Otter Lutra lutra damage at farmed fisheries in southeastern Poland, II: exploitation of common carp Cyprinus carpio

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SHORT COMMUNICATION

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Otter *Lutra lutra* damage at farmed fisheries in southeastern Poland, II: exploitation of common carp *Cyprinus carpio*

Janusz Kloskowski

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I carried out a 2-year study on otter *Lutra lutra* dietary composition at a fish farm in southeastern Poland, where otters were perceived to inflict serious damage to common carp *Cyprinus carpio* stocks. The aim of my study was to determine the role of commercial fish in the diet of otters living in habitats comprising carp fisheries. Otter diet was examined by scat analysis. On an annual basis, carp dominated otter diet with 43% by weight. However, in terms of numbers, smaller wild species such as Prussian carp *Carassius auratus gibelio* (27%) and roach *Rutilus rutilus* (12%) were more abundant in the diet, whereas carp accounted for only 10%. The availability of farm cohorts of different age compared with frequencies of carp age classes recorded in spraints indicated otter preference of 1+ over 2+ carp. The exploitation of farmed stocks was most intense from autumn to early spring, unless the access to stocks was prevented by the presence of ice cover. In areas with carp farms, otters may rely on cultured stocks, especially during periods of food stress.

Key words: carp, Cyprinus carpio, fish culture, Lutra lutra, predation, spraint analysis

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The apparent expansion of otter *Lutra lutra* populations in some central and East European countries is associated with a growing concern about otter depredation of commercial fish stocks (Brzeziński et al. 1996, Kranz 2000). Common carp *Cyprinus carpio* is the main species cultivated in the region. Carp stocks are particularly susceptible to otter predation because fish are maintained in large outdoor facilities. The non-lethal measures of predation control (Bodner 1995), applicable in other conditions, remain impractical (Kloskowski 2005). Information on the size of fish most efficiently exploited and the seasonal use of farming sites by predators can be used to lower the potential for losses (Parkhurst et al. 1987). Hence, understanding of otter ecology at farmed fisheries, especially of possible prey preferences and seasonal patterns of predation could be potentially helpful both to mitigate depredation problems and for an appraisal of the role of cultured fish in otter food. However, despite some studies on otter diet at cyprinid fisheries (e.g. Roche 1998, Geidezis 1999, Kloskowski 1999), knowledge on otters' feeding ecology in conditions of carp ponds' presence is still limited.

In this paper, I present the results of a 2-year study on otter feeding habits at a pond complex in southeastern Poland, where the fishery staff perceived otter damage to carp stocks as heavy. The results are discussed with reference both to the importance of farmed ponds for otter populations and to the implications for fisheries management practices.

Material and methods

Data on otter diet were obtained at the Jedlanka fish farm in the province of Lublin (22°56'E, 51°29'N). Spraints were collected during 1-4 day-walks bimonthly in 1994-1995 at 13 carp ponds covering areas of 1.1-16.6 ha and in total comprising 130 ha of total water surface, a small lake adjacent to the ponds covering 8.1 ha area, stocked and harvested at the same time as the ponds, dykes adjacent to and interweaving the study area, and a part of the Bobrówka river supplying water to the ponds.

Carp did not occur naturally in the Bobrówka watershed and the river was not stocked by anglers, so assessing the origin of carp remains found in otter spraints posed no methodological problem. Otters were the main natural predator on farmed fish. In the study period, the fishery staff unanimously assessed stock losses to otters as heavy (Kloskowski 2005).

Spraints were analysed following standard methods (e.g. Webb 1976). Discernible fish species and amphibian material (species-specific 'keybones') were identified in the laboratory. The highest minimum total of any of the keybones (mainly pharyngeal teeth, maxillae, dentaries, preoperculae, operculae and articularies) present was scored to obtain the number of consumed individuals in a spraint. Fish scales and vertebrae were used only when no other keybones of the given species were retrieved from a day's spraints sample. Keybone length was converted to total fish length and then to weight using regressions established from fish samples collected in the region (Kloskowski et al. 2000), or taken from literature (e.g. Kovalev 1958, Libois et al. 1987). In a few cases of unidentified cyprinids, conversion equations for the most likely species were applied. Amphibian body mass was estimated from a reference collection by adopting three weight classes for each species. Birds were identified by their feathers and mean weights were taken from Brom (1986). Mammal hair was identified either to family or order (Day 1966) and weights of 10 g were approximated for soricids and rodents.

In total, 1,116 spraints were analysed. Independent of certain inequalities in the sampling effort, numbers of spraints collected varied dramatically with especially low scores in summer 1994 (see Results). As the small sample from July-August 1994 (N = 4 spraints) was insufficient for reliable indication of prey proportions, data from this period were omitted in the seasonal comparisons.

Faecal samples were pooled to provide bimonthly totals. Results are presented as relative frequency of numbers - percentage of the minimal number of individuals of a prey category relative to the total number of prey individuals, and relative weight percentages - percentage of total weight of individuals of a prey category relative to the total weight of all prey individuals (Bekker & Nolet 1990). Most statistical analysis is based on weight percentages, as these probably most adequately quantify the importance of various prey categories (Bekker & Nolet 1990) and the data pertain to this method, unless explicitly mentioned.

All carp age classes were raised in Jedlanka, but 0+ (fry) cohorts were translocated to another pond complex in October for the winter and restocked in the following spring. This allowed assessment of otter selection of 1+ (fish having wintered once) and 2+ ('marketable' carp having wintered twice) cohorts. The local fisheries managers provided detailed data on fish supply and stocking regimes at each pond. Each year 1-2 ponds were not drawn down for/after wintering; their losses were estimated using the data from the next draining and from other ponds with the same age classes. In both years of study data on total 1+ and 2+ carp numbers acquired from harvesting or transfer to wintering ponds (starting in October) and from restocking in spring (starting in March) were compared with numbers of individuals of different age classes represented in spraints collected in November (i.e. during the first month following restocking in autumn) and in February (the last month before restocking in spring). Preferences for the two carp age classes, based upon the frequency of prey numbers, were calculated using Manly's standardised selection ratio (Manly et al. 1993). The selection ratio, $\hat{w}_i$, can be calculated as

$$\hat{w}_i = o_i/\pi_i,$$

where o_i is the proportion of prey type i in the diet and π_i is the proportion of prey type i available in the environment. The selection ratios can be standardised so that they add to 1:

$$B_i = \hat{w}_i/\sum\hat{w}_j$$

and 95% confidence limits for the selection ratios w_i were computed (Manly et al. 1993). I used χ^2-test to determine whether the frequencies of carps representing the given age class in otter spraints were significantly different from their numerical availability in the ponds.

Results

Otters fed primarily on fish, and this prey group comprised > 90% of food both by weight and numbers in all months except in January-February 1995 when it comprised 68.2% in terms of weight (this was also the only period during which waterbirds of Anseriformes with 29.8% were important in otter food) and in July-August 1995 when it comprised 67.5% in terms of weight and 63.4% in terms of numbers and during which period amphibian contribution reached its peak with 31.5% of food biomass and 35.2% by numbers. With the exception of these months the proportion of fish varied little throughout the study period (Fig. 1). The estimated carp proportion in otter food by weight was on average highest in March-April (50.2% in 1994 and 53.9% in 1995) and lowest in May-June (33.5% in 1994 and 36.2% in 1995; see Fig. 1). High exploitation of carp was recorded in November-December 1994 (52.1%), while it was the lowest in the same period of 1995 (29.2%).

The total length of carps taken by otters ranged within 35-442 mm (N = 382), however, 96% of captured carps were within 66-304 mm. The importance ranks of fish species taken by otters diverged, when expressed by different methods. In terms of biomass, carp was the major dietary item with a mean of 43.5% on an annual basis, while roach *Rutilus rutilus* (12.8%) and Prussian carp *Carassius auratus gibelio* (10.2%) were the most important wild fish prey. Numerically carp with an estimated 10.3% of the diet was less abundant in spraints than both Prussian carp (27.4%) and roach (12.0%). Even the smallest species (all specimen taken by otters < 60 mm), i.e. white bream *Leucaspius delineatus* and the gasterosteids *Pungitius pungitius* and *Gasterosteus* *aculeatus*, which together made up only 2.4% by weight, figured strongly in otter diet in terms of numbers (17.9%). Piscivorous fish, such as pike *Esox lucius* and perch *Perca fluviatilis* >100 mm in length, exceeded 5% of otter food both by weight and numbers only in January-February 1994.

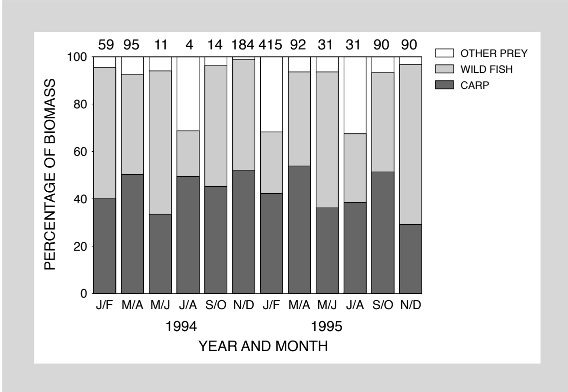

Figure 1. Bimonthly variation in the major prey categories in otter diet by weight in the Jedlanka ponds during 1994-1995. The figures above the columns denote sample sizes (number of spraints).

Spraint analysis showed that otters had a clear preference for 1+ over 2+ carp in February and November 1994, but the preference indices in February 1995 only approached significance (Table 1). In November 1995 the sample of carp individuals (N = 9) represented in spraints was insufficient for a meaningful analysis. Wild fish species taken by otters were smaller than carp throughout the study period (Mann-Whitney U-test: all $P < 0.01$).

Discussion

Estimating diet composition from spraints is a rough method associated with a number of potential biases (Carss & Parkinson 1996). Moreover, assessment of the extent of otter depredation requires data on numbers of individuals visiting the fish farm. Such estimates are difficult as both the size of home ranges of resident otters

Table 1. Estimated selection indices for the exploitation of 1+ vs 2+ carp stocks by otters. Selection ratios are given only for 1+ carp as the values of B_i add to 1. Confidence limits of the selection ratio $\hat{w}_i > 1$ indicate significant preference for the given age class.

		Confidence limits					
Month	$\hat{w}_i$	Lower	Upper	B_i	χ^2	P	Number of spraints
February 1994	1.38	1.37	1.38	0.89	10.0	0.001	42
November 1994	1.52	1.50	1.53	0.92	7.6	0.006	107
February 1995	1.19	1.17	1.21	0.75	2.9	0.088	109

and numbers of individuals visiting the farms can fluctuate in the course of the year. Especially during food shortage in winter otters may congregate at overwintering ponds (Dulfer et al. 1998).

Otter droppings collected at fish ponds or in the areas adjacent to the ponds were dominated by remains of carps cultured in the ponds. Carps taken by otters were also consistently larger than wild fish prey throughout the year. It indicates that in 'natural' habitats adjacent to the ponds the available fish were smaller than preferred by otters (Kloskowski 1999). Still, wild prey, mainly fish and amphibians, constituted on average more than half of the estimated diet by weight. Carps formed only $^{1}/_{10}$ of the overall diet in terms of numbers. Prey importance rankings obtained by the two methods of prey proportion estimation showed pronounced differences as frequency of numbers emphasised the role of small-bodied fish species. Predatory fish large enough to be piscivorous were scarcely represented in spraints; hence, only a small fraction of the tiny fish in the otter diet could have been secondarily consumed (Carss & Parkinson 1996). Another source of underestimation of larger carps in spraints is higher bone:flesh ratio in small prey (Erlinge 1968) and the differential recovery of various size classes of keybones (Carss & Nelson 1998). Similarly, only feathers and no bones of relatively large overwintering birds (Anseriformes) were retrieved from spraints. On the other hand it is relatively unlikely that large 'marketable' carps were eaten whole by the otters, so using weights calculated on the basis of keybone sizes may lead to overestimation of the proportion of large carps in otter diet. Bearing in mind the above caveats of spraint analysis, the apparent preference of 1+ over 2+ carps should be interpreted with caution. Even if otters generally favour small fish, or just avoid the biggest fish (e.g. > 1 kg; Lanszki et al. 2001), it is of little meaning for fisheries practices, as otters may, under circumstances, attack the heaviest specimen (brood fish) maintained at the fisheries (Kloskowski 2005).

Carp contribute substantially to otter diet in areas with fish farms (Roche 1998, Geidezis 1999, Kloskowski 1999). Otters appear to rely on farmed stocks because of poor natural fish resources or situations of artificial high density of prey. Cultured fish may be especially important as big and easily accessible prey when cubs are being reared, and in winter when food is scarce and food requirements increase (Kruuk 1995). Although carp was a stable food source throughout the year, its use increased in colder months, except in the months when heavy ice formation apparently hindered exploitation of pond fish (see also Kloskowski 1999), e.g. in December 1995 which was the coldest month of the decade in the region (Institute of Meteorology and Water Management in Radawiec, unpubl. data). Similarly, the numbers of spraints found at carp fisheries dropped markedly in summer and increased in cold months. Seasonal fluctuations in marking activity of otters may be unrelated to food resources, but it cannot be ruled out that they roughly mirror the extent of habitat exploitation (Kruuk 1995, Kloskowski 2000). The attractiveness of farmed stocks to otters in winter is of importance for fisheries management, because carps are usually concentrated for overwintering in a few ponds. Disturbance of inactive fish during this period is associated with considerable loss of weight and condition, and consequently reduced market value and even stress-related mortality (Bodner 1995, Roche 1998). Therefore, use of non-lethal predator control devices, and also adoption of reimbursement systems, in winter could ensure the highest effectiveness, both because a smaller area would be protected and because they would prevent the seasonally heaviest economic damage.

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