Arch. Pol. Fish. (2010) 18: 163-172
DOI 10.2478/v10086-010-0018-8

RESEARCH ARTICLE

Feeding strategies and resource utilization of 0+ perch, *Perca fluviatilis* L., in littoral zones of shallow lakes

Received – 12 August 2009/Accepted – 06 September 2010. Published online: 30 September 2010;

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Abstract. The aim of the study was to analyze the diet and feeding strategies of 0+ perch, *Perca fluviatilis* L., in two lakes (Gosławskie and Dołgie Wielkie) with different trophic and thermal regimes. Water temperature was higher in Lake Gosławskie (Mann-Whitney test, P<0.01), but oxygen concentration was similar in both lakes (Mann-Whitney U test, P>0.05). The mean abundance, biomass, and species richness of zooplankton during the study period were statistically significantly lower in Lake Gosławskie (test U Mann-Whitney, P < 0.0001. The share of perch with empty digestive tracts was very low. The fish from Lake Dołgie Wielkie had higher condition factors (mean 1.87) than did those from Lake Gosławskie (1.73). The analysis of the size structure of the prey consumed by perch from the two lakes indicated that the fish employed different foraging strategies. In Lake Dołgie Wielkie the perch consumed a large quantity of small plankton organisms (copepodites and Daphnidae) that occurred in large quantities, while in Lake Gosławskie, where zooplankton abundance was low, the basic diet comprised larger organisms (*Sida crystallina*, larval Chironomidae). Perch feeding intensity in Lake Dołgie Wielkie was positively correlated with body length, while in Lake Gosławskie it remained at the same level.

Keywords: fish, predation, zooplankton, resource limitation, percids

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Introduction

The dietary composition of most fish species varies throughout ontogenetic development. Juvenile fish are particularly susceptible to fluctuations in food availability. Identifying the patterns of changes in diets can be key to understanding mechanisms that regulate growth, survival, and recruitment processes (Nunn et al. 2007). Perch, *Perca fluviatilis* L., is a freshwater species inhabiting different aquatic ecosystems from small artificial ponds to large brackish basins. Larval perch have been observed to vary choice of habitat as a strategy to increase survival. Initially, most larvae move from the littoral zone to open water areas and then return to the littoral zone after a few weeks (Urho 1996). In some aquatic basins, larval perch can remain in the pelagic zone for several months (Čech and Kubečka 2006).

The dietary composition of 0+ perch in various types of aquatic systems is well described (Guma'a 1978, Vašek et al. 2006, Urbatzka et al. 2008). Initially, larval perch feed on protozoans, phytoplankton, rotifers, and Cyclopidae nauplii. Dietary composition changes with fish growth; the most frequent dominants are cladocerans and benthic invertebrates. The overall feed composition of different perch populations is usually dissimilar, and is dependent on the specifics of the lake, the species composition, and the availability of the feed base. Variations in habitat and predator-prey interactions impact differences in the dietary composition of many fish species inhabiting littoral zones (Kornijów et al. 2005, Okun and Mehner 2005). Shifts in the exploitation of food resources during ontogenetic development is a strategy for optimizing feeding throughout all stages of life and a solution for satisfying increasing energy demands (Persson and Greenberg 1990). Juvenile perch impact the species composition and size structure of zooplankton and benthic fauna. In turn, they are also under pressure from predators and/or competition from either within the species or among others (Diehl 1993, Terlecki 1993, Rezsu and Specziár 2006).

The current study investigated feeding patterns of 0+ perch in lakes with different environmental conditions. Lake Gosławskie is a basin with heated waters from a local power plant, while Lake Dołgie Wielkie is located in the Słowiński National Park and has a natural thermal regime. Water temperature is one of the main factors impacting the juvenile feed base in both lakes (Bogacka 2005). The dietary composition of fish in Lake Dołgie Wielkie was not previously the subject of study, while the feeding of larval cyprinids in Lake Gosławskie was studied earlier (Wilkońska and Strelnikova 2000). The aim of the current study was to identify the dietary composition and feeding strategy of 0+ perch in two lakes with different trophic and thermal statuses.

Materials and methods

Study area

The studies were conducted over the course of two years (2001-2002) in two shallow, polymictic, eutrophic basins – Lake Dołgie Wielkie and Lake Gosławskie. Lake Dołgie Wielkie (156.4 ha) is a shallow, coastal lake located between the Baltic Sea and lakes Łebsko and Gardno (Słowiński National Park, northern Poland). Despite being in the vicinity of the Baltic Sea, there is no direct connection between the lake and the sea. The lake is a nature reserve, and no fishing is permitted. Earlier studies reported that nine species of fish occur in the lake, among which the most abundant were bleak, *Alburnus alburnus* (L.), roach, *Rutilus rutilus* (L.), and perch (Kapusta and Bogacka 2003). Lake Gosławskie (454.5 ha) is a shallow, eutrophic, pond-type basin located in central Poland. Since 1969, it has been utilized as a reservoir for cooling waters and a discharge reservoir for heated waters from the power plant in Konin (Socha and Zdanowski 2001). A water temperature of 21°C in Lake Gosławskie is noted from late April, while in Lake Dołgie Wielkie this temperature is noted from July (Table 1).

Table 1
Characteristics of the analyzed lakes

Variable	Lake Dołgie Wielkie	Lake Gosławskie
Surface area (ha)	156.4	454.5
Mean depth (m)	1.4	3.0
Maximum depth (m)	2.9	5.3
Secchi disc depth (m)	0.1-1.5	0.5-1.7
Mean temperature (°C)	18.6	21.8
Thermal regime during study period (°C)	T reached 21°C in July	T reached 21°C in late April
Mean oxygen content (mg O_2 dm^{-3})	11.4	12.5
Fish 0+	Sunbleak dominated	Silver bream dominated
Mean concentration of Cladocera (indiv. dm^{-3})	79.5	9.6
Mean concentration of Copepoda (indiv. dm^{-3})	21.02	27.2
Concentration of Chironomidae (indiv. m^{-2})	2.12	>10
Macrophyte bottom cover (%)	<10	ca. 25

The littoral zone in Lake Dołgie Wielkie covers a small of the bottom area, while in Lake Gosławskie hydrophytes cover about 25% of the bottom area. Twenty-four species of fish occur in Lake Gosławskie (A. Kapusta, unpublished data), and they are fished by both commercial fisheries and many anglers. The three dominant species of the native ichthyofauna are roach, bream, *Abramis brama* (L.), and silver bream, *Blicca bjoerkna* (L.) while Asian cyprinid species that were introduced in the late 1960s and early 1970s include grass carp, *Ctenopharyngodon idella* (Val.), silver carp, *Hypophthalmichthys molitrix* (Val.), and bighead carp, *Hypophthalmichthys nobilis* (Richardson).

Fish and zooplankton catches

Perch larvae and juvenile were caught in shallow, littoral habitats at six designated stations in Lake Dołgie Wielkie and at four in Lake Gosławskie. Samples were collected once monthly from April to August using fry nets with mesh bar length of 1 mm, height – 0.8 m, and length – 5 m. In order to reduce slight differences in fish activity, samples were always collected on sunny days within the same time period (12:00-15:00). After they had been caught, the fish were anesthetized and then preserved in a 4% solution of formaldehyde. They were sorted by species in the laboratory (Mooij 1989, Pinder 2001). Larval and juvenile stages of perch were measured (± 0.1 mm) and weighed (± 1 mg).

Zooplankton samples were collected with a five-liter Patalas sampler at the same time the fish were collected. Five hauls were performed to collected a total of 25 dm^3 of water, which was filtered through a plankton net with a 60 μm diameter mesh. Then the samples were preserved in Lugol's solution and 96% ethyl alcohol. During zooplankton sampling, measurements of water temperature (± 0.1°C), oxygen content (± 0.1 mg O_2 dm^{-3}), and Secchi disc depth (± 0.1 m) were taken.

Material analysis

Entire perch digestive tracts were analyzed in 131 individuals from Lake Dołgie Wielkie and in 86 from Lake Gosławskie. Zooplankton organisms were identified to the species (Flössner 1972, Koste 1978, Kiefer and Fryer 1978), and they were counted and measured. The lengths and widths of all prey items were measured. It was assumed that the width of the prey precisely reflected the dependence between the size of the food item consumed and fish body length (Cunha and Planas 1999). The intensity of feeding was described by the index of digestive tract fullness which is the ratio of the weight of the food to the body weight of the fish. Feeding intensity was also measured by the number of prey items identified in the digestive tracts of the fish.

Zooplankton samples were used to describe the feed base available to the perch. The zooplankton were determined to the species with a microscope (Flössner 1972, Kiefer and Fryer 1978, Koste 1978, Radwan et al. 2004). Each time, three sub-samples were viewed in a Sedgewick Rafter chamber, and then the abundance and biomass of the zooplankton were described by measuring the body lengths and widths of 20-30 individuals from each species.

Comparisons of the water temperature, oxygen content, and perch condition factor from the two lakes was performed with the Mann-Whitney U test and the Kruskal-Wallis test. The dependence between body length and feeding intensity was determined with the Spearman correlation and the Kruskal-Wallis test. All of the statistical analysis was performed with Statistica (StatSoft Inc. Tulsa, USA).

Results

Environmental conditions

Water temperature in both years of the study was significantly higher in Lake Gosławskie than in Lake Dołgie Wielkie (Mann-Whitney test, $P < 0.01$). The temperature dynamics in the water in subsequent months was similar in both lakes. The lowest temperatures were noted in April 2001 (Dołgie Wielkie – 7°C, Gosławskie – 13.4°C). The highest temperatures were also in 2001 in July in Lake Dołgie Wielkie (26.0°C) and in May in Lake Gosławskie (29.0°C).

Comparisons of water oxygen content between the lakes in both years of the study indicated that there were no statistically significant differences (Mann-Whitney U test, $P > 0.05$). The mean dissolved oxygen concentration in the waters of Lake Gosławskie was similar in all months (Kruskal-Wallis test, $P > 0.05$), with the highest noted in April 2002 (20.0 mg O_2 dm^{-3}) and the lowest in August 2002 (7.2 mg O_2 dm^{-3}). No differences in the content of dissolved oxygen were noted in subsequent months in Lake Dołgie Wielkie in 2001 (Kruskal-Wallis test, $P > 0.05$). In 2002 differences in the mean monthly content of dissolved oxygen in the water in subsequent months was statistically significant (Kruskal-Wallis test, $P < 0.0001$). The highest statistically significant concentration of oxygen was noted in April (17.2 mg O_2 dm^{-3}) and the lowest was in August (6.8 mg O_2 dm^{-3}).

Zooplankton assemblage structure

The mean abundance, biomass, and species richness of zooplankton during the studied period was statistically significantly lower in Lake Gosławskie than in Lake Dołgie Wielkie (Mann-Whitney U test, $P < 0.0001$). The mean zooplankton abundance in Lake Dołgie Wielkie ranged from 52 indiv. dm^{-3} (June 2001) to 1855 indiv. dm^{-3} (June 2002). In Lake Gosławskie the lowest mean zooplankton abundance was noted in June 2001 (31 indiv. dm^{-3}), while the highest was 97 indiv. dm^{-3} in May 2001. The mean zooplankton biomass in Lake Gosławskie was very low; the lowest values were noted in June 2001 (0.222 mg dm^{-3}), and the highest were noted in May 2001 (0.821 mg dm^{-3}). In Lake Dołgie Wielkie the zooplankton biomass values noted were much higher at about 3 mg dm^{-3} except in June 2001 (0.295 mg dm^{-3}).

During the study period, rotifers (Rotifera) comprised 75.6% of the zooplankton in Lake Dołgie Wielkie. Among them, the largest share was of small, common pelagic forms that are typical of eutrophic waters, i.e., *Trichocerca cylindrica* (Imhof) at 48.1% and *Brachionus angularis* (Gosse) at 11.3%. The crustacean assemblage, which is potentially the dietary base of juvenile perch, was dominated quantitatively by young developmental stages of Cyclopoida nauplii (45.5%) and cladocerans (Cladocera) *Chydorus sphaericus* (O.F. Müller; 13.06%) and *Daphnia cucullata* Sars (13.2%), which also dominated the zooplankton biomass by weight (30.7%).

Of the three systematic groups analyzed in Lake Gosławskie, the shares of copepods (Copepoda) were the highest in both number (53.3%) and weight (30.2%). Among these, as was noted in Lake Dołgie Wielkie, the quantitative dominant was juvenile stage nauplii, which comprised as much as 39.5% of the overall zooplankton, However, the weight dominant was the copepodits *Mesocyclops leuckarti* (Claus) at 11.2%. Since the study material from this lake was only collected from among the vegetation in the near-shore zone, the zooplankton was dominated by the typically littoral cladocerans *Sida crystallina* (O.F. Müller) and *Diaphanosoma brachyurum* (Liévin) at weight shares of 39.7 and 13.0%, respectively.

Feed analysis

Larval and juvenile perch were caught in May and June of 2001 and 2002 in Lake Gosławskie and in June and July in Lake Dołgie Wielkie. In the first lake, fish size ranged from 16 to 39 mm, while in the second it ranged from 14 to 39 mm (Table 1). The mean total length of perch from Lake Gosławskie (29.4 mm) was statistically significant (Mann-Whitney U test, $P < 0.01$) longer in comparison to that of fish from Lake Dołgie Wielkie (27.3 mm). The share of perch with empty digestive tracts was very small. All of the fish from Lake Gosławskie had full digestive tracts, while 3% of the fish from Lake Dołgie Wielkie had empty digestive tracts.

Table 2
List of dietary components of 0+ perch in lakes Dołgie Wielkie and Gosławskie during the studies (mean ± SD). P values of differences between lakes tested by Mann-Whitney U test, are shown; ns – not significant

	Dołgie Wielkie	Gosławskie	P
Rotifera			
Brachionus angularis angularis (Gosse)	4.0 ± 0.00	-	ns
Brachionus quadridentatus Hermann	1.2 ± 0.50	-	ns
Trichocerca capucina capucina Wierz. & Zach.	2.0 ± 0.00	-	ns
Cladocera			
Alona quadrangularis (O.F. Müller)	1.8 ± 1.39	-	ns
Alona affinis (Leydig)	1.8 ± 1.64	1.7 ± 1.53	ns
Alona rectangula Sars	-	1.0 ± 0.00	ns
Alonella nana (Baird)	2.3 ± 2.30	1.0 ± 0.11	0.001
Bosmina coregoni Baird	8.8 ± 7.25	-	ns
Bosmina longirostris (O.F. Müller)	10.4 ± 13.03	6.4 ± 8.78	ns
Camptocercus lilljeborgi Schoedler	2.0 ± 0.00	1.0 ± 0.00	ns
Ceriodaphnia quadrangula (O.F. Müller)	2.0 ± 0.00	-	ns
Chydorus sphaericus (O.F. Müller)	7.3 ± 10.06	1.3 ± 0.62	0.001
Daphnia cucullata Sars	57.5 ± 73.33	1.0 ± 0.11	0.001
Daphnia hyalina Leydig	1.0 ± 0.00	-	ns
Daphnia longispina O.F. Müller	1.0 ± 0.00	-	ns
Diaphanosoma brachyurum (Liévin)	3.3 ± 3.50	-	ns
Disparalona rostrata (Koch)	25.9 ± 118.33	-	ns
Eurycercus lamellatus (O.F. Müller)	1.2 ± 0.45	2.6 ± 1.78	0.001
Leptodora kindti (Focke)	5.7 ± 10.91	2.2 ± 1.30	0.001
Leydiga quadrangularis (Leydig)	-	1.0 ± 0.00	ns
Monospilus dispar Sars	1.9 ± 1.86	-	ns
Pleuroxus striatus Schoedler	3.82 ± 2.91	-	ns
Pleuroxus uncinatus Baird	2.0 ± 0.00	-	ns
Rhynchotalona falcata (Sars)	2.7 ± 1.50	-	ns
Sida crystallina (O.F. Müller)	11.7 ± 16.14	20.8 ± 19.71	0.001
Simocephalus vetulus (O.F. Müller)	3.3 ± 2.08	5.7 ± 8.49	0.001
Copepoda			
Acanthocyclops vernalis (Gurney)	6.7 ± 7.23	-	ns
Eucyclops serrulatus (Fischer)	12.0 ± 12.73	69.2 ± 8.34	0.001
Eudiaptomus gracilis (Sars)	20.4 ± 38.98	-	ns
Mesocyclops leuckarti (Claus)	8.2 ± 12.56	6.6 ± 7.40	0.001
Thermocyclops crassus (Fischer)	89.5 ± 102.16	-	ns
Copepoda naupli	1.2 ± 0.75	-	ns
Harpacticoida	1.2 ± 0.50	-	ns
Others			
Amphipoda. Gammaridae (*Corophium* sp.)	-	1.2 ± 0.62	ns
Coleoptera larvae	1.0 ± 0.00	-	ns
Diptera (Chironomidae) larvae	2.0 ± 1.57	9.2 ± 15.72	0.001
Heteroptera	-	1.4 ± 0.89	ns
Hirudinea	2.0 ± 0.00	-	ns
Hydrachnidia	2.0 ± 1.41	1.0 ± 0.00	ns
Odonata (Anisoptera) larvae	1.0 ± 0.00	-	ns
Odonata (Zygoptera) larvae	1.5 ± 1.00	1.0 ± 0.00	ns

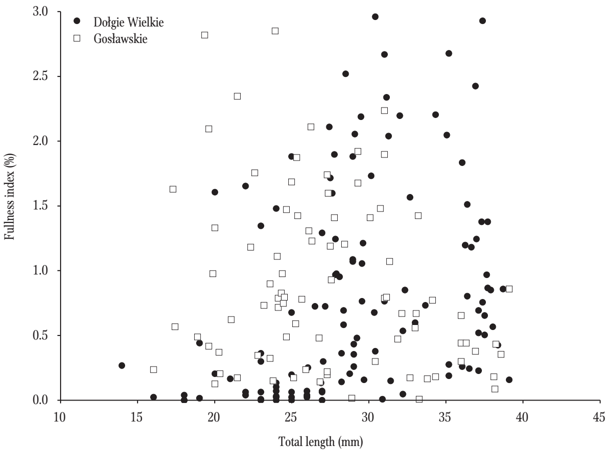

Figure 1. Feeding intensity of 0+ perch in lakes Dołgie Wielkie and Gosławskie in relation to fish body length.

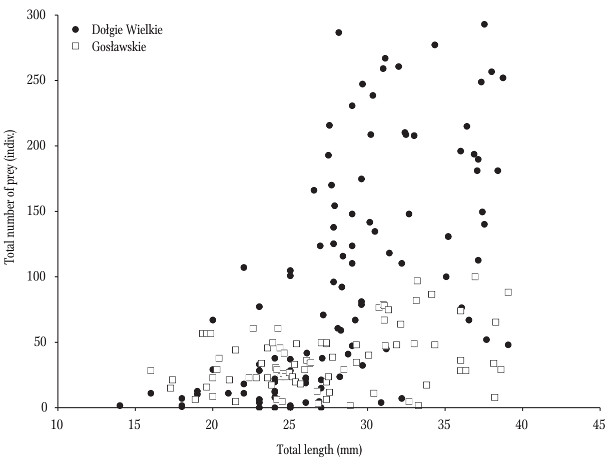

Figure 2. Amount of prey in the digestive tracts of 0+ perch in lakes Dołgie Wielkie and Gosławskie in relation to fish body length.

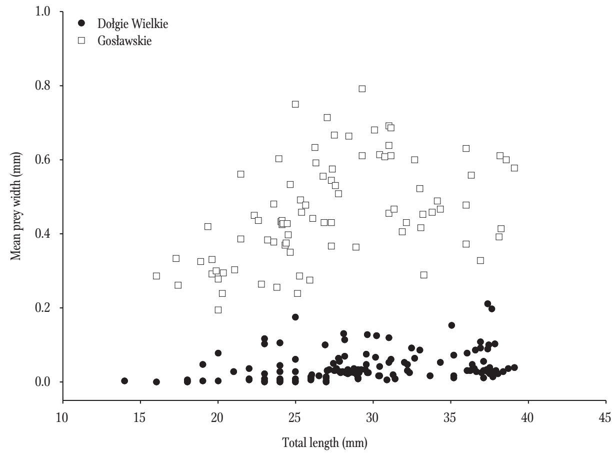

Figure 3. Comparison of juvenile perch total length and the mean prey width in lakes Dołgie Wielkie and Gosławskie.

The condition of the perch from the two lakes differed statistically significantly (Mann-Whitney U test, $P < 0.001$). The fish from Lake Dołgie Wielkie had higher condition factor values (mean 1.87) in comparison to those of the fish from Lake Gosławskie (1.73).

The diet of 0+ perch from Lake Dołgie Wielkie included three rotifer (Rotifera) species, 21 cladocerans (Cladocera), and six copepods (Copepoda) (Table 2). The diet of perch from Lake Gosławskie was poorer in taxa. The feed consumed did not include any rotifers, 12 cladoceran taxa, and only two copepod species. Additionally, insect larvae and small benthic organisms were identified in the feed of perch from both basins.

The feeding intensity of juvenile developmental stages of perch from Lake Dołgie Wielkie was positively correlated with body length (Fig. 1). As the fish body length increased, the fullness index values increased ($r = 0.462$, $P < 0.05$) as did the amount of prey consumed ($r = 0.696$, $P < 0.05$). The feeding intensity of juvenile perch from Lake Gosławskie only corresponded slightly to body length. The correlation between body length and the fullness index was not statistically significant ($r = -0.166$, $P > 0.05$), while that between body length and the amount of prey was very weak ($r = 0.306$, $P < 0.05$). More prey was identified in the digestive tracts of perch from Lake Dołgie Wielkie than in Lake Gosławskie at relatively similar fullness indexes (Fig. 2). The species richness of the diets of 0+ perch from Lake Dołgie Wielkie increased with increasing body length ($r = 0.735$, $P < 0.05$), while in Lake Gosławskie there was no link between this and the length of the fish analyzed ($r = 0.173$, $P > 0.05$).

The size of the prey consumed by 0+ perch from the two lakes changed with fish length ($P < 0.05$). In Lake Dołgie Wielkie perch consumed large quantities of small planktonic organisms (Fig. 3). The dietary composition was dominated quantitatively by copepodites of *Thermocyclops oithonoides* (Fischer), with a 43% of total number, and the cladoceran *D. cucullata* (21%), which also comprised the largest weight share of the feed weight at 43%. In Lake Gosławskie, the dietary base of juvenile stages of perch was the cladoceran *S. crystallina*, which comprised as much as 45% of the total number and 57% of the weight share. A significant component of the diet of 0+ perch from this lake also included copepodites of *Eucyclops serrulatus* (Fischer) and *M. leuckarti* (Claus) and chironomid larvae.

In Lake Dołgie Wielkie the highest feeding intensity of 0+ perch was confirmed at a water temperature of 17-18°C, but further increases in water temperature caused a decrease in feeding intensity (Kruskal-Wallis, $P < 0.05$). In Lake Gosławskie, increases in the feeding intensity of larval and juvenile perch was not noted until water temperature reached 17°C, while the highest feeding intensity was noted at temperatures of 24-25°C.

Discussion

The ecology of fish feeding in the first year of life has been the subject of many studies. It is widely accepted that this is a critical period in fish life histories. For young fish, uninterrupted access to food is a matter of life and death, and even partial malnutrition can lead to high mortality among larval fish (Letcher et al. 1996, Rellstab et al. 2004). Planktivores are predatory fish that rely on sight to hunt, thus they choose the largest prey which are the most visible. The selection of the largest prey is explained by the theory of optimizing food acquisition (Pyke 1984, Nunn et al. 2007). Perch are a species that feeds on zooplankton in its first year of life, while feeding on zooplankton in later life is usually linked to the conditions prevailing in a given basin (Rask 1983).

The analysis of the dietcomposition of 0+ perch in the two lakes compared indicates that different feeding strategies were employed. In Lake Dołgie Wielkie perch fed on small zooplankton, mainly copepodites of *Thermocyclops oithonoides* and the cladoceran *Daphnia cucullata*. In Lake Gosławskie, however, the perch diet was dominated by large cladoceran *Sida crystallina* and Chironomidae larvae. Fish from Lake Dołgie Wielkie consumed several-fold as much prey in comparison to perch of the same size from Lake Gosławskie. Generally, consuming larger prey is energetically advantageous. Assuming that catching prey of small or large body size requires similar energy expenditures, then it is obviously more advantageous to consume large prey. However, in the current study the fish that consumed smaller prey had higher condition factor. While the explanation for this might be found in the differences in water temperature and the metabolic rates of the fish, it is above all to be found in the effectiveness of the consumption different types of prey. Perch are more effective at catching small cladocerans than copepods (Person and Greenberg 1990).

Among the many abiotic environmental factors that impact the various life processes of larval fish, water temperature has the greatest impact on feeding intensity. The strict dependence between water thermal regime and metabolic rate means that this factor belongs to the group of lethal factors (Wootton 1990). This is why excessive temperatures (in excess of optimal for a given species) halt fish growth, cause bodily damage, and, in extreme cases, even death. Juvenile individuals are especially susceptible to changes in water thermal regimes (Blaxter 1992). Higher temperatures and mechanical damage to larval and juvenile fish result in high mortality in the waters of power plant cooling systems (Wilkońska 1994). Most studied indicate there is a simple proportional dependence between feeding intensity and water temperature (Tolonen et al. 2000). The results of the current study also indicate that the feeding intensity of juvenile fish was also determined by water temperature. Additionally, the juvenile perch from Lake Dołgie Wielkie fed more intensely at lower water temperatures than in Lake Gosławskie. In the first of these lakes, which has a natural thermal regime, the highest feeding intensity was noted at a water temperature of 17-18°C, while further temperature increases caused decreases in feeding intensity. However, in Lake Gosławskie larval and juvenile perch feeding intensity was not noted to increase until a temperature of 17°C, while the highest feeding intensity was noted at temperatures of 24-25°C. Wilkońska and Żuromska (1977) confirmed that fish mature more quickly and spawning occurs earlier in waters which are heated intensely and for long periods. The results of the current study indicate that fish are capable of adapting to high temperatures; this finding confirms the thesis put forward by Blaxter (1992) which stated that acclimatization conditions cause lethal temperature values to shift.

Most of the perch individuals analyzed were confirmed to have prey in their digestive tracts. Only 3% of the fish from Lake Dołgie Wielkie had empty digestive tracts. The share of fish with empty digestive tracts depends on the type of food consumed, the abundance of the feed base, feeding activity, and abiotic factors (Arrington et al. 2002, Graeb et al. 2004). In comparison to predators, fish that consume diets less rich in energy (planktivores, detritivores) have to feed more frequently to meet their daily nutritional needs (Arrington et al. 2002). Diurnal fish feed less intensively at night, and the share of individuals with empty digestive tracts increases at night (Vašek and Kubečka 2004). In lakes in the temperate zone the highest share of fish with empty digestive tracts are noted in winter (Vinni et al. 2005). In the current study, the period studied was limited to the spring and summer months which is why significant differences were not noted in the share of fish with empty digestive tracts.

The analysis of the size structure of prey consumed by perch in two lakes indicated that they employed different feeding strategies. The dietary composition of perch from Lake Dołgie Wielkie was significantly more varies in comparison to that of perch from Lake Gosławskie. In the Lake Dołgie Wielkie perch ate large quantities of small, plankton organisms (copepodites and Daphnidae) that occurred commonly, while in Lake Gosławskie, where there was low zooplankton abundance in the water, the diet was based on larger organisms (*S. crystallina*, Chironomidae larvae). Perch feeding intensity in Lake Dołgie Wielkie was positively correlated with body length, while in Lake Gosławskie it remained at a constant level. Relations between water temperature and feeding intensity were different in the two lakes. In Lake Dołgie Wielkie the highest feeding intensity was confirmed during the period when the water temperature was 17-18°C, while in Lake Gosławskie it was during water temperatures of 24-25°C.

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Streszczenie

Strategie żerowania i wykorzystanie zasobów pokarmowych przez larwy i narybek okonia *Perca fluviatilis* L. w litoralu płytkich jezior

Celem badań była analiza składu diety oraz strategii żerowania 0+ okonia *Perca fluviatilis* L. w dwóch jeziorach (Gosławskie i Dołgie Wielkie), zróżnicowanych troficznie i termicznie. Temperatura wody była wyższa w Jeziorze Gosławskim (test Mann-Whitney, P < 0,01), natomiast zawartość tlenu była podobna (test U Mann-Whitney, P > 0,05). Średnia liczebność, biomasa i ilość gatunków w okresie prowadzonych badań była istotnie statystycznie niższa w Jeziorze Gosławskim (test U Mann-Whitney, P < 0,0001). Udział okoni z pustymi przewodami pokarmowymi był bardzo niski. Ryby z Jeziora Dołgie Wielkie wyróżniały się wyższymi wartościami współczynnika kondycji (średnio 1,87) niż z Gosławskiego (1,73). Analiza struktury wielkościowej ofiar zjadanych przez okonia w dwóch jeziorach wykazała realizowanie przez niego odmiennych strategii żerowania. W Jeziorze Dołgie Wielkie okoń zjadał duże ilości drobnych, licznie występujących organizmów planktonowych (copepodity widłonogów i Daphnidae), natomiast w Jeziorze Gosławskim przy niewielkiej liczebności zooplanktonu w wodzie, podstawą diety były większe organizmy (*Sida crystallina*, larwy Chironomidae). Intensywność żerowania okonia w Jeziorze Dołgie Wielkie była dodatnio skorelowana z długością ciała, natomiast w Jeziorze Gosławskim pozostawała na tym samym poziomie.