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# Impacts of otter (*Lutra lutra* L.) predation on fishponds: A study of fish remains at ponds in the Czech Republic

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**Abstract.** The increasing numbers of otters (*Lutra lutra* L.), which are protected by the Czech Act of Nature and Landscape Protection, are causing serious problems for fishpond management. The diet of otters on pond farms consists predominantly (80%) of common carp, *Cyprinus carpio*, and to a lesser extent other pond fish species (perch, *Perca fluviatilis*, zander, *Stizostedion lucioperca* and grass carp, *Ctenopharyngodon idella*). The size of carp captured by otters ranged between 376–683 mm TL (500 ± 88 mm) and 1,049–11,768 g (3,478 ± 2,867 g). Reconstructed original weight and length of captured grass carp and perch were 599 and 182 mm TL, and 2,665 and 163 g, respectively. In most of prey fish corpses left by otters, only viscera and associated parts were consumed. The weight of individual common carp corpses was estimated as 73.0 ± 24.6 (26.3–95.9)% of the original reconstructed weight, which means that only 27.0 ± 17.2 (4.1–73.7)% of fish body mass was consumed by otters. In perch, 62.8% of fish body mass was left unconsumed. Heavy losses have been reported also on fish stocks in ice-covered ponds during the winter period, when shoals of resting fish have been disturbed and stressed due to otter hunting.

**Key words:** Czech Republic, European otter, *Lutra lutra* L., Predation, Pond aquaculture

## Introduction

Recently, Czech fishpond management has been threatened by the serious problem of rapidly increasing losses caused by the animals, which are protected by the Act of Nature and Landscape Protection No.114/1992 (Adámek et al. 1999). Regarding fisheries, this concerns cormorant (*Phalac-*

*rocorax carbo*), beaver (*Castor fiber*) and otter (*Lutra lutra*). Losses of fishpond stocks by piscivorous and other birds in general, which in addition to cormorant also include protected grey heron (*Ardea cinerea*) and grebe (*Podiceps cristatus*), gull (*Larus ridibundus*) and swan (*Cygnus color*), are steadily rising. Although the financial compensation of fisheries deprivation caused by cormorant, otter and beaver is partly solved by the new Act (Recompense of Losses Caused by Selected Particularly Protected Animals; No. 115/2000), data supporting its application and use are still scant.

The problems associated with fisheries management and otter interference are of increasing importance in Central Europe due increasing otter population density and re-colonisation of biotopes where they had formerly occurred. These trends are particularly pronounced in fishpond regions (Kemenes and Nechay 1990; Bodner 1995). As concluded already by Baruš and Zejda (1981), otter occurrence on rivers decreased during the 1970's whilst increasing in still waterbodies including fishponds.

Estimated otter numbers in the Czech Republic, as presented by Nature Protection Agency, Anglers Union and Fish Farmers Association, diverge quite considerably – these institutions reported 600–700, 1380 and 1710 individuals respectively in 1998 (Adámek et al. 1999). By comparison, only 174, 187 and 200–300 individuals were reported in 1977/78 (Baruš and Zejda 1981), the early 1980's and early 1990's (A. Toman, personal communication). The reasons for the rapid increased spread of otters in Central Europe are associated with rapid improvements in their natural habitats and environment, including water quality. According to Baruš and Zejda (1981), the otter density was dependent among other factors, on water quality – in river sections with water of very good quality, one otter was reported per 14 km of this type of watercourse whilst in highly polluted water, this distance rose to 84 km.

It is generally accepted that fishpond production suffers from otter occurrence due to predation on fish stock. The total amount of losses caused by otters on fish farms was estimated as 7.28 million CZK in 1999, whilst in all waterbodies within the Czech Republic it was 48.2 million CZK (equivalent to approx. $US 0.192 and $US 1.268 million, respectively) (Czech Ministry of Agriculture 2000).

## Material and methods

The remains (corpses) of fish captured and consumed by otters were collected and registered in the area of Vodňany fishpond systems during the winter period of 1999/2000 and 2000/2001. Where possible, fish corpses were measured to nearest TL (mm). The parts of fish, which were left uneaten, were

weighed (to nearest gram) in order to enable an assessment of the proportion of the body mass consumed by the otter. Altogether, 4 and 21 corpses were examined in the seasons 1999/2000 and 2000/2001 respectively. Some corpses were subsequently consumed by birds (crows in particular) as seen from their footprints in snow and evidence of pecking in frozen flesh. These remains were not included in the evaluation.

The 10th caudal vertebra from the urostyl (distal end) was removed for determination of the original fish size and weight. For further estimations, regression equations of the relationships between horizontal diameter of the vertebra and fish TL and weight were calculated. Fish, in which the caudal part including vertebral column had been removed by otters, were excluded from size reconstruction estimate. This applied to four specimens of common carp (*Cyprinus carpio*) and one specimen of zander (*Stizostedion lucioperca*).

The removal of vertebra was carried out as follows: The caudal part of fish was detached and the maximum possible amount of flesh was removed from the area of vertebral column by scalpel. In preliminary trials, two ways of eliminating remaining flesh were compared – application of enzymatic powder and liquid Golem Bio (Druchema Prague, CR) and boiling. The application of biological enzymatic disintegration of fish flesh using washing powders was recommended by Carss (1997) for the analyses of fish remains in cormorant stomachs whilst boiling for 1–10 minutes was used for these purposes e.g., by Prenda and Granado-Lorencio (1992). In eight randomly selected samples of common carp vertebrae after the enzymatic disintegration of flesh, the diameter was measured after drying and subsequently subjected to boiling for 10 minutes, dried and measured again. The values of original vertebral diameters after enzymatic disintegration and corresponding values after subsequent boiling were compared by the paired t-test analysis to check the compatibility of the two procedures.

Ten-minute boiling was selected for further evaluation of the relationship between vertebral diameter and fish size. Altogether 22 individuals of local Vodňany strain of common carp (*Cyprinus carpio*), 3 grass carp (*Ctenopharyngodon idella*) and 9 perch (*Perca fluviatilis*) individuals were used to construct the appropriate linear regressions from which the corresponding original sizes were estimated (Figures 1 and 2).

## Results

The average diameter of vertebrae removed by enzymatic disintegration was 9.41 $\pm$ 2.78 mm. After subsequent processing by boiling for 10 min, the corresponding vertebral diameter was 9.57 $\pm$ 2.67 mm. The values do not differ significantly ($P = 0.06$, $n = 8$). The regression equations of the rela-

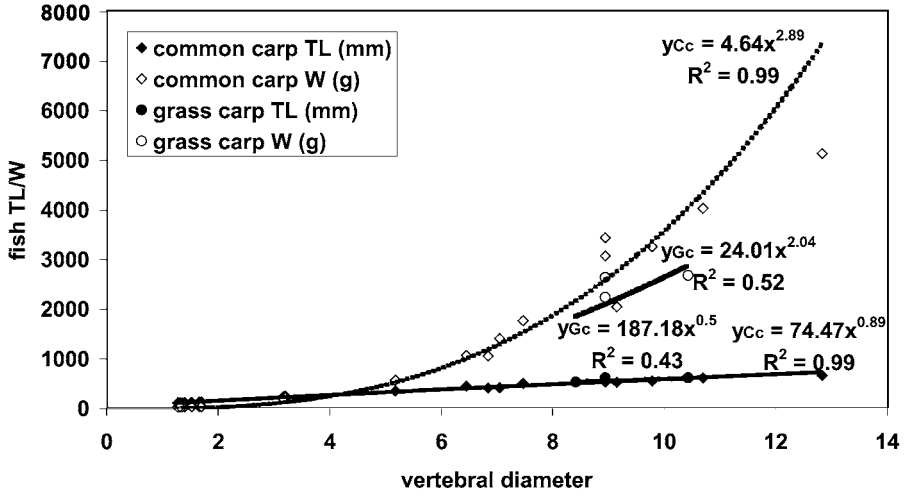


*Figure 1.* Regression curves for the relationships between the vertebral diameter and fish length (TL) and weight (W) in common carp (Cc) and grass carp (Gc).

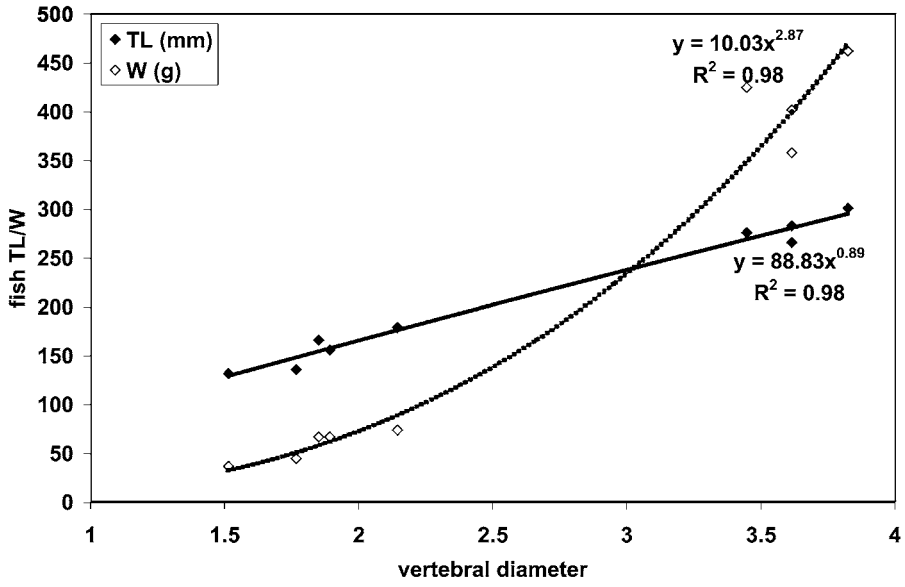


*Figure 2.* Regression curves for the relationships between the vertebral diameter and fish length (TL) and weight (W) in perch.

*Table 1.* Mean actual (MA) and reconstructed (MR) sizes of prey fish corpses left by otters (mean ± S.D.)

| Fish species | n | Length (mm) | | Weight (g) | | % left | % consumed |
|---|---|---|---|---|---|---|---|
| | | MA | MR | MA | MR | | |
| Common carp (*C. carpio*) | 22 | 498±101 | 533±113 | 1743±1099 | 2320±2448 | 73.0±24.6 | 27.0±24.6 |
| Grass carp (*C. idella*) | 1 | | 602 | | 2754 | | |
| Perch (*P. fluviatilis*) | 3 | 258 | | 112±122 | 195±134 | 62.8 | 37.2 |
| Zander (*S. lucioperca*) | 1 | 458 | | 602 | | | |

tionship between the vertebral diameter and common carp size (n = 22) were as follows: $y = 74.47x^{0.89}$ ($r^2 = 0.99$; $P < 0.01$) and $y = 4.64x^{2.89}$ ($r^2 = 0.99$; $P < 0.01$) for TL (in mm) and W (in g), respectively (Figure 1). In grass carp (n = 3), following formulas were applied: $y = 187.18x^{0.51}$ ($r^2 = 0.43$; $P > 0.05$) and $y = 24.01x^{2.04}$ ($r^2 = 0.52$; $P > 0.05$) for TL (in mm) and W (in g) respectively (Figure 1). In perch (n = 8), the respective equations were as follows: $y = 88.83x^{0.89}$ ($r^2 = 0.98$; $P < 0.01$) and $y = 10.03x^{2.87}$ ($r^2 = 0.98$; $P < 0.01$) (Figure 2). Using these data, the original sizes of prey fish were reconstructed.

During the winter seasons, 24 corpses of fish caught and left by otters were found and examined. One corpse (carp) was found during the summer (7 Aug 2001). From the total amount, 17 fish (13, 3 and 1 specimens of carp, perch and zander, respectively) were found at the supply channel to the fishpond ($Q_a = 0.7$ m$^3$ s$^{-1}$) while the remaining 8 fish were found in the immediate vicinity of fishponds and/or on their ice-covered surface. Among the fish, there were twenty (80.0%) common carp, three (15.0%) perch, one grass carp and one zander (2.5% each). The original size of common carp captured and partly consumed by otters ranged between 376 and 683 mm TL (500 ± 88 mm; n = 13) and 1,049 and 11,768 g (3 478 ± 2 867 g, n = 13). Reconstructed original weight and length of captured grass carp and perch were 599 and 182 mm TL and 2,665 and 163 g, respectively.

In most prey fish, only viscera and associated parts of the flesh were consumed by otters. The weight of prey carp and perch remains was estimated as 73.0 ± 24.6 (26.3–95.9) and 62.8% of original reconstructed weight

respectively (Table 1). This means that at most only 27.0 ± 24.6 (4.1–73.7) and 37.2% of carp and perch body mass respectively was consumed by otters.

## Discussion

The evaluation of otter diet composition as apparent in the literature is usually based on the data revealed from analyses of bones found in otter faeces (e.g., Prenda and Granado-Lorencio 1992; Adámek et al. 1999; Kloskowski et al. 2000). No available published scientific study deals with estimates based on analyses of unconsumed remains left by otters. The first mentioned approach might possibly be suitable in analyses of otter diet in trout waters, in which fish sizes do not exceed a certain limit, as given by Kožená et al. (1992). However in bigger fish captured and partly consumed by otters on fishponds, further analysis based on "the amount of hypuralia, eye lenses, vertebrae and scales of different sizes, or toothed jaws preserved in the faeces" (Kožená et al. 1992) is impossible. Because of the size of fish captured, they do not appear in otter faeces. Erlinge (1967) and Jacobsen and Hansen (1996) believe there is under-representation of larger fish in the diets of otters determined from analysis of spraints, because parts of the prey are discarded by otters.

On the other hand, small fish are often consumed completely and their proportion in otter diet cannot usually be estimated from remains left on ice or on pond or river banks. Hence, the complete analysis of otter diet should include both indicators of feeding activity: partly consumed corpses and faeces composition.

Common carp is a preferred food item in otter diet with 23–52% of the biomass of fish taken in South Bohemia, as revealed from analyses of otter faeces (Adámek et al. 1999). This is because these fish are most abundant in fishponds with highest concentration and easiest availability during the overwintering period. The same study showed that the proportion of carp in otter diets rose from 17–18% in summer and autumn to 25–34% during winter and early spring.

The above mentioned study also documents the discrepancies in otter diet studies performed in fishpond regions. In spite of the local proximity and similarity (identical in fact) of fisheries management of fishponds of the Třeboň (Adámek et al. 1999) and Vodňany (present study) regions, the estimated maximum size of fish consumed by otter differs considerably. In the Třeboň region, where procedures based on otter faeces analyses were applied, the $< 100$ mm size class unambiguously dominated and fish size class $> 200$ mm comprised only 2% with no fish exceeding 350 mm TL. However in this study, based on analyses of fish corpses left by otters, the

maximum size of registered fish was 678 mm. Data from the other Czech regions (e.g. Třeboň in winter 2000/2001) document the otter attacks and fatal damages of common carp over 6 kg. The record size of otter's success in carp capture was documented in Finland (J. Pennanen, personal communication) by an 88 cm specimen of common carp (14.5 kg of remains was left by otter).

The question of fisheries management and otter impacts has been generally inferred from the presence of fish in otter diets. No data have been published up to now about the secondary losses caused by otter predation and hunting activities in fishponds as they appear particularly during the period of fishpond stock overwintering. In Central Europe, carp and other fishpond species pass the winter in inactivity ("winter resting") associated with considerably reduced rates of metabolism including respiration, movement etc. This is a period during which fish are extremely susceptible to disturbance and stress caused by otters attacking shoals resting on the bottom. Fish shoals interrupt the resting phase and start to move along under the ice cover of a pond. This situation is associated with weight losses, weakening of fish and increased susceptibility to infections and parasite invasions. Fish appear under the ice and in the area of the pond inflow. As a result, a considerable part of the fish pond stock may subsequently die.

These heavy losses have been reported from various fishponds in South Bohemia. During the period of ice thawing in early March 2001, 12 common carp and grass carp were reported as captured and partly consumed by otters on Dřemliny Pond (Vodňany region). However on the same occasion, 57 fish were found dead as a result of stress associated with otter hunting. Similar losses were also reported from the Jindřichův Hradec region (J. Švec, personal communication), where almost the whole stock of golden orfe (*Leuciscus idus* m. *orfus*) was lost after repeated otter incursions during the winter of 2000/2001. Only 600 individuals survived from the initial 20 thousand fish stocked in the autumn. These findings suggest an urgent need for research into otter ecology and predatory behaviour on fishponds.

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