), Grass and Silver Carp, Goldfish, Bighead Carp *Hypophthalmichthys nobilis,* Tench, Pike, Catfish, Sturgeon |
| | Cycle of production | 3 years |
| | Yield | 600 kg/ha |
| | Total production per year | 500 tonnes |
| | Percentage on non-commercial fish | 1% |
| | Seperated age classes of Carp | K1, K2, K3 |
| | Additional feeding | Grain |
| | Fertilisation | Low |
| Fishery company data | Number of employees | 40 |
| | Owner(s) | State |
| | Number of owners | 1 |
| | Proportion of income from fish production | 100% |
| | Proportion of income from ecotourism | 0 |
| | Proportion of income from waterfowl hunting | 0 |
| | Price per kg Carp | K1 = 3.0–3.5 euro/kg<br>K2 = 2.5–3.0 euro/kg<br>K3 = 2.0 euro/kg |
| | Price development in the last 5–10 years | Stable |

**(3) POLAND**

| Case Study area | Spytkowice and Zator | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 0 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 30 |
| | Mean no. of migrating birds — spring | 100 |
| | Mean no. of migrating birds — autumn | 300 |
| | Mean number of wintering birds | 0 |
| | Cormorant days (Cormorant numbers x no. of days) | 43,190 |
| | Trend in numbers, 2004–2008 | Stable |
| | Seasonal peak in numbers (month) | Mar, Oct |
| | Seasonal peak in numbers (numbers) | 500 |
| | Number of roosting sites inside area | 0 |
| | Roosting Cormorants (maximum number) inside area | 0 |
| | Roosting Cormorants (month of max number) inside area | n/a |
| | Number of roosting sites outside area (within 40 km) | 1 |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 520 |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | Oct–Nov |
| | Origin of birds (from ringing recoveries) | POL, EST, FIN |

**(4) HUNGARY** Hungary is one of the traditional Carp producing countries of the eastern-central European region, along with others such as the Czech Republic, Poland, and Germany. The total area of fish ponds here is approximately 23,000 ha, with an annual production of around 19,000 tonnes. These pond fish farms are located all over the country, mostly in areas of high natural value which are therefore protected by national and international legislation.

| Case Study area | Rétimajor | | |
|---|---|---|---|
| Status of Protection | Natura 2000 (all ponds) | | |
| Mean latitude | 46.52 | Mean altitude | 97 m |
| Mean longitude | 18.32 | Total area | 970 ha |

The Rétimajor fish pond system is located in the central-western part of Hungary, approximately 100 km southwest of Budapest. The ponds were constructed in the Valley of Sárrét, a shallow marshland converted into agricultural use at the end of the 19th Century. Since the 1970's, the fish pond system, now long-established here, and the surrounding areas have been recognized as a National Park area, a Ramsar site, and are also designated as a Natura 2000 site. The fish farm system has been privately owned since 1993, and extensive fish production continues. The relationship with the environmental protection authorities has been very good and fish production is thought not to conflict with the nature protection.

**(4) HUNGARY**

| Case Study area | Rétimajor | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | Since 1900 |
| | Median size of ponds | 25 ha |
| | Number of ponds | 30 |
| | Total surface area of ponds | 810 ha |
| | Natural shore line | 10% |
| | Mean water depth | 1.5m |
| | Mean water transparency in July | 0.2–0.4 m |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 10% of ponds |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 20% |
| | Concentration of Nitrogen | No data |
| | Concentration of Phosphorous | No data |
| | Ice cover in normal winter | Dec–Feb |
| Pond management data | Main fish species | Carp, Silver Carp, Bighead Carp *Hypophthalmichthys nobilis*, Pike, Pikeperch, Catfish |
| | Cycle of production | 3 years |
| | Yield | 700 kg/ha |
| | Total production per year | 500 tonnes |
| | Percentage on non-commercial fish | <1% |
| | Seperated age classes of Carp | K1, K2, K3 |
| | Additional feeding | Yes |
| | Fertilisation | Yes |
| Fishery company data | Number of employees | 24 (3/100 ha) |
| | Owner(s) | Private |
| | Number of owners | 1 |
| | Proportion of income from fish production | 70% |
| | Proportion of income from ecotourism, angling tourism, waterfowl hunting. | 30% |
| | Price per kg Carp | Wholesale = 1.80–3.00 euro/kg |
| | Price development in the last 5–10 years | More or less stable |

**(4) HUNGARY**

| Case Study area | Rétimajor | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 0 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 30–40 |
| | Mean no. of migrating birds — spring | 80–100 |
| | Mean no. of migrating birds — autumn | 120–150 |
| | Mean number of wintering birds | 180 (50–300) |
| | Cormorant days (Cormorant numbers x no. of days) | 144,000 |
| | Trend in numbers, 2004–2008 | Big increase |
| | Seasonal peak in numbers (month) | Oct–Nov |
| | Seasonal peak in numbers (numbers) | 150–250 |
| | Number of roosting sites inside area | 3–5 |
| | Roosting Cormorants (maximum number) inside area | 80–100 |
| | Roosting Cormorants (month of max number) inside area | Oct–Nov |
| | Number of roosting sites outside area (within 40 km) | 5–6 |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 400–500 |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | Oct–Nov |
| | Origin of birds (from ringing recoveries) | DK, POL, EST |

**(5) CZECH REPUBLIC** In the Czech Republic the total water surface area of the fish ponds reaches 52,000 ha. Třeboň Basin represents one of the most important fish pond regions, with more than 2,000 ponds (total fishpond area about 7,500 ha). Here, the first fish ponds were established in the Roman period, whilst the first artificial reservoirs were built in Central Europe in the 3rd Century (by Celts). The construction of fish ponds started in Bohemia in the 10th Century and the main fish pond systems in Bohemia come from the 16th Century when the total fish pond area reached about 180,000 ha. The destruction of fish ponds took place in 17th Century after the Thirty Years War and in 19th Century (through conversion to sugar beet culture). The average fish production was 40 kg/ha in 16th Century compared with a fish production level of 423 kg/ha in 1995.

| Case Study area | Jindřichův Hradec | | |
|---|---|---|---|
| Status of Protection | Partly Natura 2000 (6% of fish ponds) | | |
| Mean latitude | 49.1 | Mean altitude | 500 m |
| Mean longitude | 15.0 | Total area | 70,500 ha |

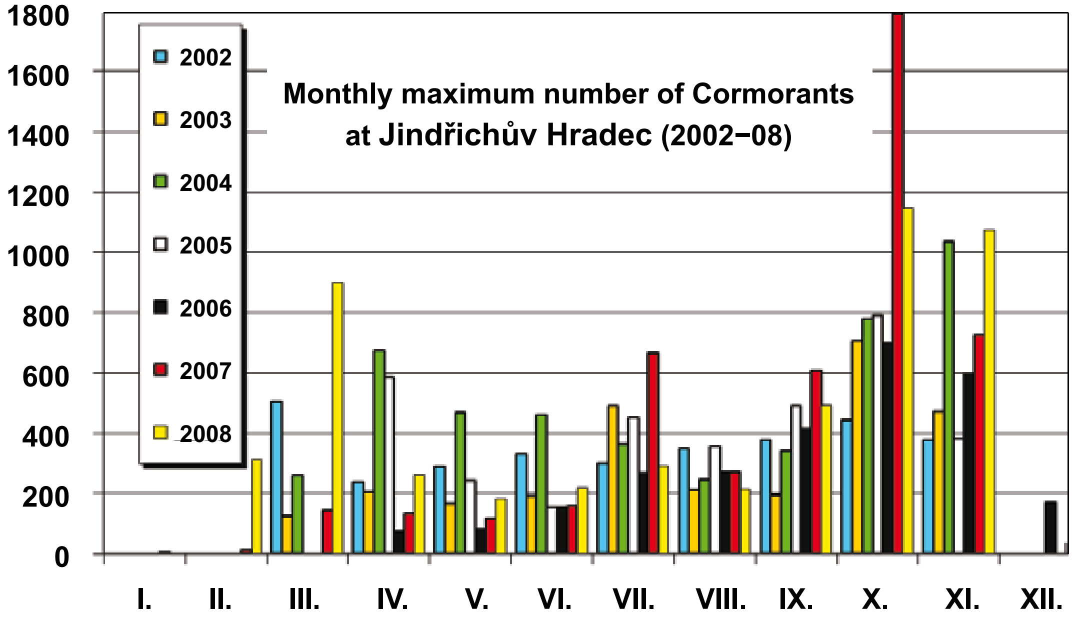
The fish pond region in Jindřichův Hradec is located on the northern edge of the Třeboňsko Biosphere Reserve. Fish ponds have been created here since the 12th Century and mostly in the 16th Century when they replaced the original wetlands. The surrounding landscape is a mixture of forests (45%), fields (30%), meadows (10%) and urban settlements (10%). In total, 140 breeding bird species and more than 200 migratory species have been recorded in the area. Target species for Natura 2000 include Greylag Goose, Gadwall, White-tailed Eagle, and Common Tern. The intensity of fish production in Czech fishponds (mostly Carp) has increased in the area during the last decades. More recently, the important grazing effect of Carp has been recognised as a factor affecting benthic and plankton communities, the extent of littoral vegetation, and consequently, water transparency and chemistry. As a result, there is an overgrowth of phytoplankton, water turbidity increases, and the light cannot penetrate to the deeper water layers of fish ponds where anaerobiosis (metabolic processes in the absence of molecular oxygen) may occur. This process also negatively affects many waterbird species, especially those which are in food competiton with Carp.

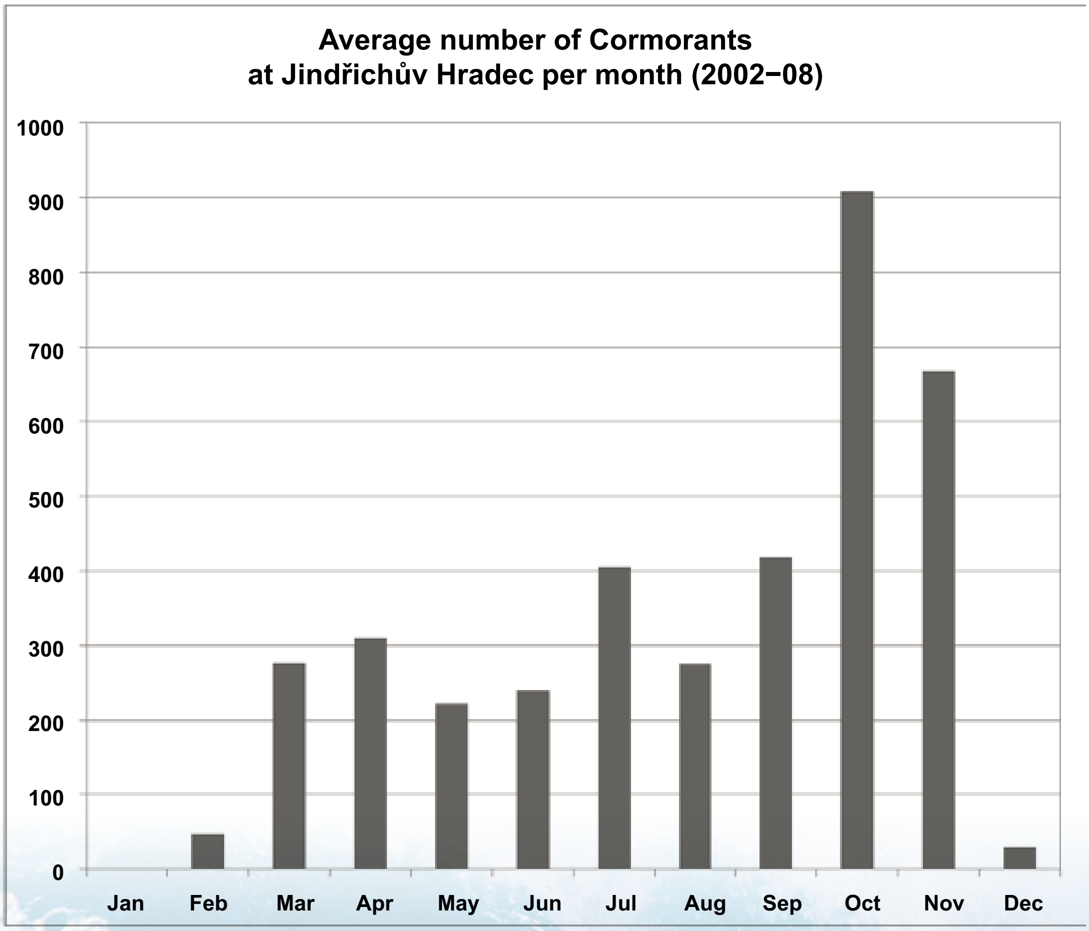
### (5) CZECH REPUBLIC

| Case Study area | Jindřichův Hradec | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | Since the 12th Century |
| | Median size of ponds | 6–7 ha |
| | Number of ponds | Approximately 447 |
| | Total surface area of ponds | 2,992 ha |
| | Natural shore line | 80% |
| | Mean water depth | 1.5m |
| | Mean water transparency in July | 35cm |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 1–10% of ponds |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 15% |
| | Concentration of Nitrogen | 2.0–3.0 ml/l |
| | Concentration of Phosphorous | 0.24 ml/l |
| | Ice cover in normal winter | Dec–Mar |
| Pond management data | Main fish species | Carp (93%), Grass Carp (3%), Tench (1%), Pike, Pikeperch, Roach, Catfish |
| | Cycle of production | 3 years |
| | Yield | 500 kg/ha |
| | Total production per year | 13,000 tonnes |
| | Percentage on non-commercial fish | <1% |
| | Seperated age classes of Carp | K1, K2, K3 |
| | Additional feeding | Grain |
| | Fertilisation | Yes |
| Fishery company data | Number of employees | 50 |
| | Owner(s) | Private |
| | Number of owners | 10 |
| | Proportion of income from fish production | 100% |
| | Proportion of income from ecotourism | 0 |
| | Proportion of income from waterfowl hunting | 0 |
| | Price per kg Carp | K1 = 5.0 euro/kg<br>K2 = 2.0-3.0 euro/kg<br>K3 = 2.0-3.0 euro/kg |
| | Price development in the last 5-10 years | Stable in local currency (CZK), increase in euros |

### (5) CZECH REPUBLIC

| Case Study area | Jindřichův Hradec | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 0 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 210 |
| | Mean no. of migrating birds — spring | 260 |
| | Mean no. of migrating birds — autumn | 700 |
| | Mean number of wintering birds | 0 |
| | Cormorant days (Cormorant numbers x no. of days) | 109,356 |
| | Trend in numbers, 2004–2008 | Stable |
| | Seasonal peak in numbers (month) | Mar, Oct/Nov |
| | Seasonal peak in numbers (numbers) | 1,000 |
| | Number of roosting sites inside area | 1 |
| | Roosting Cormorants (maximum number) inside area | 600 |
| | Roosting Cormorants (month of max number) inside area | Oct/Nov |
| | Number of roosting sites outside area (within 40 km) | 2 |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 1,000 |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | Oct/Nov |
| | Origin of birds (from ringing recoveries) | CZE, POL, FIN, SWE, EST, RUS |


Monthly maximum number of Cormorants
at Jindřichův Hradec (2002–08)
2002
2003
2004
2005
2006
2007
2008
1800
1600
1400
1200
1000
800
600
400
200
0
I.
II.
III.
IV.
V.
VI.
VII.
VIII.
IX.
X.
XI.
XII.


Average number of Cormorants
at Jindřichův Hradec per month (2002–08)
1000
900
800
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

**(6) GERMANY** In Germany there are some very old, traditional Carp pond landscapes in different parts of the country. The biggest are suituated in the Federal States of Bavaria (20,000 ha water surface area of Carp ponds), Saxony (8,382 ha), and Brandenberg (4,330 ha). There are considerable differences between these pond areas, depending on their recent management history and on the management of the ponds themselves. One of the most valued pond landscapes for nature protection is the Upper Lusation Heath and Pond Landscape in Saxony.

| Case Study area | Upper Lusation Heath and Pond Landscape | | |
|---|---|---|---|
| Status of Protection | Partly Natura 2000 (FHH, SPA), Biosphere Reserve | | |
| Mean latitude | 51 | Mean altitude | 145 m |
| Mean longitude | 14 | Total area | 75,000 ha |

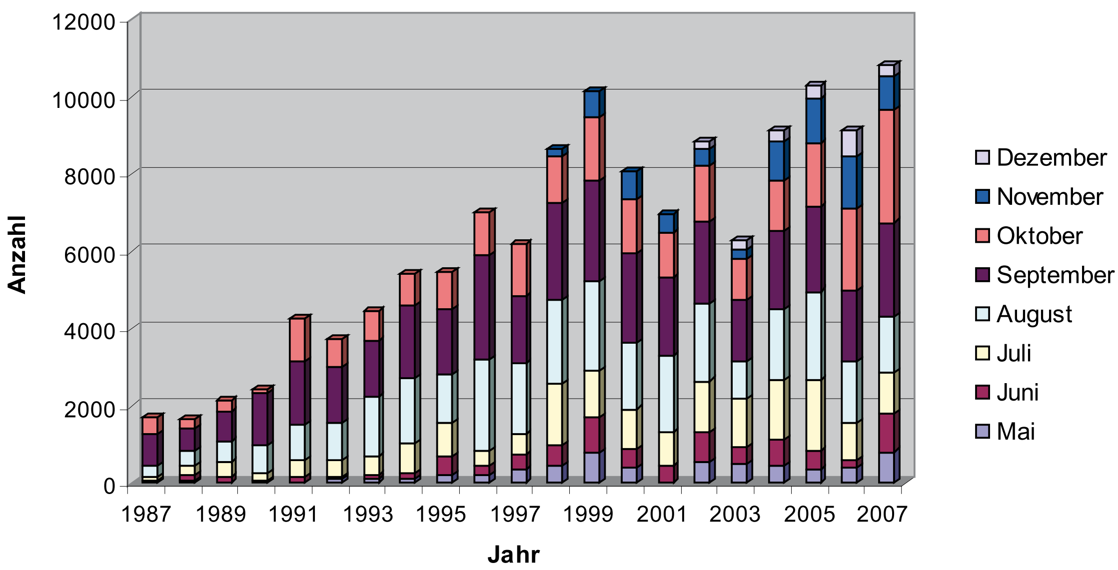
The Upper Lusation Heath and Pond Landscape region belongs to the most precious cultural landscapes in Germany. As well as its protection being the protection of cultural heritage, it is also very important for the protection of nature. The surrounding landscape is a mixture of forest (50%), crop fields (25%) and old, opencast coal mine workings. There is a long list of endangered species recorded in Upper Lusatia and 145 breeding bird species and over 200 migratory ones are reported for the region. Target species for Natura 2000 are for example: Greylag Goose, Common Kingfisher, White Stork, Great Egret, Marsh Harrier, White-tailed Eagle, Bittern, Little Bittern, Black Kite, Crane, Little and Spotted Crake. The maintenance of the region's value for nature protection is considered to be closely connected to the maintenance of fish production there.

**(6) GERMANY**

| Case Study area | Upper Lusation Heath and Pond Landscape | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | Since the 15th Century |
| | Median size of ponds | 6–7 ha |
| | Number of ponds | Approximately 900 |
| | Total surface area of ponds | 5,500 ha |
| | Natural shore line | 50% |
| | Mean water depth | 0.5–1.5m |
| | Mean water transparency in July | Maximum 35cm |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 5–10% of ponds |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 10% |
| | Concentration of Nitrogen | 0.3–4.0 ml/l |
| | Concentration of Phosphorous | 0.01–0.06 ml/l |
| | Ice cover in normal winter | Dec–Feb/Mar |
| Pond management data | Main fish species | Carp (80%), Tench (5%), Grass and Silver Carp (4%), Pike, Pikeperch, Catfish, Sturgeon |
| | Cycle of production | 3 years |
| | Yield | 500–600 kg/ha |
| | Total production per year | 2,000 tonnes |
| | Percentage on non-commercial fish | 1–5% (in K3 Carp ponds) |
| | Seperated age classes of Carp | K1, K2, K3 (only in a very few cases are they mixed) |
| | Additional feeding | Grain |
| | Fertilisation | Low |
| Fishery company data | Number of employees | 30 |
| | Owner(s) | Private |
| | Number of owners | 20 |
| | Proportion of income from fish production | Approximately 90% |
| | Proportion of income from ecotourism | No importance (less than 5%) |
| | Proportion of income from waterfowl hunting | No importance |
| | Price per kg Carp | K1 = 4.00 euro/kg<br>K2 = 2.50 euro/kg<br>K3 (wholesale, 70-80%) = 1.70–2.10 euro/kg<br>K3 (direct marketing, 15–20%) = 2.70–3.00 euro/kg |
| | Price development in the last 5–10 years | Wholesale market — increasing |

## (6) GERMANY

| Case Study area | Upper Lusation Heath and Pond Landscape | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 0 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 500 |
| | Mean no. of migrating birds — spring | 300–400 |
| | Mean no. of migrating birds — autumn | 2,300 |
| | Mean number of wintering birds | 20–30 normally (in 2007: approximately 400) |
| | Cormorant days (Cormorant numbers x no. of days) | 250,000 |
| | Trend in numbers, 2004–2008 | Stable/+ |
| | Seasonal peak in numbers (month) | Sept/Oct |
| | Seasonal peak in numbers (numbers) | 1,500–2,000 |
| | Number of roosting sites inside area | 4–5 |
| | Roosting Cormorants (maximum number) inside area | 1,500–2,000 |
| | Roosting Cormorants (month of max number) inside area | Sept/Oct |
| | Number of roosting sites outside area (within 40 km) | 1 |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 500–600 |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | October |
| | Origin of birds (from ringing recoveries) | DK (mainly), PL, SWE, NL, CZE, GER, HUN, CRO |



**(7) FRANCE** In France, 112,000 hectares of ponds are used for extensive fish farming. Fish ponds are an important part of the landscape in several French regions: Dombes, Forez, Sologne, Brenne, and Lorraine are the main fish pond areas. Many Carp ponds here are old and traditional. The annual production of Carp in France is 12,000 tonnes. The main market (75%) is fish for stocking. Private owners are very numerous (50,000) and 80 companies manage the fish market which includes 10 small factories. Most of these regions are Natura 2000 areas.

| Case Study area | Forez | | |
|---|---|---|---|
| Status of Protection | Natura 2000 in progress | | |
| Mean latitude | 46.3 | Mean altitude | 347 m |
| Mean longitude | 5.3 | Total area | 32,840 ha |

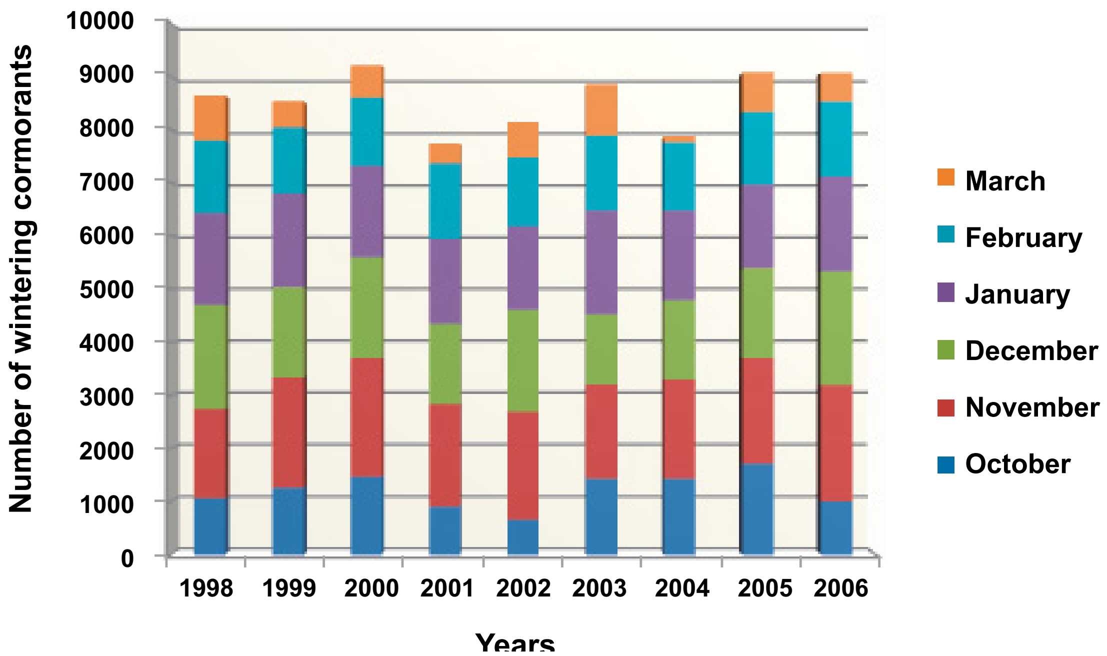
The Forez plain is in the upper part of the river Loire (river on left side of satellite picture). The mean size of the 300 fish ponds here is 4–5 ha and none of them are drained completely during any part of the fish cultivation cycle, as they are in Dombes for example. The surrounding landscape is a mixture of meadows (45%), crop fields (35%), forests and the Loire valley itself. Cormorant night roosts are found in the forests along River Loire. The Forez plain is a significant region for nature conservation. It is in the list of important zones for bird protection (ZICO RA 09), particularly for waterbirds: Night Heron, Hen Harrier, Squacco Heron, Whiskered Tern and Purple Heron. Eight species of Herons among the 9 species in France are found in the Forez region. The breeding colony of Black-headed Gull (7,000 pairs) here is the largest in west Europe.

**(7) FRANCE**

| Case Study area | Forez | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | Since the 15th Century |
| | Median size of ponds | 5 ha |
| | Number of ponds | Approximately 300 |
| | Total surface area of ponds | 1,500 ha |
| | Natural shore line | 50% |
| | Mean water depth | 1.1 m |
| | Mean water transparency in July | Low |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 15% of ponds |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 20% |
| | Concentration of Nitrogen | <2.0 ml/l |
| | Concentration of Phosphorous | <0.2 ml/l |
| | Ice cover in normal winter | Rarely–in Jan-Feb (for about two weeks) |
| Pond management data | Main fish species | Carp, Tench, Pike, Perch, Roach |
| | Cycle of production | 3 years |
| | Yield | 400 kg/ha |
| | Total production per year | 500 tonnes |
| | Percentage on non-commercial fish | 1% |
| | Seperated age classes of Carp | K1, K2, K3 |
| | Additional feeding | Rarely |
| | Fertilisation | Low |
| Fishery company data | Number of employees | 20, but not full-time |
| | Owner(s) | Private |
| | Number of owners | >20 |
| | Proportion of income from fish production | Unknown |
| | Proportion of income from ecotourism | 0 |
| | Proportion of income from waterfowl hunting | Unknown but considered to be important for maintaining the ponds |
| | Price per kg Carp | K1 = 3.5–4.5 euro/kg<br>K2 = 2.5–3.0 euro/kg<br>K3 (wholesale, 80% and increasing) = 2.0–2.5 euro/kg |
| | Price development in the last 5–10 years | Increased for fish sold for stocking, stable for fish sold for human consumption |

**(7) FRANCE**

| Case Study area | Forez | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 1 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 10 |
| | Mean no. of migrating birds — spring | 600 |
| | Mean no. of migrating birds — autumn | 1,500 |
| | Mean number of wintering birds | 1,600 |
| | Cormorant days (Cormorant numbers x no. of days) | 282,008 |
| | Trend in numbers, 2004–2008 | Stable |
| | Seasonal peak in numbers (month) | Nov/Mar |
| | Seasonal peak in numbers (numbers) | 2,000 |
| | Number of roosting sites inside area | 1 |
| | Roosting Cormorants (maximum number) inside area | 1,600 |
| | Roosting Cormorants (month of max number) inside area | Nov |
| | Number of roosting sites outside area (within 40 km) | 4 very close |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 800 |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | Dec/Jan |
| | Origin of birds (from ringing recoveries) | GB, NL, DK, SWE, GER |



**(8) FRANCE**

| Case Study area | Dombes | | |
|---|---|---|---|
| Status of Protection | Natura 2000 in progress | | |
| Mean latitude | 45.3 | Mean altitude | 236 m |
| Mean longitude | 6.3 | Total area | 47,660 ha |

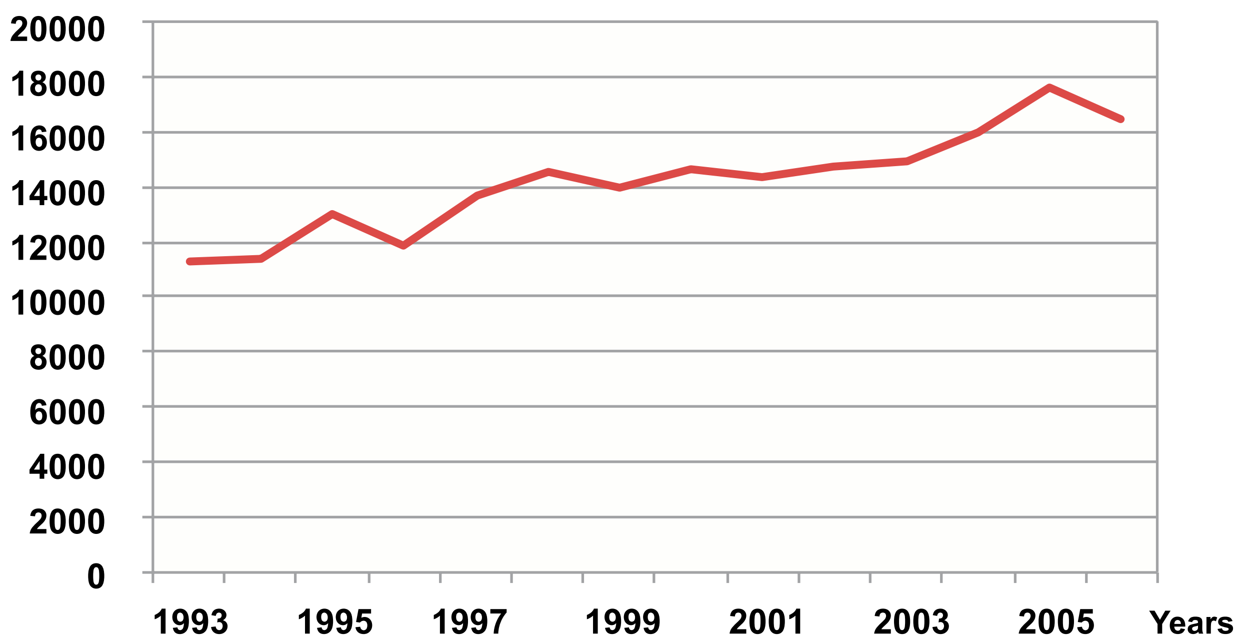
The Dombes region lies on a plateau between the Ain, Rhône, and Saône Rivers, northeast of Lyon. With 1,100 fish ponds and an area of 12,100 ha, Dombes is one of the most important zones for habitat diversity in France. The region is not only important for bird species (see Forez), but also for some dragonfly species, amphibians, and plants. The surrounding landscape is a mixture of about 43% fields, 15% artificial meadows, and only about 15% forests, often near the shore of ponds. A particularity of the management of ponds in the Dombes region is that they are allowed to dry-up every 3–4 years. This drying-up is easy because the source of water in the ponds is rainwater (as opposed to streams or rivers). The drained pond is then used for crop cultivation for a period. In Dombes, the risk in the future is thus the possibility of easy conversion of these very flat waterbodies into fields of corn.

**(8) FRANCE**

| Case Study area | Dombes | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | Since the 15th Century |
| | Median size of ponds | 11 ha |
| | Number of ponds | Approximately 1,100 |
| | Total surface area of ponds | 12,100 ha |
| | Natural shore line | 75% |
| | Mean water depth | 1.2m |
| | Mean water transparency in July | Low |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 30% of ponds |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 40% |
| | Concentration of Nitrogen | <2.0 ml/l |
| | Concentration of Phosphorous | <0.2 ml/l |
| | Ice cover in normal winter | Rarely (Jan-Feb) |
| Pond management data | Main fish species | Carp, Tench, Pike, Perch, Roach |
| | Cycle of production | 3 years |
| | Yield | About 400 kg/ha |
| | Total production per year | 1,800 tonnes |
| | Percentage on non-commercial fish | 1% |
| | Seperated age classes of Carp | K1, K2, K3 |
| | Additional feeding | Rarely |
| | Fertilisation | Low |
| Fishery company data | Number of employees | 50, but not full-time |
| | Owner(s) | Private |
| | Number of owners | >100 |
| | Proportion of income from fish production | Unknown |
| | Proportion of income from ecotourism | 0 |
| | Proportion of income from waterfowl hunting | Unknown, but important for maintaining ponds |
| | Price per kg Carp | K1 = 3.5–4.5 euro/kg<br>K2 = 2.5–3.0 euro/kg<br>K3 (wholesale, 80%) = 2.0–2.5 euro/kg |
| | Price development in the last 5–10 years | Increased for fish sold for stocking, stable for fish sold for human consumption |

**(8) FRANCE**

| Case Study area | Dombes | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 14 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 10 |
| | Mean no. of migrating birds — spring | 900 |
| | Mean no. of migrating birds — autumn | 2,500 |
| | Mean number of wintering birds | 2,750 |
| | Cormorant days (Cormorant numbers x no. of days) | 180,000 |
| | Trend in numbers, 2004-2008 | Stable |
| | Seasonal peak in numbers (month) | Nov/Feb |
| | Seasonal peak in numbers (numbers) | 5,000 |
| | Number of roosting sites inside area | 1 |
| | Roosting Cormorants (maximum number) inside area | 150 |
| | Roosting Cormorants (month of max number) inside area | Nov–Feb |
| | Number of roosting sites outside area (within 40 km) | 6 |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 1,800 |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | Dec/Jan |
| | Origin of birds (from ringing recoveries) | GB, NL, DK, SWE, GER |

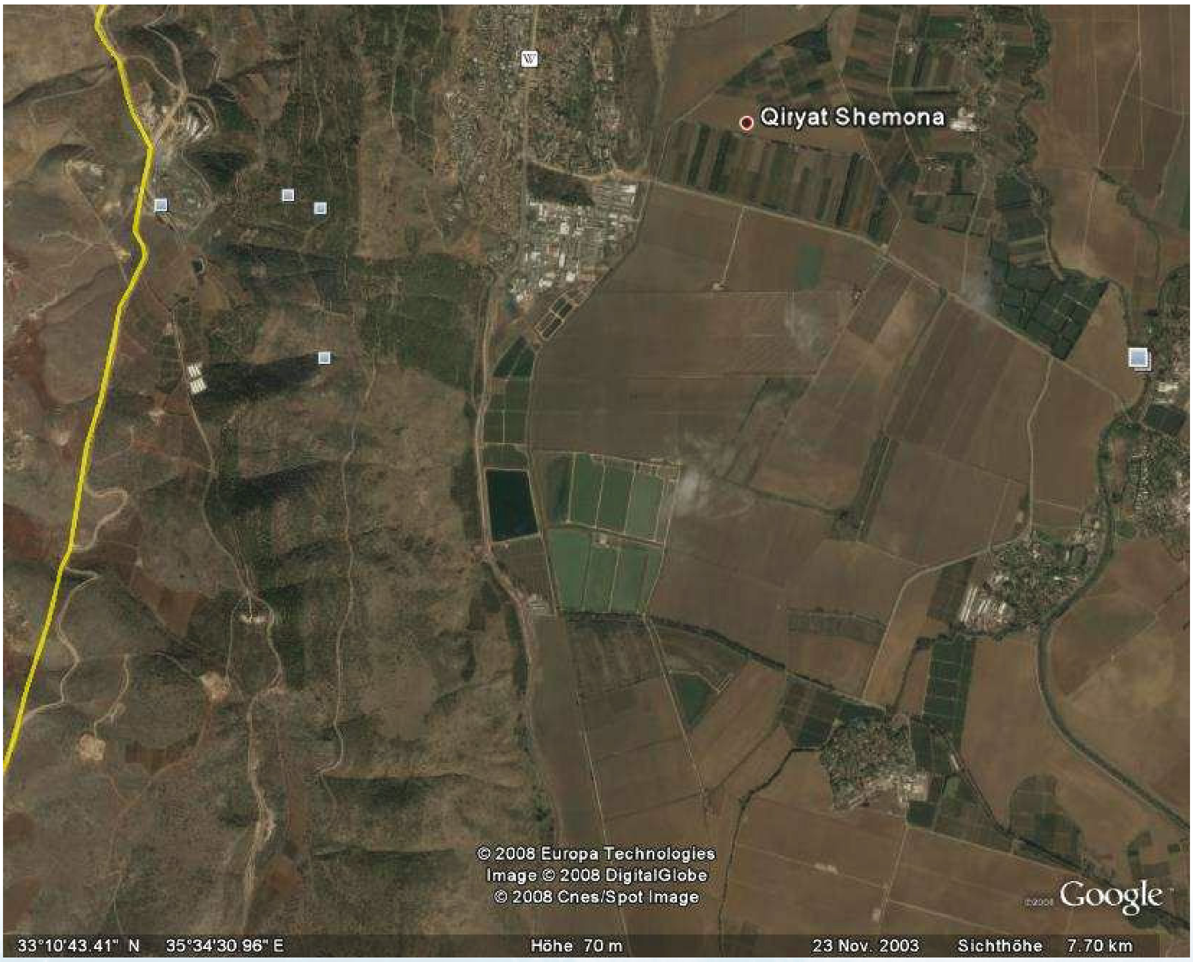



**Numbers of wintering cormorants in the whole Rhône Catchment in France (data ONCFS)**

**(9) ISRAEL** There are four regions in Israel with fish ponds, two along the coast and two in the eastern valleys. The fish ponds in Israel are highly intensive, yielding about ten times more fish than fish ponds in Europe, due to both a warmer climate and the use of advanced production systems. In the Hula Valley, the main fish produced is Carp, especially during the winter. Great Cormorants in Israel are over-wintering visitors and their numbers (per 10 ha) are 10–50 times greater than at other Carp pond farms in Europe. A special project markedly succeeded to mitigate the Cormorant-fisheries conflict here during 2002–2006 through a combination of non-lethal techniques.

| Case Study area | Hula Valley | | |
|---|---|---|---|
| Status of Protection | Natura 2000 | | |
| Mean latitude | 33.0 | Mean altitude | 100 m |
| Mean longitude | 35.4 | Total area | 9,000 ha |

Most of the European and/or the west-Asian populations of many bird species migrate to Africa and back through Israel. The majority of these birds, including the whole European population of some endangered species, migrate through the Hula Valley and traditionally stop-over there. Other species over-winter in the Hula Valley and in some other parts of Israel, often in large numbers. This phenomenon, combined with severe problem of lack of water, makes the Hula Valley — as a protected area — uniquely important for nature preservation. Consequently, hunting is prohibited in the whole area throughout the year, except for Wild Boar and Great Cormorants. Compared to most European regions, Israel is a dry country with only a very small area of natural waterbodies, thus whilst the fish ponds here are intensive and artificial, they are extremely important as wetlands.



**(9) ISRAEL**

| Case Study area | Hula Valley | |
|---|---|---|
| Pond habitat data | Establishment of fish ponds | 1954 |
| | Median size of ponds | 7 ha |
| | Number of ponds | 70–80 |
| | Total surface area of ponds | 380 ha |
| | Natural shore line | <5% |
| | Mean water depth | 1.5 m |
| | Mean water transparency in July | <0.01 m |
| | Submerged vegetation (% of ponds with over 10% vegetation) | 30% of ponds |
| | Proportion of littoral vegetation (reeds, sedges, cattails) in ponds | 0 |
| | Concentration of Nitrogen | No data |
| | Concentration of Phosphorous | No data |
| | Ice cover in normal winter | None |
| Pond management data | Main fish species | Carp, Silver Carp, Flathead Mullet |
| | Cycle of production | 1.0–1.5 years |
| | Yield | 5,000–20,000 kg/ha |
| | Total production per year | 2,400 tonnes |
| | Percentage on non-commercial fish | 5–20% |
| | Seperated age classes of Carp | K1, K2, K3 |
| | Additional feeding | Yes |
| | Fertilisation | No |
| Fishery company data | Number of employees | 20 |
| | Owner(s) | Private |
| | Number of owners | 9 |
| | Proportion of income from fish production | 100% |
| | Proportion of income from ecotourism | 0 |
| | Proportion of income from waterfowl hunting | 0 |
| | Price per kg Carp | K3 = 2.0 euro/kg<br>K3 = 2.0–2.5 euro/kg during traditional holidays |
| | Price development in the last 5–10 years | Stable |

**(9) ISRAEL**

| Case Study area | Hula Valley | |
|---|---|---|
| Cormorant data | Number of breeding pairs | 0 |
| | Mean no. of non-breeding birds during breeding and post-breeding season | 0 |
| | Mean no. of migrating birds — spring | 100 |
| | Mean no. of migrating birds — autumn | 400 |
| | Mean number of wintering birds | Before 2003: 5,350<br>During 2003–2006: 850 |
| | Cormorant days (Cormorant numbers x no. of days) | Before 2003: 535,000<br>During 2003–2006: 85,000 |
| | Trend in numbers, 2004–2008 | Reduced |
| | Seasonal peak in numbers (month) | Dec |
| | Seasonal peak in numbers (numbers) | Before 2003: 8,500<br>During 2003–2006: 1,250 |
| | Number of roosting sites inside area | Before 2002: 3<br>During 2005–2007: 1 |
| | Roosting Cormorants (maximum number) inside area | Before 2003: 8,500<br>During 2003–2006: 1,250 |
| | Roosting Cormorants (month of max number) inside area | Dec |
| | Number of roosting sites outside area (within 40 km) | 1 |
| | Roosting Cormorants (maximum number) outside area (within 40 km) | 7–10 |
| | Roosting Cormorants (month of max number) outside area (within 40 km) | Dec |
| | Origin of birds (from ringing recoveries) | UKR |

# 12 APPENDIX TWO: INTERCAFE CARP POND SUB-GROUP MEMBERSHIP

All members of INTERCAFE's Carp Pond sub-Group (except the last named) were part of the Action's 'Conflict Resolution and Management' Work Group. They met and undertook work at each of INTERCAFE's meetings and during the between-meeting periods. In addition, most of these participants met independently twice to work together, meet local fish farmers, and learn from local Case Study area situations. These additional meetings were in (i) France, west of Lyon (Forez) and east of Lyon (Dombes): 28 February–04 March 2007 and (ii) Hungary, Rétimajor: 06–10 March 2008.

| Name | Affiliation and country | |
|---|---|---|
| 1 | Kareen Seiche<br>(WG2 Vice-chair) | Saxon Ministry of Environment, Germany |
| 2 | Daniel Gerdeaux | Institut National de la Recherche Agronomique (INRA), France |
| 3 | Robert Gwiazda | Polish Academy of Sciences, Poland |
| 4 | Ferenc Lévai | Aranyponty Zrt., Hungary |
| 5 | Petr Musil | (1) Department of Zoology, Faculty of Science, Charles University, Viničná 7, CZ-128 44 Prague 2, Czech Republic<br><br>(2) Department of Ecology, Faculty of Environmental Sciences, Czech University of Life Sciences, Kamýcká 1176, CZ-165 21 Prague 6, Czech Republic |
| 6 | Oleg Nemenonoks | Association of Fish Breeders of Latvia, Latvia |
| 7 | Tamir Strod | Border Collie Rescue Inc., Israel |
| 8 | Dave Carss<br>(WG3 Vice-chair) | Centre for Ecology & Hydrology, Edinburgh, UK |

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