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 pedunculiflora) is also present. Other typical species are Smilax excelsa, Periploca graeca, and Viola 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 (Hypophthalmichthys 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...
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 their vertebrae, jawbones and scales, respectively. This method enabled an exact calculation of original length of fish. The bulk of fish biomass consumed by otters on the Alazani was composed of C. carassius 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. Rutillus rutillus and Hypophthalmichthys molitrix were of minor importance in cold season and increased in warm season (Chi-Square test for R. rutillus, \(\chi^2 = 9.01, p < 0.003\)) 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 ± 100.62 and 283.11 ± 391.19 g/100 m\(^2\) (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. The bulk of fish biomass consumed by otters on the Alazani was composed of C. carassius 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. Rutillus rutillus and Hypophthalmichthys molitrix were of minor importance in cold season and increased in warm season (Chi-Square test for R. rutillus, \(\chi^2 = 9.01, p < 0.003\)) and Chi-Square test for H. molitrix, \(\chi^2 = 15.35, p < 0.001\)).

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### Results

Fish and amphibians were identified to species level. Using personal collections, fish remains were identified from their vertebrae, jawbones and scales, respectively. This method enabled an exact calculation of original length of fish. The bulk of fish biomass consumed by otters on the Alazani was composed of C. carassius 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. Rutillus rutillus and Hypophthalmichthys molitrix were of minor importance in cold season and increased in warm season (Chi-Square test for R. rutillus, \(\chi^2 = 9.01, p < 0.003\)) and Chi-Square test for H. molitrix, \(\chi^2 = 15.35, p < 0.001\)).

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### Discussion

Otters feed on a wide 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
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; Jędrzejewska 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 1996; Jędrzejewska and Jędrzejewski, 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; Jędrzejewska and Jędrzejewski, 1998; Pri-gioni 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 season the decrease of fish occurrence in the warm season was compensated by the non-fish components (mol-luscs, 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.

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

<table>
<thead>
<tr>
<th>Preyed fish</th>
<th>Cold season</th>
<th>Warm season</th>
<th>Chi-square test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FO, n=257</td>
<td>FO, n=55</td>
<td></td>
</tr>
<tr>
<td>Rutilus rutilus</td>
<td>10</td>
<td>27</td>
<td>0.11 0.005</td>
</tr>
<tr>
<td>Ctenopharyngodon idella</td>
<td>0</td>
<td>4</td>
<td>7.27 -</td>
</tr>
<tr>
<td>Hypophthalmichthys molitrix</td>
<td>3</td>
<td>7</td>
<td>15.35 0.0001</td>
</tr>
<tr>
<td>Silurus glanis</td>
<td>0</td>
<td>2</td>
<td>3.64 -</td>
</tr>
<tr>
<td>Cyprinus carpio</td>
<td>206</td>
<td>80.16</td>
<td>49.09 0.000001</td>
</tr>
<tr>
<td>Lethocerus albus</td>
<td>6</td>
<td>2.33</td>
<td>10.91 0.0003</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Preyed fish</th>
<th>Cold season</th>
<th>Warm season</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n Mean Std. Dev.</td>
<td>n Mean Std. Dev.</td>
<td></td>
</tr>
<tr>
<td>Rutilus rutilus</td>
<td>42</td>
<td>362.68 364.82</td>
<td>266.30 11.10</td>
</tr>
<tr>
<td>Ctenopharyngodon idella</td>
<td>0</td>
<td>-</td>
<td>4 1185.49 172.08</td>
</tr>
<tr>
<td>Hypophthalmichthys molitrix</td>
<td>3</td>
<td>1.02 0.36</td>
<td>6 931.06 296.23</td>
</tr>
<tr>
<td>Silurus glanis</td>
<td>0</td>
<td>-</td>
<td>2 15.18 13.39</td>
</tr>
<tr>
<td>Carassius carassius</td>
<td>206</td>
<td>77.9985 67.03635</td>
<td>90.19 123.19</td>
</tr>
<tr>
<td>Rutilus rutilus</td>
<td>6</td>
<td>34.9967 22.60065</td>
<td>20.92 4.871</td>
</tr>
</tbody>
</table>

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; Knolleisein, 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. Though 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 Forerster (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.

References


