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Research Article

Seasonal Diet of the Otter (*Lutra lutra*) On the Alazani River (Georgia)

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Abstract

The seasonal diet of the Eurasian otter (*Lutra lutra*) was studied on Alazani river, eastern Georgia, by spraint analysis. The frequency of occurrence (FO) of prey items for fish species, and biomass consumed (BC) were estimated. Fish and amphibians formed the bulk of the otter diet in the study area (49.8-30.0% FO and 23.6-36.2% FO, in the cold and warm season, respectively). Reptiles (*Natrix tessellata* and *N. natrix*) were also important (11.5% and 13.4%). Mammals (mice and muskrats), birds, insects (Dytiscidae and Acridoidea), molluscs and crayfish formed a minor part of the diet. Crucian carp (*Carassius carassius*) and common carp (*Cyprinus carpio*) were the most important fish in the otter diet, while, and with regard to amphibians only *Rana ridibunda* was found.

Food niche breadth in the warm season was about twice as much as in the cold one. Crucian carp predominated in the diet in both the warm (37.9% BC and 52.0% FO, respectively) and cold season (90.4% BC and 82.0% FO).

Introduction

The Eurasian otter (*Lutra lutra*) has one of the widest distributions of all Palearctic mammals (Kruuk, 2006) due largely to its ability to thrive in a variety of habitat types. It can be found in highland and lowland lakes, rivers and streams as well as marshes, swamp forests and coastal areas, irrespective of their size or latitude (Mason and Macdonald, 1986). Otter diet is also highly variable (both temporally and geographically) and may incorporate a wide variety of aquatic animals, including amphibians, reptiles, crayfish, crustaceans, aquatic insects, birds and mammals (Jedrzejewska et al., 2001; Clavero et al., 2003).

In most parts of Europe otters feed primarily on fish (Mason and Macdonald, 1986; Lanszki and Molnár, 2003; Lanszki and Sallai, 2006; Prigioni et al., 2006), with seasonal and habitat-related variations. The relative importance of fish in the diet is significantly higher in reservoirs and lakes than rivers and streams (Ruiz-Olmo et al., 2001). In Mediterranean ecosystems, some authors have reported a decrease in fish consumption, with respect to temperate areas, compensated by otter predation on several alternative resources, such as crabs, crayfish, amphibians, insects (Adrian and Delibes, 1987; Ruiz-Olmo et al., 2001).

In the past, the otter was widespread throughout Georgia, occurring in almost every river and lake. With a generally declining trend, currently the Eurasian otter is listed in the Red Data Book of Georgia as "Nearly Extinct Rare Species". Habitat destruction and reduction in prey availability are thought to be the main causes of this decline. Effective conservation measures need to be based on sound ecological principles and yet the habitat and dietary requirements of the otter in Georgia are poorly known. We investigated the food requirements of otters living in the basin of the Alazani river in order to obtain data on the composition and seasonal variation of otter diet.

Study Area

The study area included a 21 km section of the Alazani river, one of the longest rivers in Georgia, and its associated riparian forest (latitude: 41.6517590 N, longitude: 46.1213690 E). The Alazani is one of the major tributaries of the Kura river and flows down from the southern slopes of the Main Caucasus Mountain Range.

The basin of the Alazani river is part of a transition zone between the sub-tropical and continental climates. Hot summers and warm winters characterize the climate, with annual average rainfall and temperatures being about 600 mm and 13.4° C, respectively. On its right bank, the steppe predominates, while the left bank mainly shows a semi desert flora and fauna. The fertile soils of the Alazani depression support a variety of crops, vineyards and livestock. These agricultural lands need to be well irrigated and thus are crossed by an extensive network of ditches. Most of the channels are medium-sized with relatively constant water levels and aquatic vegetation. The discharge of both the Alazani and its tributaries significantly fluctuates during the year. In winter, many rivers in the basin are dry whilst in spring, as the snow on the mountains begins to thaw, inundations and floods are common (Alazani Basin Management Plan, 2005).

The river flows through sandy soils. Floodplain forests are dominated by poplar (*Populus canescens*, *Populus nigra*), and oak (*Quercus pedinculiflora*) is also present. Other typical species are *Smilax excelsa*, *Periploca graeca*, and *Vitis silvestris*.

There are 18 fish farms along this section of the river, primarily on tributaries of the main river. Fish farmers produce marketable fish such as common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmiehthys molitrix*), catfish (*Silurus glanis*) and crucian carp (*Carassius carassius*). The majority of fishponds are drained for the winter with the fish either moved to selected ponds or transferred to deeper (mostly concrete) over-wintering ponds.

Methods

The diet of otters was investigated in 2006-2007 through the collection and analysis of spraints (droppings). Sprainting sites were visited twice per month and a total of 791 spraints were collected. Spraints were air dried at room temperature and weighed. Before the analysis, spraints were washed through a 0.5 mm mesh sieve, air dried again and then

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Table 1 – Diet of the otter (percent frequency of occurrence, FO) on the Alazani river in cold and warm seasons. BA = Levin's standardized niche breadth, N = number of analyzed spraints.

	Cold	Warm	Chi-square test	
Items	**FO**	**FO**	χ^2	***p***
Fish	49.8	23.6	44.71	< 0.0001
Reptiles	11.5	13.4	0.57	< 0.05
Amphibia	30.0	36.2	2.83	>0.05
Aves	3.7	-	-	-
Mammalia	4.3	3.1	0.52	> 0.05
Insecta	-	7.9	-	-
Crustacaea	0.6	9.4	42.71	< 0.0001
Molluscs	-	6.3	-	-
BA	0.260	0.492		
N	567	224		

gently broken by hand. Final examination of the contents was carried out using a binocular microscope (8 x – 40 x).

Food remains were divided into eight groups: mammals, birds, reptiles, amphibians, fish, crayfish, insects and molluscs. The undigested remains of insects (wings, legs and cuticle parts) were identified using personal collections. Fish, reptiles, mammals and amphibians were identified to species level. Using personal collections, fish remains were identified from their vertebrae, jawbones and scales; reptiles and amphibians were identified from bones; mammals were identified from teeth and hair. All analysis was performed at the Ilia State University.

The personal collections of fish were built up using samples belonging to different age groups obtained from local fish farms. Each sample was identified, measured and weighed. Vertebrae, jawbones and scales were then extracted, measured, weighed and stored. The minimum number of individuals was estimated according to paired bones and from size differences between vertebrae or other bones. The reference collection of skeletons and scales of fish was set up in order to reconstruct original fish length from key bones. The key bones of different species were measured to nearest 0.1 mm where possible. This method enabled an exact calculation of original length of fish.

Data were split into cold season (November-March) and warm season (April-October).

The frequency of occurrence (FO) of each food item was calculated as percentage of the total number of spraints. The breadth of food niche was evaluated using Levin's standardized niche breadth (BA) (Krebs, 1999):

$$B_A = \frac{1/\sum p_i^2 - 1}{n - 1} \quad (1)$$

where n is the number of food items and p is the proportion of each food item.

To estimate fish biomass (BC, g/100m^2) consumed by the otter, the weight of fish preyed upon by otters was assessed by comparing the size (length, width, thickness or weight) of vertebrae and fish jawbones obtained from spraints to those of our fish collection.

The Chi-square test was used to examine differences in otter diet composition (eight prey categories) between the different seasons. The same test was also applied to reveal how significant were changes in the frequency of occurrence of fish species in different seasons. To assess differences between the seasons of consumed fish biomass we used the t-test and Levine's Test. The SPSS 16.0 statistical package was used for the processing of the data obtained.

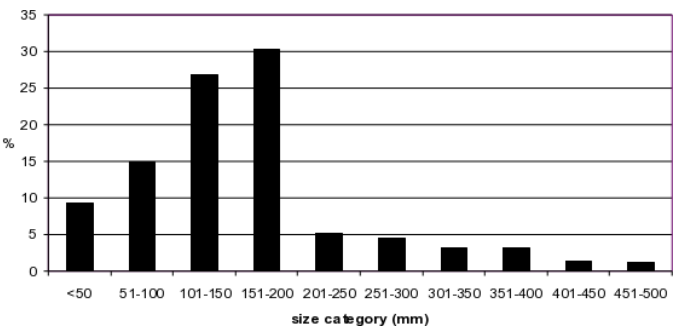

Figure 1 – Distribution of prey fish size (50 mm categories) estimated from spraints.

Results

Fish and amphibians made-up the bulk of the otter diet in the study area (49.8-30.0% FO in the cold and 23.6-36.2% FO in the warm season, respectively). Reptiles were also important (11.5% and 13.4%) while mammals, birds, insects, molluscs and crayfish (*Astacus* sp.) were of minor importance (Tab. 1).

The significant different between the seasons was observed in fish (Chi-Square test, $\chi^2 = 44.71$, $p < 0.001$) and crayfish (Chi-Square test, $\chi^2 = 42.71$, $p < 0.001$). Conversely, the cold season seemed to bring-about an increase in mammal consumption. Birds were consumed only during the cold season; insects and molluscs were found in the warm season. There was no significant difference between the seasons in consumption of amphibians (Chi-Square test, $\chi^2 = 2.83$, $p > 0.05$) and reptiles (Chi-Square test, $\chi^2 = 0.57$, $p > 0.05$). The role of the non-fish component (molluscs, insects and crayfish) of the diet was considerable in warm season, when the consumption of fish has been decreased.

It should be noted that consumption of amphibians in the study area was quite stable 30.0-36.2% FO, and in summer was even higher compared to fish. Food niche was larger in the warm season (BA = 0.492) than in the cold one (BA = 0.260).

Crucian carp (*C. carassius*) and common carp (*C. carpio*) were the most important fish in otter diet (Tab. 2). Among amphibians, only frogs, *Rana* sp. (mainly *Rana ridibunda*) were found, while dice snake (*Natrix tessellata*) and grass snake (*Natrix natrix*) were the only reptiles. All mammals preyed upon by otters were rodents with mice (*Apodemuss* sp.) and muskrat (*Ondatra zibethicus*) making up 69% and 31% of preyed mammals respectively. Water beetles (Dytiscidae) and grasshoppers (Acridoidea) were the main groups of insects consumed by otters.

The bulk of fish biomass consumed by otters on the Alazani was composed of *C. carpio* and *C. carassius*, the latter being dominant in both the warm and cold season. The consumption of *C. carassius* increased in cold season (80.16% FO, Chi-Square test, $\chi^2 = 23.12$, $p < 0.001$). *C. idella* and *S. glanis* were found during the warm season and almost disappeared from otter diet in the cold one. *Rutilus rutilus* and *Hypophthalmichthys molitrix* were of minor importance in cold season and increased in warm season (Chi-Square test for *R. rutilus*, $\chi^2 = 9.01$, $p < 0.003$ and Chi-Square test for *H. molitrix*, $\chi^2 = 15.35$, $p < 0.001$).

The mean biomass of consumed fish during the cold season was less compared to the mean biomass consumed during the warm season 122.70±190.62 and 283.31± 391.19 g/100m^2 (t = -4.54; $p < 0.0001$) (Tab. 3). The difference in biomass consumption between the seasons was with *H. molitrix*, where increase was observed in the warm season.

Small fish (< 200 mm) predominated (81.2%) in the otter diet. The highest proportion was formed by size categories 101-150 mm (26.8% of individuals) and 151-200 mm (30.3%, Fig. 1).

Only 9.2% of all fish found in spraints exceeded 300 mm.

Discussion

Otters feed on a whole range of prey (Webb, 1976; Jenkins et al., 1979; Wise et al., 1981) and the importance of each to the diet of the otter varies significantly between habitats (Brzezinski et al., 1993; Sulkava, 1996; Sidorovich, 1997, 2000; Jedrzejewska and Jedrzejewski, 1998; Taastrom and Jacobsen, 1999). On rivers in Finland, Latvia, Poland and Belarus fish and amphibians usually predominate in the diet of otters, although the dominant prey item can change in the course of the year (Sulkava, 2006; Jedrzejewska and Jedrzejewski, 1998; Sidorovich, 2000; Jedrzejewska et al., 2001). In north-west Russia, amphibians are the most important prey (Tumanov and Smelov, 1980). Our study showed that, on the Alazani, fish forms the bulk of otter diet during the

Table 2 – Fish in the diet of the otter in southeastern Georgia. Frequency of occurrence (FO), Cold season: autumn-winter, warm season: spring-summer.

	Cold season FO, n=257		Warm season FO, n=55		Chi-square test	
Preyed fish	**abs**	**%**	**abs**	**%**	χ^2	***p***
Cyprinus carpio	42	16.34	10	18.18	0.11	< 0.05
Ctenopharyngodon idella	0	0.00	4	7.27	-	-
Hypophthalmichthys molitrix	3	1.17	6	10.91	15.35	0.0001
Silurus glanis	0	0.00	2	3.64	-	-
Carassius carassius	206	80.16	27	49.09	23.12	< 0.00001
Rutilus rutilus	6	2.33	6	10.91	9.01	0.0003

Table 3 – Statistical analysis of consumed fish biomass. Cold season – autumn-winter, warm season – spring-summer.

	Cold season			Warm season			t-test	
Preyed fish	**n**	**Mean**	**Std. Dev.**	**n**	**Mean**	**Std. Dev.**	**t**	***p***
Cyprinus carpio	42	362.68	364.82	10	266.30	11.10	0.829	0.411
Ctenopharyngodon idella	0	-	-	4	1185.49	172.08	-	-
Hypophthalmichthys molitrix	3	1.02	0.36	6	931.06	296.23	-5.254	0.001
Silurus glanis	0	-	-	2	15.18	13.39	-	-
Carassius carassius	206	77.9985	67.03635	27	90.19	123.19	-0.789	0.431
Rutilus rutilus	6	34.9967	22.60065	6	20.92	4.871	1.492	0.167

cold season, whilst the consumption of amphibians and reptiles is quite stable throughout the year.

Although otters eat both frogs and toads, frogs are usually eaten, more frequently (Sulkava, 1996; Sidorovich and Pikulik, 1997; Jedrzejewska et al., 2001). As reported for Belarus (Sidorovich, 2000) and Latvia (Baltrunaite, 2006), in our study area only frogs were found in the diet of otters.

As for several other countries (e.g. Brzezinski et al. 1993; Sidorovich 2000; Harna 1993; Jedrzejewska and Jedrzejewski 1998; Baltrunaite 2006), otter diet varied seasonally and Sidorovich (2000) states that such seasonal variability in otter diet is a result of variations in the availability and abundance of prey. Generally, amphibians are more important in the cold season whilst fish become dominant in the warmer months (Sulkava, 1996; Jedrzejewska and Jedrzejewski, 1998; Prigioni et al., 2006). In contrast to these studies, but in accordance to Sidorovich (1997, 2000) and Baltrunaite (2006), amphibians can be more important than fish in the warm season. In our study, there was no significant difference between the seasons in consumption of amphibians and reptiles; in warm seasons the decrease of fish occurrence in the warm season was compensated by the non-fish components (molluscs, insects and crayfish).

The relatively long period (about 240 days) of warm conditions typically experienced in the study area allows the amphibians to reproduce from March until November. Amphibians are the most abundant prey for otters during early spring and early winter. Consequently, this resource is probably largely available to both juveniles and adults along the several canals that line the agricultural lands. The various plots of agricultural land are inter-connected with hundreds of concrete bridges under which water collects providing an ideal shelter for frogs, particularly at night. According to our data obtained from photo trapping (unpubl. results), otters regularly prey in these areas, probably attracted by their high concentration of prey.

Even during the cold season it seems that amphibians are more readily available to otters than fish. Our daytime observations in December suggest that fish remain concealed in the substrate at the bottom of the ponds during the day, especially the larger individuals. At least 3-4 warm days were necessary to warm the water to sufficient levels for the fish to rise to the surface. We argue that it could be a necessary condition for otters to hunt fish. On the other hand, it only took a few hours of sunshine before we were able to observe frogs exposed on the sides of artificial canals. Near river Alazani snakes start to hibernate early, frogs and especially juveniles stay available much longer.

Reptiles were eaten during both seasons. This group might be important at the beginning of the cold season, when we observed many holes, dug by otters, near or within the channels, to find hibernating snakes.

In our study, food niche breadth was wider in the warm season when the diet was more diverse. The same occurred on the rivers of Latvia (Baltrunaite, 2006) and Poland (Brzezinski et al., 1993).

Some studies undertaken near fish ponds in European countries have shown that small carp (with total length up to 300 mm) dominated in otter diet (Bodner, 1995; Knollseisen, 1995; Kučerová, 1997; Adamek et al., 1999). We found that crucian carp was the most important fish in otter diet. Mason and Macdonald (1986) suggested that the size of fish taken by otters depends on availability, with small individuals usually predominating in otter diet. According to local fisheries, the most abundant fish species in the study area was crucian carp, with most individuals measuring no more than 25 cm. Small fish (< 200 mm) predominated in our study in otter diet. Beside the availability, consumption of small size fish could be explained by "knowledge" of both sides. Young fish may not possess a fully developed ability of predator avoidance as well as young otters do not have good skills and/or are not strong enough to catch big prey.

The diet of otters in studied areas apparently reflects the food availability in ponds and channels. Fish ponds in our study area are connected by narrow and shallow channels. Otter use these water bodies for movement between the sites and feed on small fish (as well as on reptiles and amphibians) there, which reflects their high proportion in the diet. In cold water during the winter, groups of small size crucian carps were gathered near inflow or outflow of fish pond channels. At that time water levels in the channels were reduced and fish have limited space to escape. Such places became highly visited by otters in the cold season, when food resources were reduced. Kranz (1995) and Foerster (1996) described, that otters may tolerate the presence of other individuals within their home range. Our camera traps has captured (unpubl. results) high intensity of otter visits on inflow and outflow channels, particularly in cold months, when ponds were dried or was unreachable for otters.

Further studies on otter diet, comparing use by otters of the main food items to their relative availability, are necessary to understand better the dynamics of this predator feeding ecology.

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