Otters Causing Conflicts

The Fish Farming Case of the Czech Republic

Kateřina Poledníková, Andreas Kranz, Lukáš Poledník and Jaroslav Myšiak

Abstract In the Czech Republic fish farming is common throughout the country with a stronghold of carp production in southern Bohemia. The conflict arising from otter predation on commercial fish rapidly increased due to the political and social changes since 1989. Nature protection authorities undertook a set of measurements to appease the conflict. It included compensation schemes for losses, public relations etc., however, the conflict has continued. Within the FRAP project, social and ecological research was carried out and provided further recommendations how to mitigate the conflict. These are a continuous assessment of the compensation scheme, a simplification, differentiation and decentralization of the compensation payments, joint data collection, and setting up an organization of small pond farmers, a better involvement of stakeholders in conflict mitigation and further ecological research to better understand the biological background of the conflict.

K. Poledníková (✉) · A. Kranz · L. Poledník
Institute of Wildlife Biology and Game Management,
University of Natural Resources and Life Sciences Vienna,
Gregor Mendel Street 33, 1180 Vienna, Austria
e-mail: katerina.polednikova@alkawildlife.eu

A. Kranz
e-mail: andreas.kranz@aon.at

L. Poledník
e-mail: lukas.polednik@alkawildlife.eu

J. Myšiak
Department of Economics, UFZ—Helmholtz Centre for Environmental Research,
Permoserstraße 15, 04318 Leipzig, Germany
e-mail: jaroslav.mysiak@cmcc.it

R. A. Klenke et al. (eds.), *Human-Wildlife Conflicts in Europe*,
Environmental Science and Engineering, DOI: 10.1007/978-3-540-34789-7_5,

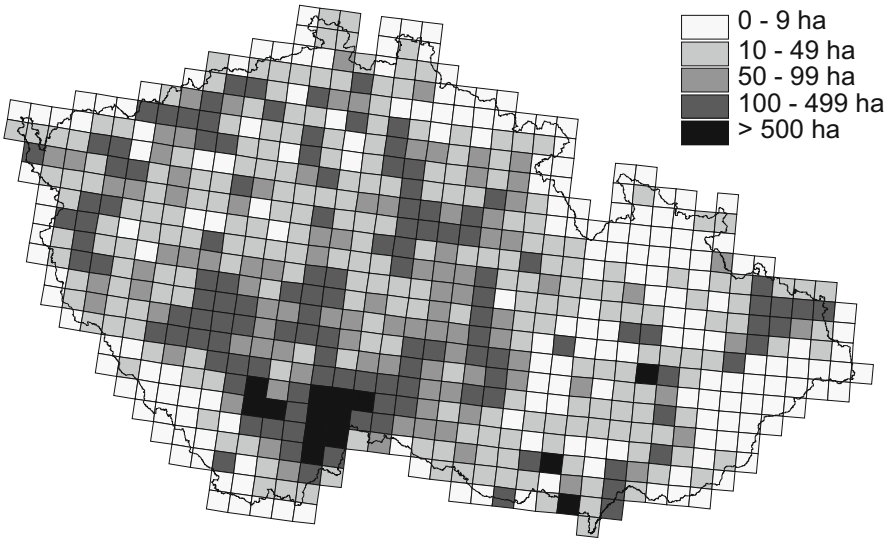

Fig. 1 Amount of fish ponds in the Czech Republic expressed in surface area (hectares). Size of grid: 11 × 12 km

1 Introduction

Conflicts arising from otter (*Lutra lutra*) predation on commercial fish are nowadays a common phenomenon in many Central European countries (Kranz 2000; Kloskowski 2005; Kranz et al. 2007). In this publication we focus on the situation in the Czech Republic, where fish farming is particularly common in the central southern part of the country (Fig. 1). The case of the Czech Republic allows insights into a conflict with special reference to the political and social changes in the past 20 years. This includes the transformation from communism to a market based economy and the EU accession in 2004.

The country is famous for producing common carp (*Cyprinus carpio*) in ponds with extensive management (Box 1). These ponds are part of the cultural landscape and at the same time are of outstanding significance for wetland biodiversity of the country, where large-scale transformations of natural wetlands into agricultural and forestry land have occurred in particular in the course of the twentieth century.

Traditional land use, particularly fish farming, creates habitats and supports biodiversity, but its further development may have negative effects on biodiversity because conservation of some species living and thriving in these habitats may cause economic burdens for the land user.

Box 1 Fish Farming in the Czech Republic

Czech Republic has an old tradition of growing carp in ponds that goes back to the thirteenth century. The maximum expansion of fish ponds, with about 1,800 km^2 of water surface, occurred during the sixteenth century. Currently, there are more than 50,000 ponds with a total area of about 520 km^2. Carp is farmed for human consumption within the country and abroad. Most families eat carp as traditional Christmas meal, similar to turkey or geese in other countries, and therefore the carp also has a cultural and emotional dimension for people.

Ponds are artificial water bodies (up to 2 m deep), which may vary considerably in size, ranging from less than 0.1 ha to about 700 ha and are usually scattered across the landscape according to prevailing natural water supplies, such as streams and rivers. In many cases they are organized in cascades of ponds, which form clusters of water bodies. Old ponds established decades and centuries ago usually have natural banks, providing cover and dens for otters, as well as habitat for otter prey other than commercial fish (Fig. 2). During the last three decades many new ponds were built and old ones were reactivated. They also provide suitable habitat for otters and this development may have increased the carrying capacity of otters considerably.

Ponds are usually stocked and harvested in spring and autumn. During the winter, some ponds (23 %) remain empty, while both juvenile and one year old carp and carp not yet sold are kept in special ponds for over wintering. After winter they are redistributed to other ponds for growing. The productivity of ponds varies between 300 and about 600 kg/10,000 m^2.

Differences in productivity reflect the two contrasting carp farming areas of the country: the lowlands along the River Lužnice in the south of the country (Třeboň Basin Biosphere Reserve, the region of South Bohemia) and the highlands found northeast of Třeboň (Czech-Moravian Highlands, the Vysočina Region). In both areas otters are present and cause conflict, though with different accents. In the highlands, carp farming is rather suboptimal due to climatic reasons and losses of fish stock are more common (Kranz 2000). Geomorphological aspects are responsible for the prevalence of small sized ponds in the highlands.

Apart from the traditional carp farming, other fish may be reared in these ponds, namely tench (*Tinca tinca*), pike (*Esox lucius*), and pikeperch (*Stizostedion lucioperca*).

Fig. 2 Small pond with diverse vegetation structure at the bank side in South Bohemia (Czech Republic). *Photo:* Lukáš Poledník

There is a long history of fish farmer-otter interactions in the Czech Republic. Otters[1] were regarded as a pest species at fish ponds since the early thirteenth century. With otter hunting methods becoming more sophisticated and with incentives fostering a large-scale reduction of otters (Hell 1980), the species became rare in most of the country by the nineteenth century. Habitat alterations and water pollution accelerated the drastic decline of the Czechoslovakian population of the Eurasian otter in the twentieth century (Kučera 1980). Otters became extinct in large parts of their previous distribution area and rare in traditional core areas, such as the large-scale pond farming areas in southern Bohemia (Baruš and Zejda 1981). Damage caused by otters ceased and otters became a species of conservation interest. In 1947 the otter became fully protected throughout Bohemia and Moravia (Hell 1980).

The otter conflict in the Czech Republic started by the end of the twentieth century, when damages caused by otters increased as a consequence of the

[1] The Eurasian otter is a medium-sized carnivore in the family Mustelidae with a high degree of adaptations for a semi-aquatic life (Kruuk 1995). In context of conflict resolution the following aspects of its biology are crucial: (1) otters are piscivore (= depend on fish as food), (2) they are mainly nocturnal, thus direct observations are only seldom possible and excrements give the main cues (3) they may breed all year round and thus any kind of regulation is highly controversial.

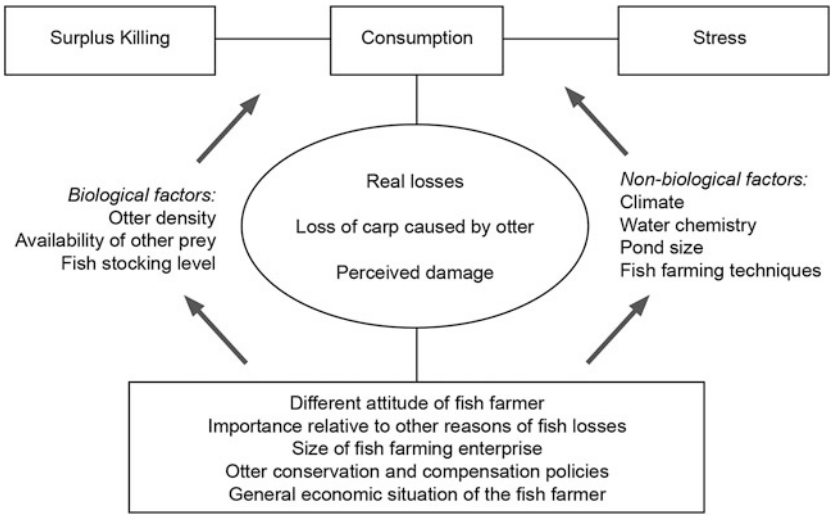

Fig. 3 Factors responsible for otter damage in carp ponds (modified after Kranz 2000)

recovery of this species (Toman 1992; Kučerová et al. 2001). On one side stands a clear conservation commitment reflected in several laws and a generally high interest in species conservation; on the other side stands property rights to use the land and to reduce losses. The conflict got a special drive due to the change in ownership structure of fish farming enterprises from public to private (Toman 1998), and escalated.

In consequence, the number of otters killed illegally in South Bohemia was estimated to exceed 100 individuals annually (Kranz et al. 1998). For conflict resolution, it was recommended that studies on the following topics should serve as fundamentals for political decisions: (1) clarification of ecological questions, in particular causes of mortality of carp and quantification of otter numbers, and (2) a human dimensions study.

Instead of investing in these open questions, a compensation law was put in force in 2000. Various stakeholders are—not surprisingly—not satisfied with this law and its implementation (Moravcová 2002; Culková 2004). Within this context, the FRAP project focused on the following questions: damage quantification, indirect losses, otter abundance, habitat factors influencing the extent of damage, spatial distribution of damage, and testing known as well as new ecological mitigation devices. With respect to social context the legal and institutional framework were analyzed to understand better legal possibilities and limitations, in particular the compensation system and its implementation. Also an analysis of stakeholder perception was done. To a lesser extent the economic role of the fish farming sector was studied, and the same holds true for policy analysis (past and present implementation of instruments used in the conflict) and participatory

decision strategies. Concerns of river anglers were excluded due to project resource limitations.

This dual approach (ecology and human dimensions) takes into account that damage is only possible to occur in context with humans. A prerequisite for damage is the existence of a resource competed for by wildlife and humans (Bath 2005). Factors responsible for otter predation and its perception as damage in carp ponds are schematically described in Fig. 3.

2 Human Dimensions

2.1 Legal Context

The otter is a severely endangered species according to Decree 395/1992, which implements the central piece of legislation with respect to the protection of nature and the landscape, the Czech Act No. 114/1992. The Act transposes the provisions of the Bern Convention and the EU Habitats Directive into national legislation. It prohibits catching, killing, and disturbing the listed species, as well as damaging and disturbing their habitats. The otter is also listed as a protected species with an all-year-round closed hunting season under the national hunting law (Act No. 449/2001 and Decree 245/2002). Derogation to the strict protection status is possible in principle, but only if there is no satisfactory alternative and the derogation is not detrimental to the maintenance of the populations of the species concerned at a favorable conservation status in their natural range[2]. The derogation is issued by the Czech Ministry of Environment (MoE) in the case of critically and severely endangered species, and by the regional administration in case of endangered species. In practice, no derogation or exception has been granted so far, although similar provisions have been hypothesized[3]. Damage caused by protected species, including the otter, is compensated according to Act No. 115/2000 (Box 2).

Municipalities and regions are territorial self-administrative units with specific state-delegated functions in the field of nature protection. When executing them, such as in the case of damage compensations caused by protected species, they are bound both by law and by central government decisions and guidelines. The Municipalities Act and the Act on District Offices regulate the relationship between local governments and territorial public administration. The regions correspond to the NUTS[4] 3 level while the municipalities build the NUTS 5 level.

[2] The derogations and conditions under which they apply are listed in Article 16 of the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora).

[3] Personal communication with Hlaváč V. and Roche, M., Toman, A.

[4] The Nomenclature of Territorial Units for Statistics (NUTS) of the EU.

2.2 Economic Relevance

The Czech Republic belongs to countries with the highest carp production among the members of the Federation of European Aquaculture Producers (FEAP) and it is the second largest carp producer among the EU member states. With a production of about 17,000 tons the Czech Republic makes up about one fourth of the EU carp production (Brožová 2005). The overall fish production in ponds amounts to about 19,000 tons of market-size fish per year, with no signs of increase or decrease during the last 15 years. About 96 % of market fish are produced in fish ponds. The average production per hectare of pond area is about 450 kg (Brožová 2005). Common carp dominates the production (about 87 %), followed by salmonids (about 5 %), herbivore fish (about 3.3 %) and tench (*Tinca tinca*) (2 %). About 43–44 % of the produced fish is exported, mainly within the European Union.

The Region of South Bohemia (10,000 km^2) and the Vysočina Region (7,000 km^2) comprise almost one half of the fish farming area of the country, and it is mainly here that the conflict flourishes. Both regions are rural areas, South Bohemia with 52 inhabitants/km^2 and Vysočina with 90 inhabitants/km^2 and with a gross domestic product per capita 5 % below the average of the whole country. The population slightly increased in the region of South Bohemia (0.9 %) and slightly decreased in the Vysočina Region (0.4 %) from 1995 to 2002. Unemployment is 5.2 and 5.3 %, respectively, significantly below the figure for the whole country (9.7 %). In the region of South Bohemia, there are 131 companies officially registered as fish producers and many more hobby and part-time farmers. From the 131 companies, less than ten have more than ten employees and just one has over 100 employees (Fig. 4).

2.3 Stakeholders

Fish farmers, anglers, environmentalists, administrative authorities, scientific experts, and the laymen community are the main actors in the conflict when narrowed down to the disputes concerning the damage instigated by otters. The groups are far from being homogeneous; some members of the same group hold more radical views on how the damage should be prevented or compensated.

Professional fish farmers who make their living on fish (mostly carp) are congregated in large and medium-sized farms widespread in the lowland part of the region. Small size farms owned by hobby or part-time farmers mostly consists of a few small ponds scattered around a given water course. Many of these smaller ponds are situated in the upland areas with suboptimal conditions (see Box 1) and less suitable for commercial pond farming. Although the Czech Fish Farmers Association is open to all farmers it assembles predominately large and medium-sized farms from all over the country.

Fig. 4 Fishermen in southern Moravia harvesting carp (*Cyprinus carpio*) after pond draining in autumn. *Photo:* Lukáš Poledník

The Czech Fishing Union (CFU) and Moravian Fishing Union (MFU) represent together more than 300,000 anglers. The unions are organized in local and regional groups, coordinated by a central board. Angling is practiced in running waters and selected ponds. Apart from angling many local groups posses or rent fish ponds for fish production (mainly carp). Produced fish are then stocked into the angling waters or sold at local market.

In terms of administration, the Ministry of Environment (MoE) has a central position. It has the responsibility to declare decrees that refine laws and has responsibility for derogation to otters. Local and regional authorities are involved in the conflict by implementing the compensation law (Box 2).

The Agency for Nature Conservation and Landscape Protection of the Czech Republic (ANCLP) as a deliberative and executive organ of MoE defines the protection status of species, prepares management programs, expert reports etc. Moreover, in 1988 ANCLP established a Station of Fauna Protection (SFP) dedicated mainly to captive breeding of otters, rehabilitation of orphan or injured individuals, research and public relations. ANCLP, with experts from NGOs and research institutes, prepared the Management Program for the Eurasian otter in the Czech Republic for the period 2009–2018 (Poledník et al. 2005, 2007). One of the goals of the document is to establish a consultative board of representatives from all stakeholder groups involved in the conflict concerning otters. The Management Program was submitted for approval by the Ministry of Environment by the end of 2005.

Besides nature protection authorities, the Ministry for Agriculture (MoA) is a key player in the conflict. Fish farming and aquaculture belong to agriculture and fish farmers benefit from subsidies managed by the MoA.

Among the non-governmental organizations engaged in otter protection and public awareness, the Czech Otter Foundation (COF) is most distinctive. Founded in 1993, it has to date organized workshops and exhibitions, published books and educational materials for schools, and carried out research and monitoring of otter populations. The foundation provides expert reports required by the compensation law 115/2000 in South Bohemia and beyond.

Finally, various institutions of secondary and higher education, as well as research institutions, are worth mentioning: the Fishery Vocational Schools in Třeboň, Palacký University in Olomouc, Masaryk University in Brno, University of South Bohemia in České Budějovice, Charles University in Prague, University of Applied Life Sciences in Vienna (Austria), and Research Institute of Fish Culture and Hydrobiology in Vodňany.

2.4 Damage Compensation

Currently, only one instrument to compensate otter damage or to assure or stimulate tolerance of otters exists in the Czech Republic (Box 2). Although the paid compensations are recorded, we are not aware of any assessment of the scheme, neither in terms of the number of farmers who adhered to the scheme, nor with respect to the paid compensations and the certified damage. Therefore, we analyzed the expert reports obligatory for the damage claims. Most of the reports are provided by COF and ANCLP.

Not all damage claims have been recognized as legitimate by the regional authority. Most claims refer to the South Bohemia region. Only a small number (up to 200) of potentially eligible beneficiaries already applied for the compensations.

The amount of money paid for otter compensations in 2005, 2006, 2007 was around 200,000 € per year. In the region of South Bohemia, the damage paid per pond averaged 74 € (minimum 15 €, maximum 962 €), which corresponds to 63 otter visits per 180 days (minimum 13, maximum 420).

The biggest part of claims was lodged by the largest group of hobby farmers (60 % of damage claims), followed by professional fishery companies (20 %), fishing unions (10 %), and by other companies (10 %), in which fish farming is not the main activity (e.g., hunting association, farmers).

Box 2 The Current Otter Damage Compensation Scheme

The compensation scheme (Act No. 115/2000) for damages caused by protected species, including the otter, has been introduced in 2000 and subsequently changed in 2001, 2002, and 2006. The law covers damages caused on fish stock in ponds and water courses. It determines the right for compensation, thus there are no upper limits or ceiling as for the extent of compensated damage. The compensation takes into account the intensity of otter presence in the pond or water course. The claimants have to report the damage within 48 h to the competent local authority, which inspects the fish pond and confirms the presence of otters. An expert is required to assess the extent of damage; the expert report is an obligatory part of the claim. There is no special provision as who can count as an expert for the purposes of the law, generally the expert reports done by the Czech Otter Foundation and the Agency for Nature Conservation and Landscape Protection of the Czech Republic are accepted by the authorities. The damage claims must be submitted to the responsible regional authority up to 10 days after the claimant got to know the damage or at latest up to six months after the damage occurred.

The methodology applied to assess the extent of damage was developed by the Czech Otter Foundation Fund and the Agency for Nature Conservation and Landscape Protection of the Czech Republic (Roche and Toman 2003). It distinguishes between a detailed and a simplified assessment. The detailed assessment is based on regular monitoring of water quality, climate factors, fish diseases, and presence of other fish predators, but has not yet been applied due to the high costs associated. The simplified technique is a very rough expert guess. The amount of otter field signs, size and stocking of the pond, expected commercial fish consumption by otter, and market price of farmed fish are taken into account. The following equation is used to calculate the amount of compensation: $Z = c \cdot p \cdot n \cdot d$ (Z: compensation; c: average price of fish stocked; p: coefficient of diet composition (it is assumed that an otter consumes between 0.5 and 0.75 kg of commercial fish per day); n: number of otters using the pond; d: number of days of otter presence). The parameters n and d are based on otters signs (tracks, spraints, food remains) found at the particular fish pond or, in the case of fish pond networks, on an estimation of otter numbers found by snow tracking. In case of a single pond or a small complex of ponds, the pond area is considered. The damage is assumed higher in small ponds; therefore, the estimated damage is increased by 20 % in case of ponds smaller than 2 ha and decreased by 20 – 50 % in case of ponds larger than 5 ha. Damage assessment covers only fish actually eaten by the otter, not secondary damages caused by injuring or stressing the fish in winter.

2.5 Stakeholders' Perceptions of the Conflict

Various analyses have been carried out in the past to assess the extent and identify the main drivers of the conflict. According to Kranz (2000), fish farmers in uplands perceived the otter as the greatest threat, whereas in lowland regions other fish predators, especially great cormorants (*Phalacrocorax carbo sinensis*), were more feared. With respect to the type of damage, secondary losses caused by stress due to otter predation were ranked highest (50 % of answers), followed by surplus killing (27 %); direct consumption ranked last. Regarding the measures to prevent and compensate for large-scale losses, the reduction of otter population and introduction of a damage compensation scheme[5] were recommended most often (Roche 2003). More than 60 % of the interviewed persons believed that the damage caused by otter has steadily increased during the last years and that the damage is between 5 and 30 % of the produced fish (Roche 2003). These perceptions varied considerably across the surveyed administrative districts and the groups of respondents (anglers and fish farmers). The same survey revealed that the current damage compensation payments in South Bohemia are well known, but about 40 % of the people interviewed did not believe that this scheme provides a solution to the conflict. The highest discontent with the damage compensation scheme was reported among the owners of small fish ponds. In Spurný et al. (2003) the acceptance of piscivorous protected species among the anglers has been investigated, revealing a rather high acceptance of the otter (55 %), while the discontentment with the protection of cormorant is reported as being high (75 %). Additionally, Novotná (1998) reports that many respondents confused the otter with mink (*Neovison vison*), which may suggest an overestimation of the damage caused by otters.

We conducted 20 semi-structured interviews involving about 35–40 people[6] with representatives of the main groups presented in the previous section. The interviews, each about one and a half hours long, were recorded, transcribed, and analyzed qualitatively. Here we include a summary of the main features of the discourses, especially ones that are relevant for the policy recommendations discussed later in this document. The interviews were complemented by an extensive review of scientific and media articles.

The actors hold divergent beliefs about the population size and extent of damage occurring, blame various drivers for the increase of damage, and propose different policies to prevent or reduce the potential harm. However, they agree that the ponds give rise to a distinctive landscape worth preserving and conserving thanks to the tradition of pond farming. Yet fish farmers and environmentalists refer to the unique cultural and ecological value of the region for different reasons and the interpretation of what is a sustainable pond and landscape management is at the core of the conflict.

---

[5] The survey had been carried out before the compensation law 114/2000 was introduced.

[6] On average two persons took part in a single interview.

The fish farmers stress the importance of traditional practices of pond management for maintenance of the typical landscape and stress that a professional pond management is based in first place on economic profitability and long term sustainability of the farms. The emphasis on professionalism preserve the status of fishermen and separate out the hobby farmers and anglers, who are commonly believed little knowledgeable and often foreign to the region. The place identity and local knowledge is frequently pleaded to contest scientific knowledge and the authority of experts. In principle, fishermen see themselves as environmentalists, but ones, which make explicit a trade-off between economical viability of the fish farming practice and ecosystem preservation.

On the other hand, the environmentalists, who encompass mainly officers of state agencies, experts, and the NGOs engaged in protection of otters, stress the value of ponds and their littoral zones as unique ecosystems endangered by intensive farming practices. According to them, the high ecological value of ponds is inversely proportional to the density of the farmed fish, and higher proportion of non-commercial species in the ponds is indispensable both for the overall species diversity and as a measure to reduce damage on commercial fish population. The place identity is also connected to the value of the landscape (and especially the Biosphere Reserve situated in the region) as a refuge for many endangered species.

Another driver of the conflict is the private ownership of the ponds—most of the formerly state-owned ponds were privatized—and the different viewpoints regarding the exercise of property rights. The fishermen sustain that the ponds are functional facilities built for the purpose of fish production. Their high value for conservation is a welcome by-product, but the productive capacity of the pond—the purpose for which the pond has been built—ought not to be compromised. The limitation imposed by environmental laws and directives is challenged as inappropriate (because of violations of the property rights) and not reasonable for the maintenance of the ecosystem (because it is not balanced). The prevailing perception among fish farmers is that restrictions, if imposed by the state, should be accompanied by compensations for foregone benefits. Furthermore, the way environmental constraints have been imposed creates additional tension, in particular the selection of NATURA 2000 sites.

The environmentalists consider the ponds and the ecological values/services provided by them as a common (or community) good and assert the rights and obligation to treat them correspondingly. The compensation is seen with suspicion and many claim that the compensation payments are counterproductive, as they spoil the attitude towards nature protection and reduce the acceptance of wildlife. In their views the losses due to predation by otter are part of the production process.

The damage assessment is complicated by various practical and ethical issues. Both fishermen and anglers assert that all damage attributed to otter ought to be compensated. In this matter, the fishermen and anglers see compensation of secondary damage as legitimate, while the environmentalists do not agree with it.

For fishermen, otters may become a threat to pond farming (and subsequently to the preservation of the pond landscape). The otter is seen as a “killer” able to wipe out a pond within a very short time-period. The killing is not a subject of survival;

the otter is believed to kill for leisure. Less radical fishermen accept the presence of otters as part of nature and as a native species, but still call for protection that would include regulation of the population. This is strictly opposed by environmentalists for two reasons. First, the population is perceived as not strong enough to sustain the illegal killing and species management. Second, female otters can be pregnant and have offspring practically anytime throughout the year.

Larger fish farms are better satisfied with the current compensation schemes than small and hobby farmers. This is believed to be due to the fact that large farms are better able to cope with the transactional costs of the compensation claim and can also exercise considerable power (lobbying) either by themselves or through their representative bodies. Small farmers, on the other hand, feel poorly represented and thus powerless, insufficiently informed and little convinced of the merit of the compensation scheme.

The fishermen and environmentalists engaged in practical management emphasized positive experience from their collaboration. The mistrust and negative attitude were substantially higher towards hobby environmentalists, who were often not further specified. Some fishermen considered them as an instrument of foreign interest groups, aiming to make the Czech farms less competitive. Uncertainty was omnipresent in the discourses. This is partly because the region has experienced fundamental political and economic changes in the last two decades (the transition to market based economy, splitting up of the former federal state into Czech Republic and Slovak Republic, and the EU accession), which were not free of concerns and anxiety. These changes are seen as a threat to the farm practices, partly because the farmers fear loss of control (and subsequently additional restrictions and bureaucratic burden), and partly because of deep mistrust. Suspicions involve the "hidden" motivation of the rules, with which the state had to comply during the EU accession. Once again, the mistrust against the changes was interwoven with the place identity and the imperative to preserve traditional practices.

3 Ecology

3.1 Distribution and Otter Densities

The distribution of otter population and its changes in the Czech Republic in the last decades are well know from several national surveys (Toman 1992; Kučerová et al. 2001; Poledník et al. 2007; see Box 3) based on the modified standardized IUCN Otter Specialist Group method. However, the reliability of various published estimates of size of the population (e.g., Kučerová et al. 2001; Brožová 2005) is questionable. Here we provide an estimate of the population size based on a statistical approach (Poledník 2005).

Otter densities were identified by snow tracking of seven 10 × 10 km squares in different parts of the Czech Republic comprising contrasting habitats. Otter numbers

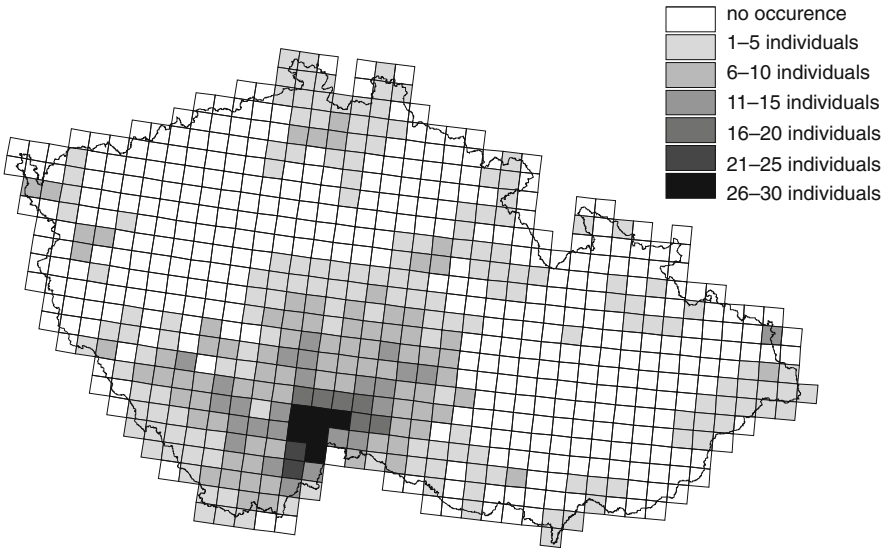

Fig. 5 Otter density in the Czech Republic in 2000 according to the national survey in 2000 (Kučerová et al. 2001), known densities based on snow tracking and the relationship between otter numbers and pond

varied highly among snow-tracked squares: from 1 to 28 adults. Subsequently, the densities were plotted against various parameters describing aquatic habitats. Total length of pond banks explained most of the variation of adult otter numbers (backward multiple regression: $R^2 = 0.9742$). Based on the relationship between otter density and length of pond bank, the total population size of otters in the Czech Republic was estimated to be between 1,600 and 2,200 adult individuals at the end of the twentieth century (Fig. 5). The correlation may be used in context with otter numbers and damage quantification at a given area as well. The existing correlation also indicates that otter numbers appear primarily food limited and the carrying capacity has been reached in many areas of the Czech Republic.

Box 3 Otter Distribution, Abundance and Diet in the Czech Republic

The population of otters was fragmented in the last decades (Toman 1992; Kučerová et al. 2001), with the largest metapopulation occurring in the southwest of the country and expanding its range into Austria and Bavaria (Kranz 1995). This metapopulation also coincides with the main fish farming area. Other otter metapopulations occur in the very east, along the border to Slovakia and Poland, and in the north on the border to Germany. In addition, otters were reintroduced in the 1990s to one mountain range in northern Moravia (Hlaváč et al. 1998). During the last 15 years otters have expanded their range considerably (Poledník et al. 2007).

Population estimates in terms of numbers, based upon comprehensible data, were not available. Therefore, some authors offered figures that should be considered rather as expert guesses: e.g., Kučera (1980) indicated about 330–350 individuals living in the whole country at the end of the 1990s, whereas Kučerová et al. (2001) suggested 800–1,100 individuals. Reliable figures were only available for single plots of 10 × 10 km squares. According to Kučerová and Roche (1999) and Kranz et al. (2002), the average number of otters in a single square amounts to approx. 3 individuals outside fish pond areas and between 15 and up to more than 30 otters in pond areas.
The diet composition of otters in the Czech Republic was intensively studied in the last decade, covering a wide range of otter habitats from mountain streams through lowland rivers to fish ponds (e.g., Knollseisen 1995; Roche 2001; Poledník et al. 2004). Otters showed an opportunistic feeding behavior. The dominant fish species and size in the diet reflected abundance and availability at a given site. Since young fish are more numerous, most of the fish predated upon by otters were smaller than 15 cm. Damage caused by otter predation on fish ponds was considered highly variable from negligible to reaching up to half of the fish stock of a pond (Gossow et al. 1999). Higher predation rate of carp was observed during winter (Gossow et al. 1999; Kučerová and Roche 1999).

3.2 Quantification of Losses

Besides economic parameters, the amount of damage should be a function of duration of otter presence in terms of otter-days presence at a pond and the proportion of commercial fish in the diet. We analyzed these two aspects and, in addition, investigated the potential impact of otters on fish in terms of secondary losses, since this is the central argument of fish farmers. Box 4 gives a short introduction to the methods and problems that occur when assessing the damage at a given pond.

Box 4 Otter Damage Assessment

At fish farms, damage is usually defined as loss of stocked fish revealed when a pond is drained. Since a fish farming period expands usually over several months, the recorded losses at the moment of pond draining represent damage accumulated during a longer period, usually several months, sometimes years. At this time the causes of damage are not necessarily evident any more. A number of different reasons for losses (other fish predators, fish diseases etc., see also Fig. 3) exist and the otter is only one of them. Therefore, it is far from easy to properly assign the correct amount of damage to the different causes of loss.

The only link between otters and losses is circumstantial evidence: spraints (Fig. 6), tracks, and in some cases food remains found at the pond. It is assumed that if a pond is stocked by fish and otter signs are found on the bank of the pond next to the water, otters were hunting in the pond, and therefore there is a certain probability that damage has occurred in this pond. In cases when otters visited a pond and caused damage to fish stocked there long time ago, it may well happen that no signs of otter presence are visible anymore.

3.2.1 Relationship Between Otter Presence and Spraint Number

The relationship between utilization of a site by otter and number of spraints found was repeatedly discussed in the past (e.g., Kruuk and Conroy 1987; Macdonald and Mason 1987) with the result that the number of spraints should be used with caution as an index of otter numbers. A new method to estimate the utilization of a site was developed and tested (Gruber et al. 2008). "Visitation rate" (proportion of nights when at least one otter visits the site) of otters at particular ponds was identified by regular surveys of 55 ponds. These surveys were conducted in weekly intervals. Age (fresh, i.e. from previous night, versus old) of each spraint was recorded and all spraints were collected. The visitation of a particular pond was then calculated based on presence/absence of fresh/old spraints using a maximum likelihood approach. Subsequently, calculated visitation was compared with the number of spraints found at the pond. The comparison revealed a strong correlation between the visitation at each pond and the average number of spraints when counted every week. Weekly intervals for pond surveys are, however, not an option for damage quantification in praxis, since this would be too costly. Further simulations (sequential reduction of the number of surveys) revealed that at least two pond surveys within six months are necessary to get a meaningful correlation between the number of spraints and the visitation rate of otters during the whole period. A single survey during the period of several months does not bring reliable results because the number of spraints deposited by otters on a particular pond strongly varies during that time.

3.2.2 Utilization of Ponds by Otters

A high variation in visitation rate among different ponds was found. Some ponds were used intensively and others rather sporadically. On average, visitation rate was 20 %, which is equivalent to visits occurring every fifth day. Every monitored pond, where fish were stocked, was visited by otters to some degree during the vegetation period.

Fig. 6 Otter spraint (*left*) with remaining fish bones and jelly (*right*), a greenish or brown secret from the anal glands. *Photo:* Lukáš Poledník

Data of four radio tracked otters in the same area provided a very similar visitation rate: 21 %. One otter had 18 ponds in its home range and an otter used on average three ponds per night (Poledník 2005).

Besides pond-to-pond differences in otter presence, spraint surveys and radio telemetry revealed an overall seasonal difference. During the summer period, all ponds are usually stocked and otters use all of them. In contrast, during winter some ponds are without water (about 23 %, Kranz et al. 2002) and most, which are filled with water, are at least for part of the time heavily frozen. Therefore, otters have to concentrate at running waters or at those ponds which are stocked and which provide some access to the water (Fig. 7).

3.2.3 Proportion of Commercial Fish in the Diet of Otters

The analysis of 2,265 spraints collected along the ponds surveyed for otter presence revealed a high variation (10–90 %) of commercial fish in otter diet. Amphibians, namely frogs (max. 49 % of diet), European perch, *Perca fluviatilis* (max. 49 %), roach, *Rutilus rutilus* (max. 31 %), and crayfish (max. 40 %) were the main alternative prey groups. Thus, high visitation rates at a particular pond and high numbers of otter signs do not necessarily imply high damage and vice versa.

Fig. 7 Frozen pond in Austria. An otter has made the narrow pass around the sticks holding the wall of the pond overflow, the only place where open water is still accessible. *Photo:* Reinhard Klenke

3.2.4 Otter Impact on Fish Due to Consumption

Based on visitation and diet analyses, otter damage varied among ponds from 0.05 to 2.37 % in terms of stocked fish at 15 regularly surveyed ponds during the vegetation period (May to September). The average damage per pond was 0.9 %.

Based on the known number of otters (12 individuals) within an area of 10 × 10 km with about 120 ponds, an average food consumption of kg per day (Kruuk and Carss 1996), and the proportion of commercial fish in the diet (about 35 %), otters consumed about 630 kg of commercial fish in one vegetation period, which is equivalent to 1.1 % of stocked fish in that area.

Hence, two fundamentally different approaches provided very similar results (0.9 versus 1.1 %) and indicate that the overall impact of otter predation on commercial fish in fish ponds during the vegetation period is very low. This is true in particular when considering the overall level of natural mortality. In this area, fish farmers generally accept losses of up to 10 %.

Data on otter damage at ponds during the winter are insufficient, but the total number of commercial fish consumed by otters at ponds should not differ dramatically from the values calculated for the vegetation period, as the number of otters within the area remains the same. However, as the predation on commercial

fish is not evenly distributed over the entire area but rather concentrated at fewer ponds (stocked and accessible), higher damage can be expected at those ponds where otters have access to fish.

3.2.5 Otter Damage Caused by Disturbing Fish

The condition, health, growth, and survival rate of fish may be affected by stress, as frequently argued by fish farmers. Otters predating in fish ponds, especially during winter when fish are mostly inactive, may cause such stress to fish. In the experiments conducted as part of our project, common carp were stressed under controlled conditions by tame otters. The analysis of blood samples of experimental fish showed changes in nitrogen, glycid, and mineral metabolism, as well as levels of hormones and fat reserves in fish disturbed by otters (Poledník et al. 2008). However, these changes had no economic impact, since subsequent survival and growth rate of stressed fish did not decrease. Nevertheless, further experiments are recommended to better understand these complex relationships.

3.3 Fishermen and Damage Assessment

The damage caused by otters assessed by regular monitoring of 55 ponds was compared with losses reported by fishermen. A strong discrepancy between these two data sets was found. There was no correlation between the damage perceived by fishermen and the damage as revealed by diet analysis and visitation rates of otters (Fig. 8).

3.4 Factors Influencing Damage

In the light of a considerable variation of damage occurring at different ponds, we investigated small-scale landscape factors in order to identify those which make otter presence and damage more likely to occur at a given pond. Such findings would be a valuable piece of information for fish farmers and could be integrated into further development of the compensation scheme.

Ecological mitigation is also supposed to have an effect on the amount of damage, though some means may function more as a placebo by have an effect on the perception of fish farmers. Since little information is available on how effective traditional means of mitigation are, some of them were tested in a standardized way.

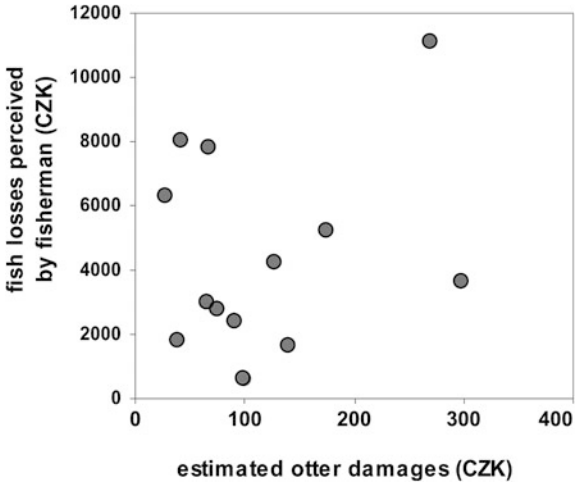

Fig. 8 Comparison of fish losses perceived by fishermen at 13 different ponds and estimated otter damage revealed by diet analysis and visitation rates there

3.4.1 Damage and Small Landscape Factors

Apart from seasonal differences and otter densities, further characteristics of the ponds and their surroundings may have an influence on the extent of damage. Such characteristics may include size of pond, size (age) of carp, the amount of refuge habitat at a given pond and the distance to the nearest river, ditch, and pond. These landscape parameters were analyzed and it was found that their impact on the total damage at ponds was relatively low. Since such factors are complicated to quantify and their effects are interrelated, their use in damage compensation schemes appears problematic and of little added value (Santos-Reis 2006).

3.4.2 Evaluation of Existing Ecological Mitigation Measures

Fences, both normal and electric, are an effective means to keep otters from fish farms, if the banks allow otter-proof fencing. This is unfortunately often not the case at centuries old carp ponds (Bodner 1996). Electric fences depend on a proper power supply, may fail under certain weather conditions (wet, cold, high snow layers), and may cause barriers to other protected species, such as amphibians migrating to ponds. Winter ponds may be protected by making use of the ice cover and frost (protective measures at the inflow and outflow are required).

Scaring devices frequently used by fish farmers (fladry consisting of cloth pieces, human hair, and sheep wool) and additionally excrements of large carnivores were tested in paired ponds and were found to be inefficient (Kranz et al. subm).

Killing otters by shooting or trapping is at present an illegal measure. However, some aspects should be mentioned. First, it is necessary to distinguish between single killings, which have no effect on the population but may appease fish farmers, and regular culling, which may reduce the population. Both are ethically

problematic, as females with dependent cubs might be killed. Culling would also have an effect on neighboring otter populations outside the fish farming area.

Translocation of otters causes considerable costs and may expose the translocated individual to high risks in the new habitat. It is also limited by the low acceptance of fishermen and anglers in the release areas (Kranz 1999; Conover 2002; Poledník et al. 2005; Hlaváč, pers. com.).

Deviation ponds offering alternative, more readily available food than commercial fish, may work when installed for short periods particularly critical for damage. Otherwise, they raise the carrying capacity of the otter habitat, resulting in more otters without any damage reduction. However, they may work well in combination with incentives for extensive fish farming as in Lower Austria (Bodner 1996).

4 Conclusion and Recommendations

4.1 Further Ecological Research

Otter biology and the range of consumption of commercial fish by otters at a single pond are known with sufficient precision. This does not mean, however, that the damage occurring at a particular pond can be determined exactly or nearly exactly. Due to the variation in number, age, and sex[7] of otters visiting the ponds, the frequency of the visits, occurrence of alternative prey species, losses due to diseases, predation by other species, and other biotic and abiotic factors, the damage experienced by a single farmer can only be approximated. The uncertainty due to natural variation can be reduced modestly by more research.

Further research, however, can yield important data regarding the damage in extreme situations, such as surplus killing and injuries inflicted by otter. Finally, research concerning damages due to stress of fish is not sufficiently completed.

4.2 Continuous Assessment of the Compensation Scheme

The effectiveness and acceptance of the compensation schemes in place, Act No. 115/2000, has been scarcely analyzed. Data about the claimed and compensated damage are not systematically collected[8]. A comprehensive assessment is, however, crucial and should include financial costs (payments to fish farmers and transaction costs), analysis of applicants (e.g., whether pond farming is their main

[7] Especially families (females with dependent cubs) do significant damage simply because they are more individuals together and because of learning to catch prey.

[8] The most comprehensive data about the claimed compensations are available in the Czech Otter Foundation Fund, which provided expert reports for most of claims.

occupation, geographical distribution), and stakeholders' perceptions of the compensation system. Similarly, it is important to collect information about all farmers eligible for damage compensation (both commercial and hobby farmers). An inventory of ponds used for carp farming and a statistical survey of all people engaged in pond farming are essential. Furthermore, the performance of various alternative measures (e.g., fencing the ponds, composition of fish stocks) and alternative compensation schemes need to be systematically compared.

5 Simplification and Differentiation of the Compensation Payments

Otters repeatedly visit ponds and other water bodies in their territory. In areas with numerous small ponds, such as the Czech-Moravian Highlands, where the otter is common, the assessment of actual damage represents a real challenge (see chapters Distribution and otter densities, Quantification of losses). The losses of fish due to otter predation are small on average, but they occur repetitively and vary in magnitude. The current compensation scheme (Act No. 115/2000) is associated with high transaction costs, especially for small and hobby farmers, and the administrative efforts connected with handling the numerous compensation claims are huge (see Box 2). As explained in previous sections, small and hobby farmers represent the group in which the acceptance of the otter and the success of the compensation payments are not satisfactory.

We propose to tackle these issues as follows:

- The current level of administrative burden to prove the damage should be relaxed. The compensation claims can be submitted to (and dealt with by) a single authority, either at the local or regional level [9]. The certification of otter presence at ponds is not necessary every time when damage occurs. In areas with permanent otter presence, otters are expected to visit each pond in the area. Reliable information about otter presence in the area can be obtained from other sources[10].
- Types of schemes differ widely in transaction costs, which are related to distribution of the damage (Schwerdtner and Gruber 2006). Due to distribution of otter damage, a lump-sum compensation scheme [11] is recommended. Compensation system based on case-by-case damage assessment has, in the case of otters, high transaction costs, which are in addition useless (inspections do not provide reliable information). The lumped-sum compensation scheme could be cheaper and moreover friendlier because it eases the burden of the damage proof.

[9] Currently, both local and regional authorities are involved in the review of the compensation claims, though at different stages (see Box 2).

[10] e.g., the otter surveys carried out for the Ministry of Environment.

[11] Lump-sum compensation is based on an estimation of the expected loss, independent of actual damage.

- The compensation of actual damage can be (at least partly) connected to or replaced by incentives fostering better prevention of damage and encouraging environmentally-responsible management techniques. These incentives can be connected to agri-environmental measures (e.g., Ring and Santos 2006). Examples of their successful employment are known from Saxony and Lower Austria (Thum et al. 2003; Myšiak et al. 2004). In the case of new ponds, the compliance with established standards, sound management practices, and acceptance of predators should be imposed in the permit to construct the pond.[12]
- The current damage compensation based on an extensive proof of the damage can be applied when the fish farmer believes that their actual damage is significantly higher than the lumped payments or the incentives. The evaluation of direct damage is basically a function of otter visitation rate, proportion of commercial fish in the diet of otters, and fish price. Reliable in-depth damage assessment based on these three components requires at least three separate surveys of pond (to collect enough spraints for diet analysis). The costs associated with in-depth damage assessment should be covered at least partly by the fish farmers themselves to prevent the misuse of the instrument.

5.1 Decentralization of the Compensations and Incentives

To address regional differences exacerbating the conflict (see Box 1), the compensation schemes and incentives should be flexible enough to reflect the local actors' concerns and preferences. Such flexibility can be achieved, for example, by giving a discretion to the local authorities to adjust the rules for damage applications (e.g., deadlines for the applications, interval at which the applications are submitted), without compromising the aim of the compensations. In the case of environmental incentives, the discretion can involve setting priorities for environmental targets. Decentralized conflict management should foster attitude of shared responsibility and closer involvement of the relevant actors.

5.2 Joint Data Collection

Currently, data about otter populations and the damage assessment are collected by various actors independently from each other. This practice results in different figures regarding otter population size and amount of damage, which instigates disagreements and conflicts. Joint data collection, including the collective

[12] Presently land use planning does not take the otter into account when new fish farms are built. The otter is not considered as a factor that affects future farming and some people, who build a fish farm, are not even aware that otters live in the area. In the course of land use planning and granting licenses to run a fish farm, mitigation measures and incentives for environmentally friendly management should be suggested respectively be a prerequisite.

definition of the applied methodology, requested precision, and time interval for collecting new data, can foster better communication and mutual understanding of the opposing parties. The joint data collection can be extended to other data necessary to assess the performance of the compensation schemes.

5.3 Support for Setting up an Organization/Association Representing the Concerns and Needs of, and Providing Practical Advice to Small and Hobby Pond Farmers

Although the small and hobby farmers are formally represented in the Fish Farmers Association, their specific situation and needs are not sufficiently conveyed. We propose to establish an organization that will represent the interests of numerous small and hobby farmers. Such an organization will also be practical for dissemination of the relevant information, capacity building, or organization of training courses on how to prevent damage etc.

5.4 Involvement of a Wider Range of Stakeholders

A wide range of stakeholders have been involved in the mitigation of the otter-related conflict in the Czech Republic, but the level of their involvement is far from satisfactory. A better involvement of all affected actors, applicable to almost all previous recommendations, can facilitate positive social responses and bolster legitimacy, acceptance, and satisfaction with the adopted policies.

Acknowledgments This work was financed by the EU 5th Framework Program (5th FP) Project "FRAP" (Development of a procedural Framework for Action Plans to Reconcile conflicts between large vertebrate conservation and the use of biological resources: fisheries and fish-eating vertebrates as a model case), contract number EVK 2-CT-2002-00142-FRAP.

References

Baruš V, Zejda J (1981) The European otter (*Lutra lutra*) in the Czech Socialist Republic. Acta Sci Nat Brno 12:1–41

Bath AJ (2005) Human dimensions as a strategic tool for nature conservation: using examples from large carnivores and large herbivores. HD manual report for the large herbivore foundation (LHF) and the large carnivore Initiative for Europe (LCIE, http://www.lcie.org), pp 63

Bodner M (1996) Fischotter und Teichwirtschaft. Forschungsbericht Fischotter 3, WWF Österreich, vol 14. Vienna, pp 26–44

Brožová M (2005) Situační a výhledová zpráva. Ryby, Ministerstvo zemědělství ČR, Praha

Conover M (2002) Resolving human-wildlife conflicts. The science of wildlife damage management. Lewis Publishers, Boca Raton, p 418

Culková M (2004) Rybáři versus vydra říční. Bachelor work, Faculty of Science, Palacky University, pp 62
Gossow H, Kranz A, Knollseisen M (1999) Ecology of otters in a fish pond area and some of its socio-economic aspects. Final report for the Austrian science foundation, project No P10626-Bio, Vienna
Gruber B, Reineking B, Kranz A, Poledníková K, Poledník L, Klenke R, Valentin A, Henle K (2008) A new way of estimating visitation rates of cryptic animals via repeated surveys of indirect signs. J Appl Ecol 45:728–735
Hell P (1980) Die Situation des Fischotters in der ČSSR. In: Reuther C, Festetics A (eds) Der Fischotter in Europa, Verbreitung, Bedrohung, Erhaltung. Selbstverlag der Aktion Fischotterschutz e V, pp 195–198
Hlaváč V, Toman A, Bodešínský M (1998) Experimentální reintrodukce vydry v Jeseníkách. Bull Vydra Vol 8. pp 37–39
Kloskowski J (2005) Otter *Lutra lutra* damage at farmed fisheries in southeastern Poland, I: an interview survey. Wildl Biol 11(3):201–206
Knollseisen M (1995) Aspects of the feeding ecology of the Eurasian otter Lutra lutra L. in a fishpond area in central Europe (Austria and Czech Republic). Diploma thesis, university of natural resources and applied life sciences, Vienna, pp 59
Kranz A (1995) Verbreitung der bayerisch-böhmisch-österreichischen Otterpopulation (*Lutra lutra*) 1994 in Österreich. BOKU Rep Wildl Res Game Manag 9:1–25
Kranz A (1999) Fischotterschutz, Aktionsplan für Österreich. Schriftenreihe des Naturschutzbundes Niederösterreich—Band 2
Kranz A (2000) Otters (*Lutra lutra*) increasing in central Europe: from the threat of extinction to locally perceived overpopulation. Mammalia 64(4):357–368
Kranz A, Toman A, Roche K (1998) Otters and fisheries in Central Europe: what is the problem? BOKU Rep Wildl Res Game Manag 14:142–144
Kranz A, Toman A, Knollseisen M, Prášek V (2002) Fish ponds in central Europe: a rich but risky habitat for otters. IUCN Otter Spec Group Bull 19A:181–186
Kranz A, Poledník L, Poledníková K, Toman A (2007) Otters in central Europe—Status, habitats, and new conflicts. In: Conroy JWH, Gutleb AC, Ruiz-Olmo J, Yoxon GM (Eds) Proceedings of the European Otter Conference "Return of the otter in Europe—Where and how?". J Int Otter Surv Fund No 2
Kranz A, Poledník L, Poledníková K (subm.) Efficacy of otter (*Lutra lutra*) odour repellents at fish farms
Kruuk H (1995) Wild otters: predation and populations. Oxford University Press, Oxford
Kruuk H, Conroy J (1987) Surveying otter *Lutra lutra* populations: a discussion of problems with spraints. Biol Conserv 41:179–183
Kruuk H, Carss DN (1996) Costs and benefits of fishing by a semi-aquatic carnivore, the otter *Lutra lutra*. In: Greenstreet SPR, Tasker ML (eds) Aquatic predators and their prey. Fishing New Books, London, pp 10–16
Kučera L (1980) Bestandesentwicklung des Fischotters in Böhmen und Mähren (ČSSR). In: Reuther C, Festetics A (eds) Der Fischotter in Europa, Verbreitung, Bedrohung, Erhaltung. Selbstverlag der Aktion Fischotterschutz e V, pp 199–204
Kučerová M, Roche K (1999) Otter conservation in the Třeboň biosphere reserve and protected landscape. Area: scientific background and management recommendations. Internal document of the council of Europe. T-PVS (2000) 20, Strasbourg, 2000, pp 103
Kučerová M, Roche K, Toman A (2001) Rozšíření vydry říční (*Lutra lutra*) v České republice. Bull Vydra 11:37–39
Macdonald SM, Mason CF (1987) The use of spraints for surveying otter *Lutra lutra* population: an evaluation. Biol Conserv 41:167–177
Moravcová J (2002) Biologie a ekologie vydry říční (Lutra lutra), výchova a vzdělávání k její ochraně. Diploma work, pedagogical faculty, Charles University, Prague
Myšiak J, Schwerdtner K, Ring I (2004) Comparative analysis of the conflicts between carp pond farming and the protection of otters (*Lutra lutra*) in upper Lusatia and South Bohemia. UFZ

Discussion Papers 8/2004, UFZ-Umweltforschungszentrum Leipzig-Halle GmbH, Leipzig. http://www.frap-project.ufz.de/downloads/Schwerdtner_et_al_2004.pdf. Accessed 15 Oct 2007

Novotná E (1998) Lidé a vydra, závěrečná zpráva sociologického průzkumu. Jiho-česká sociologická agentura, Zahrádky, pp 24

Poledník L (2005) Otters (*Lutra lutra* L.) and fishponds in the Czech Republic: interactions and consequences. PhD thesis, Palacky University Olomouc, pp 109

Poledník L, Mitrenga R, Poledníková K, Lojkásek B (2004) The impact of methods of fishery management on the diet of otters (*Lutra lutra*). Folia Zool 53:27–36

Poledník L, Poledníková K, Roche M, Hájková P, Toman A, Culková M, Hlaváč V, Beran V, Nová P, Marhoul P (2005) Záchranný program—program péče pro vydru říční (*Lutra lutra*) v České republice v letech 2006–2015. AOPK Praha

Poledník L, Poledníková K, Hlaváč V (2007) Program péče o vydru říční a výsledky monitoringu vydry v roce 2006. Ochrana přírody 62(3):6–8

Poledník L, Řehulka J, Kranz A, Poledníková K, Hlaváč V, Kazihnitková H (2008) Physiological responses of overwintering common carp (*Cyprinus carpio*) to disturbance by Eurasian otter (*Lutra lutra*). Fish Physiol Biochem 34(3):223–234. doi:10.1007/s10695-007-9180-3

Ring I, Santos R (2006) Module 9: development of policy instruments. In: Klenke R, Ring I, Kranz A, Jepsen N, Rauschmayer F, Henle K (eds) Human-wildlife conflicts in Europe—fisheries and fish-eating vertebrates as a model case. Springer, Berlin Heidelberg

Roche K (2001) Sprainting behaviour, diet and foraging strategy of otters (*Lutra lutra*) in the Třeboňsko protected landscape area and biosphere reserve. PhD thesis, academy of sciences of the Czech Republic, pp 135

Roche M (2003) Výsledky mapování výskytu vydry říční v ČR a zkušenosti s náhradami ztrát způsobených vydrou. In: Sýkorová Z (ed). Rybářství a predátoři. Sborník referátů z Odborného Semináře, Praha 18.9.2003. Český rybářský svaz, pp 14–18

Roche M, Toman A (2003) Metodika stanovení výše náhrad škod pro vydru říční. Report for ministry of environment of the Czech Republic. Czech Otter foundation found and agency for nature conservation and landscape protection of the Czech Republic, Třeboň, pp 5

Santos-Reis M (2006) Module 2: wildlife abundance and habitat. In: Klenke R, Kranz A, Jepsen N, Rauschmayer F, Ring I, Henle K (eds) Human-wildlife conflicts in Europe—fisheries and fish-eating vertebrates as a model case. Springer, Berlin

Schwerdtner K, Gruber B (2006) A conceptual framework for damage compensation schemes. Biol Conserv 134(3):354–360

Spurný P, Mareš J, Kopp R, Fiala J (2003) Socioekonomická studie sportovního rybolovu v České republice. Český rybářský svaz, Brno, pp 24

Toman A (1992) První výsledky Akce Vydra. Bull Vydra 3:3–8

Toman A (1998) Otters (*Lutra lutra*) versus privatisation in the Czech Republic. BOKU Rep Wildl Res Game Manag 14:6–7

Thum R, Schwerdtner K, Ring I (2003) Artenschutz und Teichwirtschaft. Rechtliche und institutionelle Rahmenbedingungen in Deutschland unter besonderer Berücksichtigung des Freistaates Sachsen. UFZ-Diskussionspapiere 11/2003, UFZ-Umweltforschungszentrum Leipzig-Halle GmbH, Leipzig, http://www.frap-project.ufz.de/downloads/ThumSchwerdtnerRing_2003.pdf. Accessed 15 Oct 2007