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Dietary importance of various prey fishes for pikeperch *Sander lucioperca* (L.) in large shallow lake Võrtsjärv (Estonia)

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Abstract. The present study examines the composition of the diet and size-related as well as seasonal changes in the prey selection of pikeperch in large eutrophic L. Võrtsjärv. The total stomach contents of 325 pikeperch with a standard length of 5–76 cm were analysed in 1994–2005 with the goal to assess how the predation pressure of pikeperch is distributed over various prey species. The frequency of occurrence (FO), the number and restored weight of prey fish as well as the index of relative importance (IRI) and Ivlev's selectivity index (E) were used for the description of pikeperch diet. The results of our study showed that the first prey fish for young pikeperch were mainly congeners and smelt *Osmerus eperlanus* (L.). With increasing body size the diet of pikeperch was enriched with ruffe *Gymnocephalus cernuus* (L.), perch *Perca fluviatilis* L., and roach *Rutilus rutilus* (L.). According to IRI, ruffe (IRI = 56%) was the most important prey for pikeperch in L. Võrtsjärv, while roach and perch were of second-rank importance. Bream *Abramis brama* (L.) was a rejected prey fish (E = –0.9) for pikeperch, while smelt (E = 0.8) was actively selected. In comparison with data from the 1950s (Erm, V. 1961. Eesti riim- ja magevete kohade bioloogilistest ja morfoloogilistest erinevustest. In *Hüdrobioloogilised uurimused*, Vol. 2, pp. 289–342, Tartu), the main long-term changes in the diet of pikeperch are related to shifts in the fish community structure. Vendace *Coregonus albula* (L.) was the main prey (FO = 54%) for pikeperch in the 1950s, but it is absent from the recent diet. At present smelt replaces vendace in the diet of young pikeperch. Cannibalism was not observed half a century ago due to the small number of pikeperch in the lake at that time.

Key words: pikeperch, diet composition, size-related changes, seasonal changes, Lake Võrtsjärv.

INTRODUCTION

Predator–prey interactions can play a major structuring role in aquatic ecosystems, and can affect the biological community both directly and indirectly

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(Carpenter & Kitchell, 1993; Bíró, 2001). A direct effect of predation can be a reduction in prey abundance and biomass. Predation on fish, especially on smaller individuals, changes the size-class structure of the fish community in favour of large individuals and reduces population densities (Skov et al., 2002). Indirect effects can include behavioural alterations in prey activity and distribution (Arnekleiv & Raddum, 2001) as well as modification of energy flow and nutrient cycling at lower trophic levels (Carpenter et al., 1985). Much of our current understanding of the autecology and ecological role of fish populations is derived from studies of diet based on analysis of stomach contents (Windell & Bowen, 1978). The identification of stomach contents allows us to know about food consumption, feeding and assimilation rate, cannibalism, and even habitat segregation (Hindar & Jonsson, 1982).

Pikeperch *Sander lucioperca* (L.) is the main open-water piscivorous fish in eutrophic waters in Europe (Deelder & Willemson, 1964; Kitchell et al., 1977). Favourable biotopes of pikeperch are relatively warm, productive, still or slow flowing waters that are rich in small fish (Popova & Sytina, 1977; Steffens et al., 1996; Smith et al., 1998). Preferred temperature of pikeperch is from 24 up to 29 °C (Hokanson, 1977). Pikeperch are favoured in highly eutrophic and turbid systems, since they have visual adaptations enhancing their foraging capacity in turbid environments (Ali et al., 1977; Karås & Sandström, 2002). The dominance of pikeperch has increased in several lakes in Central and Northern Europe due to growing eutrophication in the last century (van Densen & Grimm, 1988). Lammens (2001) noted that eutrophication in most European countries has caused a change of fish community from pike *Esox lucius* L. and perch *Perca fluviatilis* L. as main predators to one dominated mainly by pikeperch.

In Estonia pikeperch inhabits eutrophic and hypertrophic lakes that are relatively large and deep, have a rather high pH, and are rich in small fish (Pihu, 1993). In L. Võrtsjärv pikeperch is an ecologically and economically significant game fish, whose population is heavily affected by exploitation. After considerable rearrangement of fishery in the lake in the 1970s the abundance of pikeperch and its catches began to increase rapidly (Kangur et al., 2002; Järvalt et al., 2004). Increasing eutrophication of the lake supports this process.

The role of top predators (e.g. pikeperch and pike) in controlling the populations of coarse fish and in maintaining a balanced fish community structure (in which consumption of prey fish by piscivorous fish equals the production of unwanted prey fish) in lakes is great (Adams, 1991; Salonen et al., 1996). Pikeperch could directly affect the fish community structure through the effects of predation (van Densen & Grimm, 1988; Lammens et al., 1992; Winfield et al., 1993) and has the potential to influence the abundance of their prey (Benndorf, 1990; Lehtonen et al., 1996). Feeding of pikeperch in L. Võrtsjärv was thoroughly investigated by Erm (1961) in the 1950s; later data are scarce. Since 1994 we have investigated feeding of pikeperch in L. Võrtsjärv and considered the distribution of predatory pressure of pikeperch over different prey species. The

aim of our study was to estimate the composition of the diet and size-related as well as seasonal changes in the prey selection of pikeperch. The results are compared with data from the 1950s (Erm, 1961).

STUDY AREA

Lake Võrtsjärv (270 km^2) in central Estonia is the second largest lake in the Baltic region. It is a very shallow turbid water body with a mean depth of 2.8 m and maximum depth of 6 m (Järvet et al., 2004). The drainage basin of L. Võrtsjärv is 3374 km^2. The outflow, the Emajõgi River, connects the lake with L. Peipsi. The ice cover on the lake lasts from November to April, on average 135 days. In winter oxygen deficit can occur under the ice. The mean annual range of water level fluctuations is 1.4 m (Järvet et al., 2004). Lake water is the most transparent in winter when Secchi depth is up to 2.5–3.2 m. During the ice-free period it is typically 0.9 m, but may be only 10–15 cm after storms (Reinart & Nõges, 2004). Based on nutrient concentrations, the middle and central parts of L. Võrtsjärv can be considered eutrophic, whereas the narrow and sheltered southern part is assessed hypertrophic. The total phosphorus concentration in the lake water (53 mgP m^{-3}) has been stable over the years (Tuvikene et al., 2004). The concentration of total nitrogen was 1400 mgN m^{-3} in the recent decade (Tuvikene et al., 2004).

Thirty-one fish species and one lamprey species inhabit permanently L. Võrtsjärv or lower reaches of its inflows (Järvalt et al., 2004). Seven of them have commercial or recreational importance. Regarding catches, the main commercial fishes in L. Võrtsjärv in recent decade have been large bream *Abramis brama* (L.) (standard length, Sl > 30 cm), pike, eel *Anguilla anguilla* (L.), and pikeperch. Trash fishes are caught as by-catch and consisted mainly of small bream (Sl < 30 cm), ruffe *Gymnocephalus cernuus* (L.), and roach *Rutilus rutilus* (L.). In the fish community of L. Võrtsjärv several drastic and economically important changes have occurred during recent decades (Kangur et al., 2002; Järvalt et al., 2004). In the 1950s and 1960s L. Võrtsjärv was regarded as a ruffe lake because the bulk of the fish caught there consisted of small inferior fishes, mainly ruffe. Fine-meshed trawls damaged the stocks of commercially important big fishes, first of all pikeperch. Catches of pikeperch were low in the 1950s and the early 1960s. In the late 1960s and in the 1970s, a rapid increase in the stock and catches of pikeperch were observed after introduction of catch quotas, closed spring season, restriction and subsequent prohibition of trawling in the lake. The increasing pressure of predatory fishes (mainly pikeperch and pike) led to a significant reduction in the abundance of ruffe, perch, and roach. In the late 1980s and in the 1990s the catch of pikeperch again declined. Vendace *Coregonus albula* (L.) lost its commercial importance in the late of 1950s, and the fishery of smelt *Osmerus eperlanus* (L.) was stopped in 1972 in order to maximize its production for predatory fishes.

MATERIAL AND METHODS

Pikeperch were sampled once or twice a month during the ice-free period using experimental bottom trawls with a mesh size of 12–14 mm in the codend. Trawling was carried out in morning hours in the same region of the open water of the lake in 1994–2005. A total of 325 fish with a Sl of 5–76 cm (Table 1) were dissected immediately and their stomach content was analysed. Prey fish or their remains were identified, counted, and measured. The total weight (Tw) of prey fishes was restored on the basis their Sl, using the length–weight relationship of fish sampled from the lake (Table 2).

For the assessment of the dietary importance of different prey species, the following indices were calculated:

- frequency of occurrence (the percentage of all fish examined n in which that prey species i occurred n_i), $\mathrm{FO}\,(\%) = 100 \times \Sigma n_i / \Sigma n$
- average number of prey fish per individual
- the percentage of prey number (the number of each prey species i expressed as a percentage of all observed prey), $\mathrm{N}\,(\%) = 100 \times \Sigma \mathrm{N}_i / \Sigma \mathrm{N}$

Table 1. Number and measurements of examined pikeperch from L. Võrtsjärv

Month	Standard length, cm						Total
	<20	20–29	30–39	40–49	50–59	60<	
April	–	1	4	6	4	3	18
May	1	7	9	20	7	11	55
June	14	29	14	24	9	14	104
July	2	12	10	9	4	0	37
August	22	13	6	9	1	0	51
September	8	8	9	9	6	0	40
October	1	2	4	4	3	0	14
November	0	0	1	5	0	0	6
Total	48	72	57	86	34	28	325

Table 2. Standard length (Sl, cm) and total weight (Tw, g) relationship of some fish species from L. Võrtsjärv

Species	Relationship	R^2	No. of measured fish
Smelt	$\mathrm{Tw} = 0.0123\ \mathrm{Sl}^{2.791}$	0.98	23
Roach	$\mathrm{Tw} = 0.0145\ \mathrm{Sl}^{3.092}$	0.99	92
Bream	$\mathrm{Tw} = 0.0981\ \mathrm{Sl}^{2.429}$	0.86	762
Ruffe	$\mathrm{Tw} = 0.0213\ \mathrm{Sl}^{2.887}$	0.98	3478
Perch	$\mathrm{Tw} = 0.0101\ \mathrm{Sl}^{3.218}$	0.98	200
Pikeperch	$\mathrm{Tw} = 0.0111\ \mathrm{Sl}^{3.072}$	0.99	348

– the percentage of prey weight (the weight of each prey species i expressed as a percentage of all observed prey), $\mathrm{W}\,(\%) = 100 \times \Sigma \mathrm{W}_i / \Sigma \mathrm{W}$
– index of relative importance (IRI) was calculated by summing numeric and weight percentage values and multiplying the frequency of occurrence percentage value (Pinkas et al., 1971; Hacunda, 1981), $\mathrm{IRI} = (\mathrm{N}\% + \mathrm{W}\%) \times \mathrm{FO}\%$.

The main assessment categories of the prey fishes (e.g. the most important, second rank, rare, unimportant) were identified in the diet of pikeperch. The feeding selectivity of the predator was measured using Ivlev's selectivity index (E; Deudero & Morales-Nin, 2001):

$$\mathrm{E} = \frac{r_i - p_i}{r_i + p_i},$$

where r_i is the relative abundance of food category i in the stomach (as a proportion or percentage of all stomach contents) and p_i is the relative abundance of this prey in the environment. Values of this index range from -1 to $+1$, with negative values indicating rejection or inaccessibility of the prey, zero indicating random feeding, and positive values active selection. The relative abundance of prey fish (p_i) was calculated according to the results of experimental trawling.

In order to analyse seasonal changes in the feeding of pikeperch, individuals with a length of 35–59 cm, i.e. the most numerous group, were used. Pearson correlation analysis was used to measure the relationship between the length of the predator and the length of the prey fish as well as their number and frequency of occurrence. For statistical analysis the STATISTICA program (StatSoft, Inc., 2005) was applied.

RESULTS

Composition of the diet

Pikeperch become piscivorous during their first summer. It was determined that 63% of the 325 individuals studied had swallowed prey fish and 37% of the stomachs did not contain any food. Pikeperch stomachs examined in this study contained on average (± standard error) 1.4 ± 0.1 prey fish whereas individuals that had taken food contained on average 2.3 ± 0.2 fish. The maximum number of prey fish engulfed was 21; these were found in the stomach of a pikeperch of Sl 54 cm.

The diet of pikeperch included six prey fish species: smelt, roach, bream, perch, pikeperch, and ruffe (Table 3). In addition, a pupa of *Chironomus plumosus* (L.) was found in the stomach of one pikeperch. The FO of ruffe was the largest (28%), followed by perch and roach (both about 16%). About 11% of the examined specimens had consumed smelt.

Ruffe dominated in the diet of pikeperch also numerically (Table 4). This fish was consumed almost equally to all other prey species combined. Ruffe was followed with respect to number by roach (19%), perch (18%), and smelt (13%).

Table 3. Frequency of occurrence (FO) of prey items in the diet of pikeperch from L. Võrtsjärv in 1950–1958 (Erm, 1961) and 1994–2005

Prey	1950–1958	1994–2005	
	FO, %	Number of stomachs	FO, %
Vendace	54.3	–	–
Smelt	–	35	10.7
Pike	1.2	–	–
Roach	27.2	51	15.9
Bream	3.7	4	1.2
Bleak	2.4	–	–
Ruffe	24.7	92	28.0
Perch	25.9	53	16.2
Pikeperch	–	11	3.4
Invertebrates	–	1	0.3

Thus, ruffe dominated by FO and by number in the recent diet of pikeperch in L. Võrtsjärv. According to weight the dominating prey fish was roach (40%), followed by ruffe (32%) and perch (17%) (Table 4), while smelt, pikeperch, and bream were of secondary importance in the recent diet of pikeperch in L. Võrtsjärv.

Pikeperch consumes rather small fish (Table 5). The mean length of prey fish varied between species, but did not commonly exceed 10.5 cm, although the largest swallowed fish (bream) was 16 cm long.

Table 4. Number and weight of prey items in the diet of pikeperch from L. Võrtsjärv in 1994–2005

Prey	Number of stomachs	Number of prey specimens	Number, %	Weight, g	Weight, %
Smelt	35	60	12.8	126.7	3.8
Roach	51	88	18.8	1337.4	39.9
Bream	4	4	0.9	154.0	4.6
Ruffe	92	219	46.9	1085.3	32.4
Perch	53	84	18.0	567.1	16.9
Pikeperch	11	11	2.4	79.3	2.4
Invertebrates	1	1	0.3	0.0	0.0

Table 5. Length (cm) of consumed fishes in the diet of pikeperch from L. Võrtsjärv in 1994–2005

Length of prey	Smelt	Roach	Bream	Ruffe	Perch	Pikeperch
Mean	6.3	8.9	11.8	5.9	6.4	6.7
Standard error	0.2	0.2	1.4	0.1	0.3	0.8
Mode	6	7	10.5	5	5	6
Maximum	12	14	16	12	14.5	12
Minimum	4	4	4	3	3	3

To estimate the importance of a food taxon the IRI index was calculated. This index assists in evaluating the relationship of the various food items found in stomachs as it combines the numerical, weight, and frequency of occurrence measurements into one value and enables to rank each prey species. According to IRI values, the most important prey fish for pikeperch in L. Võrtsjärv was ruffe (IRI = 56%, Table 6), while roach and perch were of secondary importance (IRI = 24% and 14%, respectively). The relative importance of bream and pikeperch in the recent diet of pikeperch was small.

Pikeperch feeding selectivity was examined by comparing the similarity between fish stomach contents and fish sampled by the experimental trawl in the same area and time period. Comparison of similarity among pikeperch stomach content and data of experimental trawling (Fig. 1) revealed that bream was an avoided prey fish (E = –0.9, Table 6) for pikeperch in L. Võrtsjärv, while smelt (E = 0.8) was the most preferred prey, followed by perch (E = 0.3).

Table 6. Index of relative importance (IRI) and Ivlev's selectivity index (E) of prey fishes in the diet of pikeperch from L. Võrtsjärv in 1994–2005

Prey fish	IRI, %	E
Smelt	4.5	0.8
Roach	24.0	–0.2
Bream	0.2	–0.9
Ruffe	56.5	0.2
Perch	14.4	0.3
Pikeperch	0.4	0.1

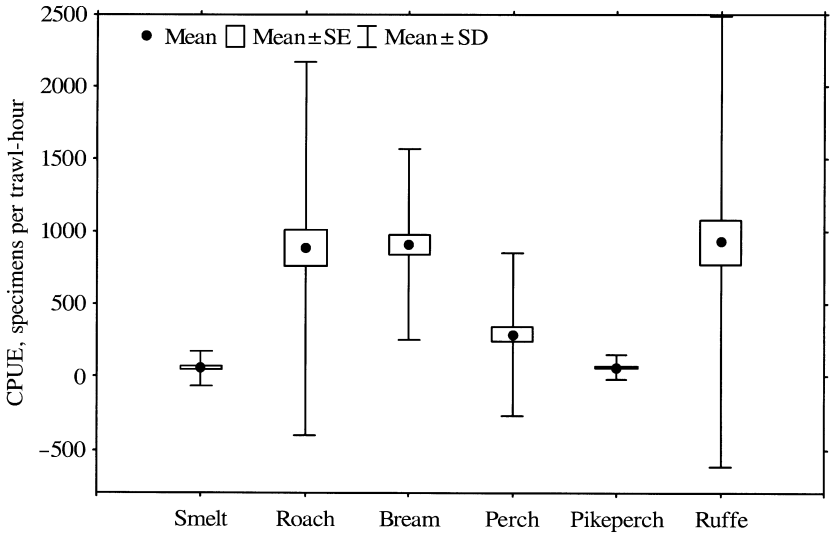

Fig. 1. Relative abundance of fishes (CPUE) in the open part of L. Võrtsjärv according to experimental trawling in 1994–2005.

Size-related and seasonal changes of feeding

Comparison of the diet of pikeperch of different size demonstrated a shift in prey choice. According to our observations, the first prey fish for pikeperch was congener fry. We found remains of pikeperch (Sl about 48 mm) in the stomach of pikeperch with Sl of 10 cm. Pikeperch of Sl < 15 cm had consumed three prey species: smelt, ruffe, and pikeperch fry (Fig. 2a, b). With increasing body size the diet of pikeperch was enriched mainly with roach and perch. As the size of pikeperch increased the FO as well as the number of ruffe in its food increased

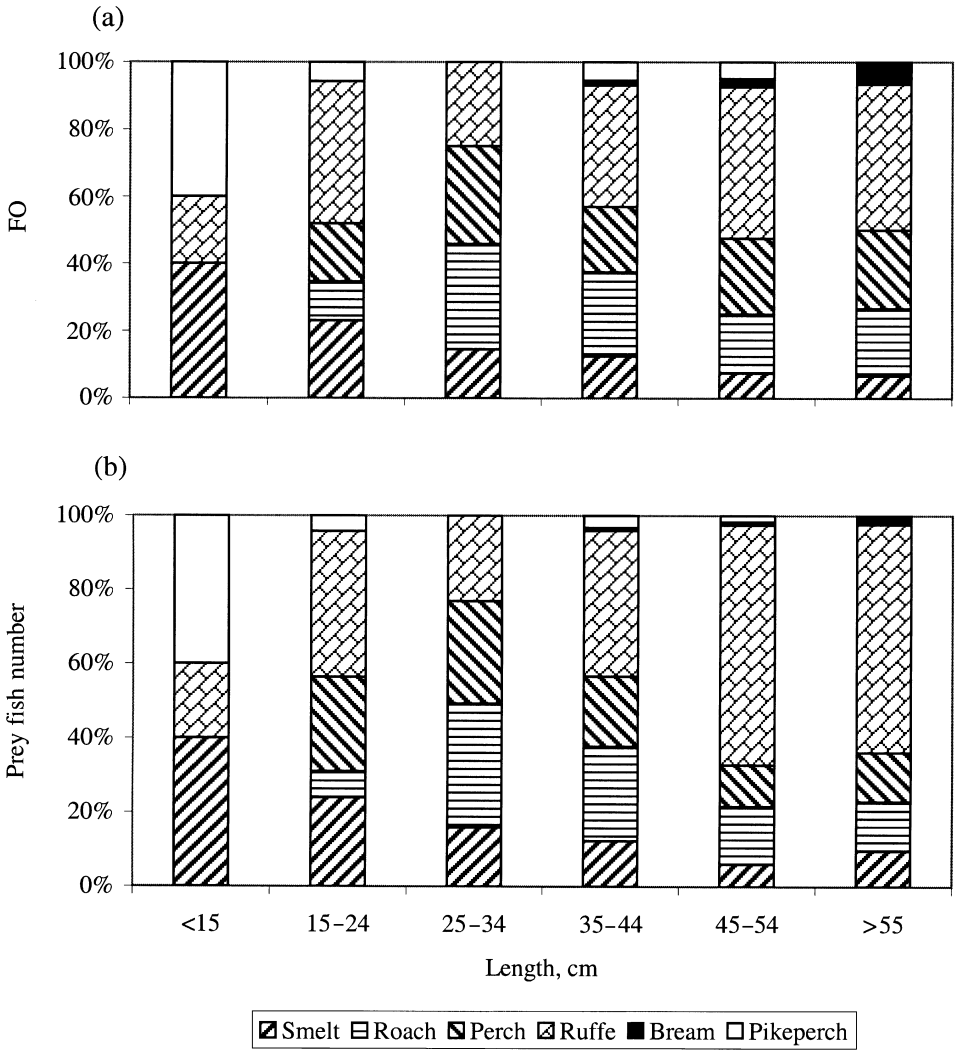

Fig. 2. Size-related variation (a) in the frequency of occurrence (FO, %) and (b) prey fish number (%) in the diet of pikeperch from L. Võrtsjärv in 1994–2005.

gradually ($r = 0.92$, $p = 0.01$ and $r = 0.86$, $p = 0.03$, respectively), whereas numerical percentage of smelt decreased ($r = -0.90$, $p = 0.01$). Ruffe occupied the first place in the food of pikeperch of Sl > 35 cm and constituted about two thirds of all fishes consumed by the predator of Sl > 45 cm (Fig. 2b). Cannibalism was observed almost in all length groups of pikeperch.

The main seasonal change was a significant decrease ($r = -0.77$, $p = 0.04$) of ruffe's numerical proportion in the diet of pikeperch during the open-water period. The proportion of ruffe was large in early spring: FO = 61% and N = 87% in April (Fig. 3a, b). The numerical proportion of smelt was the largest in July

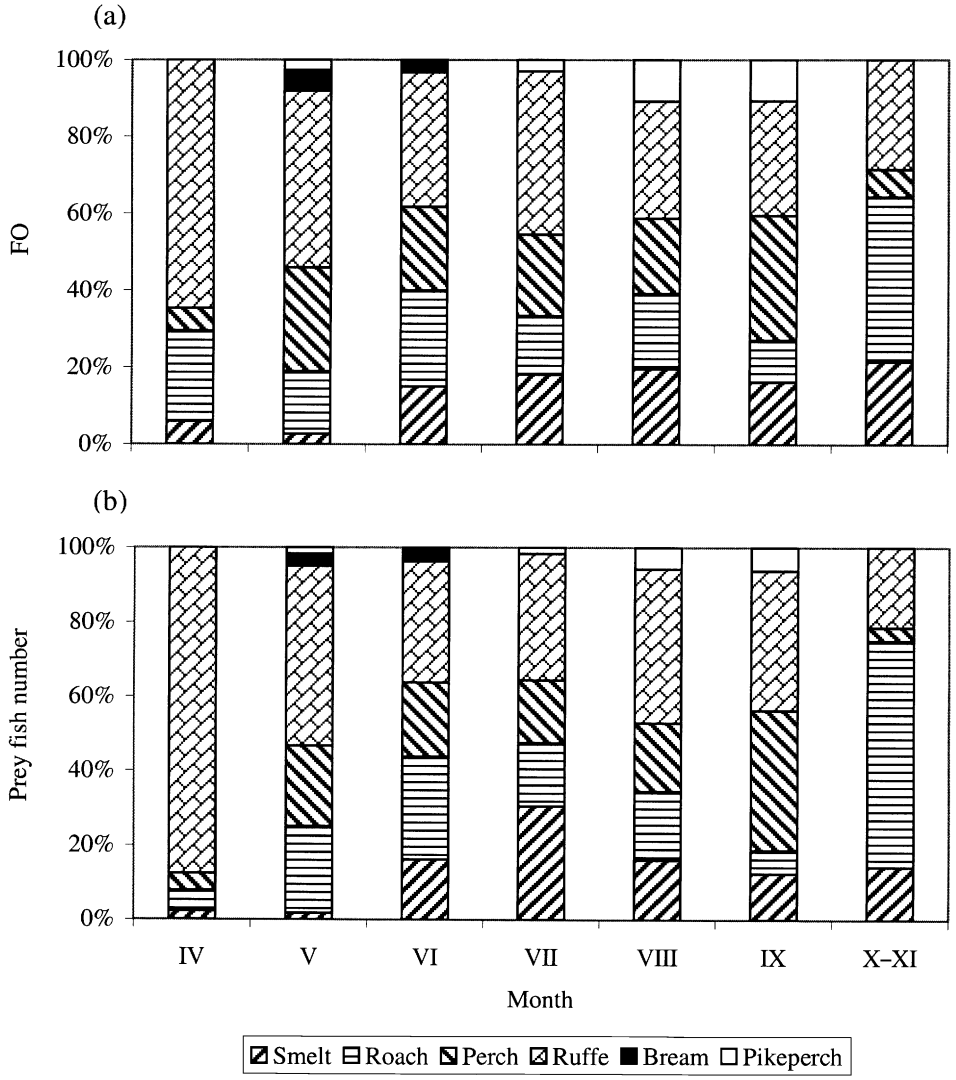

Fig. 3. Seasonal variation (a) in the frequency of occurrence (FO, %) and (b) prey fish number (%) in the diet of pikeperch (Sl 35–59 cm) from L. Võrtsjärv in 1994–2005.

(Fig. 3b). Empty stomachs were numerous in May and June, during the breeding period of pikeperch and immediately after it. Close to autumn the proportion of empty stomachs decreased.

DISCUSSION

Dietary descriptions of fish are greatly influenced by the choice of the method used to quantify the relative importance of each prey type to the diet (Pinkas et al., 1971; Cortès, 1998). The most commonly used measures (frequency of occurrence, numerical abundance, and weight measures) convey different types of information on feeding habits. Therefore, all three individual measures should be reported when attempting to describe diets of fish species because use of only one or two of them can be misleading (Cortès, 1998). Compound indices containing more than one parameter are considered to be more reliable for measuring the importance of a specific organism in the diet of a predator (Hacunda, 1981; Cortès, 1998; Deudero & Morales-Nin, 2001). Pinkas et al. (1971) proposed the index of relative importance (IRI), which combines percentage prey number, weight, and frequency of occurrence. This compound index contains information on the contribution of each prey type to the nutrition of the predator population as a whole (Deudero & Morales-Nin, 2001; Liao et al., 2001).

According to our study, the diet of pikeperch in L. Võrtsjärv included six common prey fish species: ruffe, roach, perch, smelt, pikeperch, and bream. The most frequent and numerically dominant prey fish for pikeperch was ruffe, followed by perch and roach (Tables 3, 4). By weight roach and ruffe were dominating in the food of pikeperch. According to IRI, ruffe was the most important prey for pikeperch in L. Võrtsjärv, overweighing all other prey species together in the predator diet (Table 6). The second-rank preys were roach and perch.

Considering the complex nature of the feeding habits of pikeperch it has been necessary to calculate the selectivity index, which might throw some light on the fish's food preference (Deudero & Morales-Nin, 2001). Our results indicate that smelt and perch fry were positively selected by pikeperch in L. Võrtsjärv, while bream was rejected (Table 6).

The recent diet of pikeperch in large shallow L. Peipsi is slightly different in comparison to L. Võrtsjärv. Pikeperch in L. Peipsi feed mainly on smelt, ruffe, and perch, whereas the diet of small specimens (Sl < 15 cm) consists only of smelt (Kangur & Kangur, 1998; Kangur, 2000). Smelt is the most numerous fish in the pelagic area of L. Peipsi where pikeperch mostly feed (Kangur et al., 2007). Differently from L. Peipsi, the recent abundance of smelt in L. Võrtsjärv is relatively low (Kangur et al., 2003; Järvalt et al., 2004). Nevertheless its relatively high proportion in the diet of pikeperch testifies that this predator prefers smelt to other prey fishes. Our calculations of Ivlev's selectivity index supported this

statement (Table 6). Studies performed on other lakes also indicate that pikeperch, or at least its youngest age-groups, prefer smelt as a prey species if it is available (e.g. van Densen & Grimm, 1988; Peltonen et al., 1996; Salonen et al., 1996).

Pikeperch can change their prey selection relatively rapidly in response to changes in the abundance and vulnerability of prey species (Popova, 1978). Comparison of the recent diets of pikeperch from L. Võrtsjärv with data from the early 1950s (Erm, 1961) demonstrates some important changes. In the 1950s, vendace was the main food (FO = 54%) for pikeperch in the lake (Erm, 1961). Cannibalism was not observed half a century ago due to the low abundance of pikeperch in the lake at that time. Thus, shifts in the fish community structure (e.g. increase of the pikeperch and collapse of the vendace population in L. Võrtsjärv) were reflected in the food composition of pikeperch.

Specialized piscivores such as pikeperch switch from zooplankton to a fish diet at an early stage and their year-class strength of 0+ cohorts is positively related to early onset of piscivory (Persson & Brönmark, 2002). Pikeperch often become piscivorous during their first summer but fish may constitute a considerable proportion in their diet already when the length of pikeperch is 2–3 cm (Erm, 1981). According to Fickling (1986), pikeperch are usually piscivorous after they reach a length of 6 cm. We determined cannibalism in the case of pikeperch of Sl 10 cm.

Adult pikeperch are opportunistic in their feeding habits (Erm, 1981; Salonen et al., 1996). Their annual feeding patterns are closely linked to the seasonal abundance of food (Popova & Sytina, 1977). On the other hand, changes in the feeding of pikeperch can be largely explained by the morphology of pikeperch. Pikeperch is known to be a gape-limited predator (Salonen et al., 1996; Smith et al., 1998). The number and type of prey will be affected not only by the total biomass of predators present in a water body but also by its population size structure (Popova, 1978). Especially, the small pikeperch may not be able to eat the large individuals of deep-bodied prey species such as bream, but they can forage on the more elongated species like smelt (Smith et al., 1998). Our results supported this statement. In L. Võrtsjärv, the modal length of pikeperch prey fish varied, depending on the species, between 5 and 7 cm (Table 5). The diet of pikeperch in the North Oxford Canal (UK) consists largely of fish less than 8 cm fork length (Fickling, 1986).

In L. Võrtsjärv, ruffe and smelt as relatively small fishes with high reproduction rates are accessible to pikeperch predation during their whole life. Pikeperch can play an important ecological role as the main regulator of the abundance of ruffe and other trash fishes in L. Võrtsjärv. However, the pikeperch stock of the lake is heavily exploited, with large fish being removed in a size-selective manner. As a result, the abundance of the older age classes has declined (Kangur et al., 2002). This in turn has implications on type, number, and size of prey fish consumed by pikeperch.

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Üksikute saakkalaliikide osatähtsus koha *Sander lucioperca* (L.) toidus Võrtsjärves

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Koha on praegusel ajal üks olulisemaid tööndusкalu Võrtsjärves. Artikli eesmärgiks on kindlaks teha üksikute saakkalaliikide vahekord koha toidus, uurida tema toidu koosseisu sesoonset ja kala pikkusest sõltuvat muutlikkust, samuti selgitada, kas koha toidu koosseisus on viimastel aastakümnetel toimunud muutusi. Kokku on uuritud aastatel 1994–2005 järve avaveelisest osast katsetraaliga püütud 325 koha (kalade standardpikkus on 5–76 cm) mao sisu. Koha toiduratsiooni kirjeldamiseks on kasutatud järgmisi suurusi: saakkalade esinemissagedus (FO, %), nende suhteline arvukus (N%) ja mass (W%) röövkalade maos. Neist andmeist lähtudes on arvutatud saakkalade suhtelise tähtsuse indeks (IRI, *index of relative importance*) ja Ivlevi saakkalade selektiivsuse indeks (E). Uurimistulemused näitavad, et noorte kohade jaoks on esimesteks saakkaladeks kohamaimud ja tint *Osmerus eperlanus* (L.). Suuremate isendite toit on rikastunud kiisa *Gymnocephalus cernuus* (L.), ahvena *Perca fluviatilis* L. ja särjega *Rutilus rutilus* (L.). Suhtelise tähtsuse indeksi järgi on koha olulisemaks toiduobjektiks kiisk (IRI = 56%), järgnevad särg ja ahven. Tint on Võrtsjärves kohale kõige eelistatum toit (E = 0,8), kuid latikat *Abramis brama* (L.) välditakse (E = –0,9). 1950. aastate andmetega (Erm, 1961) võrreldes on täheldatud koha toidu koosseisus olulisi muutusi, mis seonduvad kalaliikide vahekorra muutustega järves. Pool sajandit tagasi oli koha põhitoit Võrtsjärves rääbis *Coregonus albula* (L.) (FO = 54%), kuid viimasel kümnendil pole seda kalaliiki kohade maost leitud. Praegusel ajal asendab noorte kohade toidus rääbist tint. Kannibalismi pool sajandit tagasi ei täheldatud, mida võib seostada koha väikese arvukusega järves tol ajal.