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The distribution of waterfowl in relation to mollusc populations in the man-made Lake Zegrzyńskie

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Abstract

Preliminary investigations on the occurrence of molluscs and waterfowl at the man-made Lake Zegrzyńskie were begun in 1986.

The numbers, biomass and dominance structure of molluscs were analysed at different stations in the Lake. Some mollusc species were observed in huge numbers. Waterfowl, especially benthivorous species, were found in big flocks all the year round, but reached highest numbers in autumn. The possible effects of predation pressure from waterfowl on mollusc communities were analysed.

Introduction

High densities of molluscs observed on Lake Zegrzyńskie, and correspondingly high numbers of molluscivorous birds, provide suitable conditions for ecological studies of dependencies between two groups. Determination of chosen population features in these two trophic levels, and their mutual relationships, are the subject of studies started in 1986. The data presented here have been gathered during the first two years of the extensive CPBP Programm (No. 04.10.08) entitled 'Functioning of freshwater ecosystems, their protection and restoration', planned to be continued for the next three years. That is why the results are not conclusive and at this stage cannot be fully interpreted. A long-term objective of this research is to assess the magnitude of the impact of waterfowl on the molluscan prey populations. We believe that such work is required because in hydrobiology the majority of investigations on predator–prey relationships refer to planktonic organisms (Karfoot & Ship, 1987). Interactions between predators and their prey as determined by the impact of fish or birds on benthos are problems relatively rarely examined.

Freshwater molluscs are known to be consumed by waterfowl such as coot (*Fulica atra*), tufted duck (*Aythya fuligula*), pochard (*Aythya ferina*), goldeneye (*Bucephala clangula*) and other benthos feeders (Leuzinger & Schuster, 1970; Willi, 1971; Jacoby & Leuzinger, 1972; Stempniewicz, 1974; Suter, 1982; Crame & Simons, 1977; and others).

There are significant differences between estimations of the degree to which waterfowl utilize molluscs. Wiktor (1969) has stated that in Szczecin Firth the bivalve *Dreissena polymorpha* was only slightly utilized although its density was extremely high. It does not seem probable that waterfowl would affect the numbers of *D. polymorpha* in Masurian lakes. In Lake Gopło (central Poland) consumption of molluscs (especially of

D. polymorpha) by birds was much higher: it amounted to about 32 per cent in summer (Stempniewicz, 1974) and in winter coot itself consumed 93 per cent of the total biomass of the molluscs (Mikulski *et al.*, 1975).

In Swiss lakes, only recently invaded by *D. polymorpha*, significant changes were noted in populations of birds, most probably due to the recent appearance and mass development of this mollusc. Invasion of *D. polymorpha* affected not only the number of waterfowl but also the distribution of birds – they began to gather in places where molluscs were most numerous (Leuzinger & Schuster, 1970).

Most investigations on molluscs as food for birds were connected with one, mass-occurring species, mostly *D. polymorpha*. A specific pattern of distribution of molluscan fauna in Lake Zegrzyńskie, with a more diverse community dominated by different species in different parts of the lake, gave us the opportunity to examine food selectivity in benthivorous birds and its relation to their overall feeding strategies.

Description of study-site

The man-made Lake Zegrzyńskie arose as a result of the impoundment of the Narew and Bug rivers by a dam constructed on the Narew river at Debe in 1962-64. The total capacity of the lake is 100×10^6 m^3 and the working draw of water is 11×10^6 m^3, resulting in a variation in depth of 0.5 m.

Lake Zegrzyńskie is not deep: generally 3-4 m, being deeper (6-8 m) only in the old river beds near the dam. The lake is supplied with water by two rivers (the Bug and the Narew) carrying different pollution loads has a small water exchange rate in the main basin during low and medium water-flow, and is characterized by a great diversity of communities in different zones. The communities were found to vary considerably both in quality and numbers (Dusoge *et al.*, 1985). The phytoplankton was rich, with a maximum biomass of 32 mg wet wt l^{-1}. Zooplankton showed a high species diversity with low numbers and biomass of 0.15-1.69 mg wet wt l^{-1}. The bottom fauna (without Mollusca) consisted mainly of Oligochaeta and larvae of Chironomidae, and was very abundant (over 200 g wet wt m^{-2}). The communities of molluscs in the littoral zone in 1980-81 were rich in quality and numbers (Jurkiewicz-Karnkowska, in press).

The fish populations were also very rich in numbers. Some 23 fish species, dominated by roach (*Rutilus rutilus*), bream (*Abramis brama*), bleak (*Alburnus alburnus*) and stickleback (*Gasterosterus aculeatus*), have been recorded (Grudniewski, in prep.).

Material and methods

The distribution of molluscs in Lake Zegrzyńskie has been examined in May, July and October 1986 and in May and July 1987. Each time the samples were taken by means of a bottom dredge and a bottom Ekman-Birge sampler at 8 to 9 stations in the littoral and in the middle of the lake. In July 1987 the samples were taken from 3-5 stations set up on 17 profiles, at various depths and at various distances from the shore. The material was fixed with 4% formalin. Molluscs were identified to species; all specimens were measured, weighed, dried at about 60 °C for 24 hrs and then weighed again, to obtain dry weight with and without shell.

Observations on the distribution and numbers of waterfowl were carried out from October 1986 to August 1987. In total 18 censuses were made, 2-6 in each phenological period (breeding period, period of dispersal, autumn wintering, spring passage). The censuses were made by four observers in one day. The position and activity of the birds were mapped during the counting. When analyzing results, the reservoir was divided into 8 basins according to limnological characteristics (Fig. 5).

The average number of each species living on particular basins in the phenological periods mentioned above served as the basis, in terms of bird-day units, for calculating the exploitation of a given area by diving ducks (Nilsson, 1972). The energy requirement of benthivorous species in the

non-breeding period was assessed using available published data on daily basal metabolic rate (Suter, 1982). The differences in energy requirement between the two sexes were examined. Changes of the benthivorous guild energy requirement and the mollusc energy values (Stańczykowska, 1977; Winberg, 1971), together with data on the dynamics of the mollusc number, have been used for estimating the pressure of predator on prey.

Results

Molluscs – a total of 51 species were encountered in Lake Zegrzyńskie, including 28 snail and 23 bivalve species. All have been recorded in 1980-81 in the littoral zone of the lake by Jurkiewicz-Karnkowska (in press). From the present study it is clear that the occurrence of most species is not restricted to the littoral zone, as they are also found offshore. The number of species in Lake Zegrzyńskie is high, both as compared with other dam reservoirs (see Jurkiewicz-Karnkowska, in press) and with several tens of natural lakes situated in northern Poland (Stańczykowska *et al.*, 1983).

Studies have proved that, in spite of large species richness, only several species play a substential role in terms of numbers and biomass. Especially abundant were *Viviparus viviparus* L., *Dreissena polymorpha* (Pall.) and representatives of the Sphaeridae. The dominance of various species is connected with different lake parts and to a much lesser degree with depth (Fig. 1). *Viviparus viviparus* was especially numerous in the discharge section of the Narew river, in the western part of the lake and in some parts near the dam. In the latter environment there were places where *D. polymorpha* was especially abundant. The representatives of Sphaeridae were especially predominant in the mouth of the Bug river.

Maximum numbers and biomass of molluscs in the Lake can be considered as very high; average values are also high. Relatively few habitats have a relative paucity of molluscs. The numbers of molluscs are similar in the littoral zone and offshore (Fig. 2).

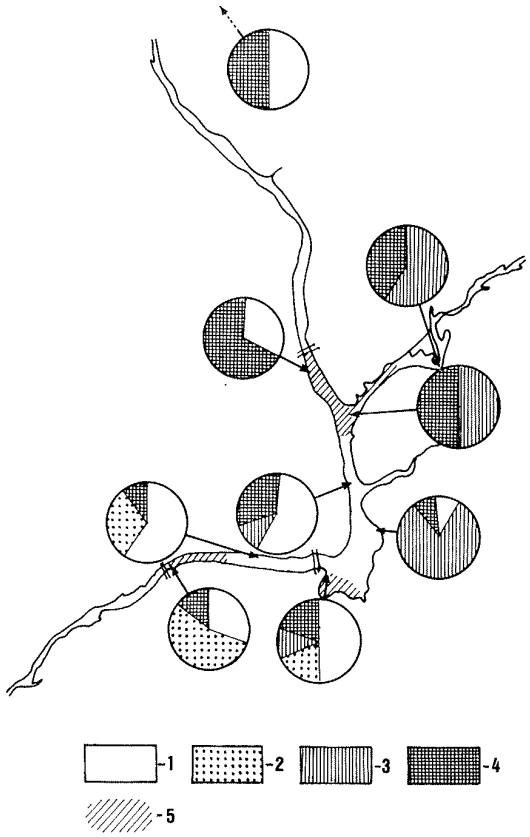

Fig. 1. Percentage composition (in terms of biomass) of the mollusc community at different sites in Lake Zegrzyńskie. 1. *Viviparus viviparus*, 2. *Dreissena polymorpha*, 3. Sphaeridae, 4. others/. Places of foraging by birds are shown by hatched areas.

Birds – during census of Lake Zegrzyńskie 31 species of birds were recorded. The number of species varied depending on the phenological periods: lowest in the breeding season – 12 species, highest in autumn passage – 22 species. Average numbers in the bird community varied from 2900 individuals in spring to 13600 birds in autumn (Fig. 3).

The whole bird community was divided into trophic groups or foraging guilds: herbivores, benthivores, piscivores, and omnivores. Benthivores were represented by 7 species: tufted duck (*Aythya fuligula*), pochard (*Aythya ferina*), goldeneye (*Bucephala clangula*), scaup (*Aythya marila*), coot (*Fulica atra*), common scoter (*Mellanitta*

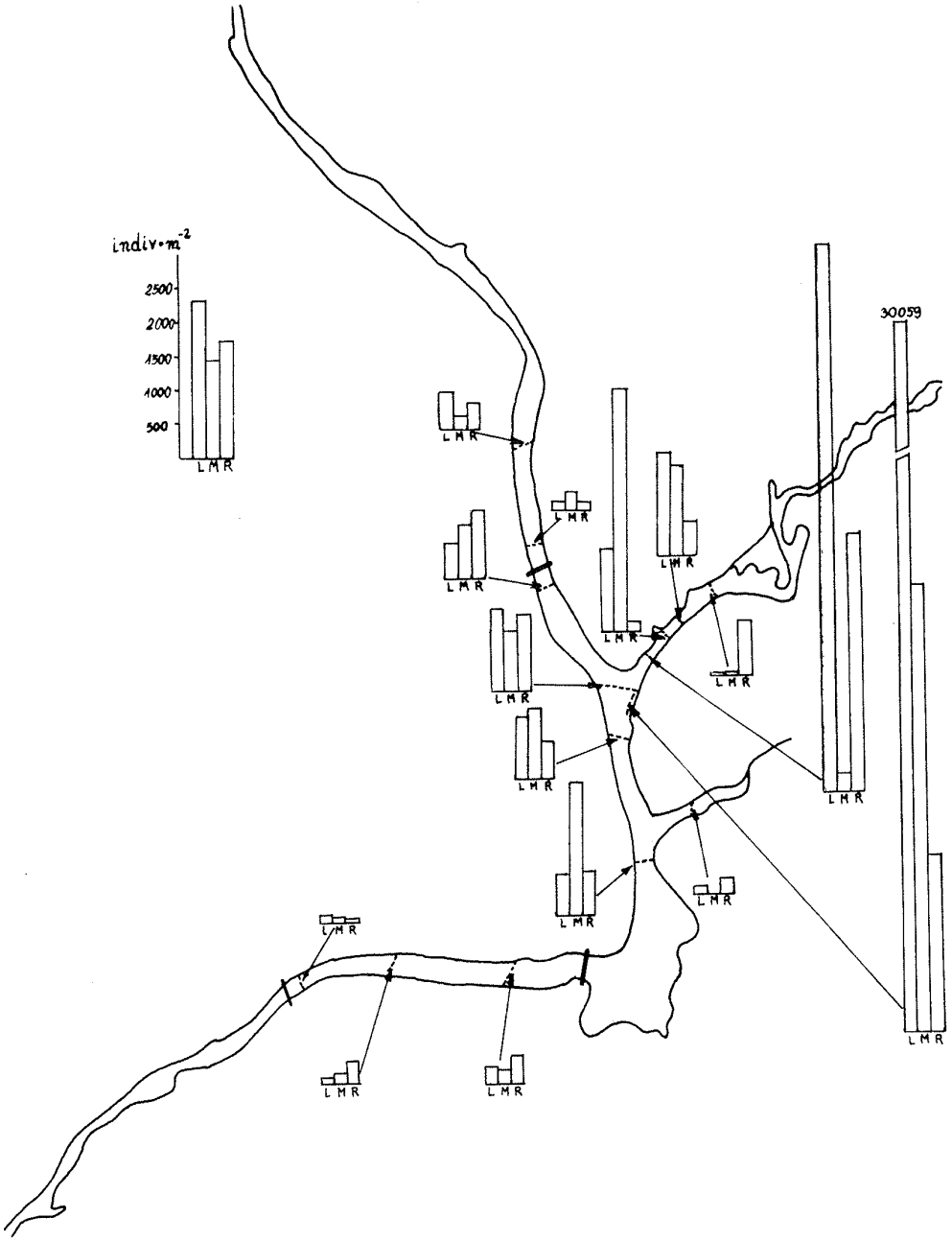

Fig. 2. Distribution of molluscs (indiv. · m^{-2}) along profiles sampled in July 1987. L – left side of the Lake, M – middle of the Lake, R – right side of the Lake.

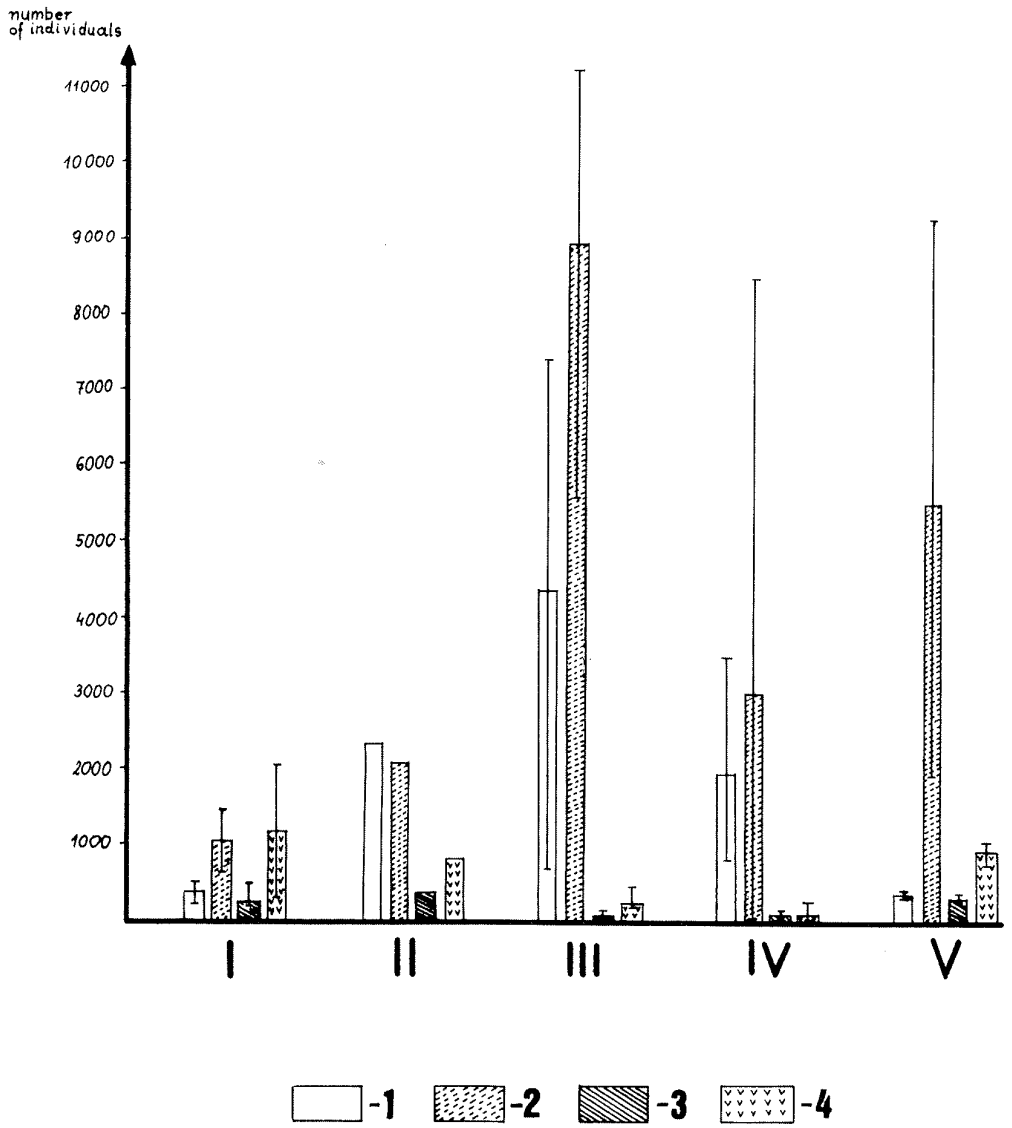

Fig. 3. The seasonal fluctuations of abundance of avian foraging guilds on Lake Zegrzyńskie. I – breeding period, II – period of dispersal, III – autumn passage, IV – wintering period, V – spring passage, 1. herbivores, 2. benthivores, 3. piscivores, 4. omnivores. The histograms indicate the average number of birds, error bars the minimum and maximum numbers.

nigra) and long tailed duck (*Clangula hyemalis*). The highest number of benthivorous species (6) was observed in autumn, with 3-4 species in the remaining seasons. The species composition of the benthivorous guild changes with season. Tufted duck was most frequent (up to 59% of the foraging guild) in the breeding season and autumn passage, whereas in other seasons it occurred only as en accessory species. The share of pochard in the benthivorous guild was clearly low during the whole season (1-22%). Goldeneye was especially abundant in autumn and in winter when its share was 26% and 31%, respectively. Coot was the most frequent species nearly all year round, varying between 9% and 90% of the guild (Fig. 4).

During the whole study period a variability of

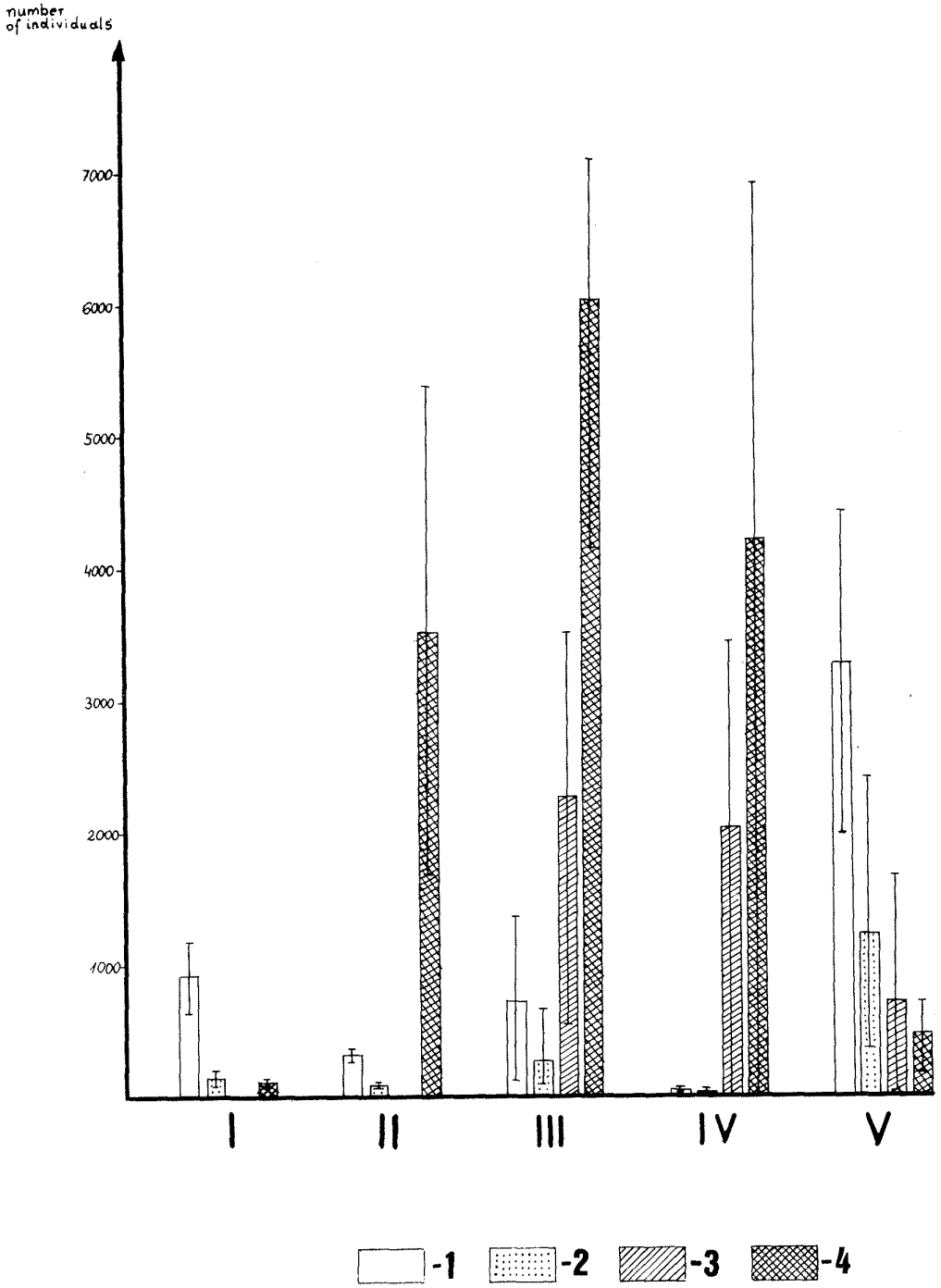

Fig. 4. The seasonal fluctuations of abundance of benthivorous species on Lake Zegrzyńskie. I-V as in Fig. 3. 1. *Aythya fuligula*, 2. *Aythya ferina*, 3. *Bucephala clangula*, 4. *Fulica atra*.

distribution of various bird species in the lake was observed. Tufted duck occurred most abundantly during autumn passage in basins 4 and 6, during spring in basins 4 and 7, and during the breeding period in basin 7. Pochard was observed in basins 4 and 7 both in autumn and in spring. Goldeneye preferred basins 2, 3, 4 and 7 in autumn passage, basins 2 and 4 in winter, and basin 7 in spring. Frequent occurrence of coot was observed during autumn in basins 2, 3, 4 and 5, during wintering in basins 2 and 4, and at spring passage in basins 2 and 5.

Taking into account the above findings it was concluded that basins 1, 2, 3, 4 and 7 were most frequently occupied by the whole foraging group during the non-breeding period. Locations of especially intensive foraging are marked in Figs. 1 and 2. The ratio of the energy requirements of the whole benthivorous bird community to the energy equivalent of mollusc biomass abundance was calculated (Fig. 5). It was found that the birds can remove 0.2% to 0.4% of the annual production of the prey population (basins 3, 4, 5, 6 and 8) or even 10-20% (basins 2 and 7) (Table 1). The weakest pressure was observed in the region of the mouth of the Bug river and in the region close to the dam.

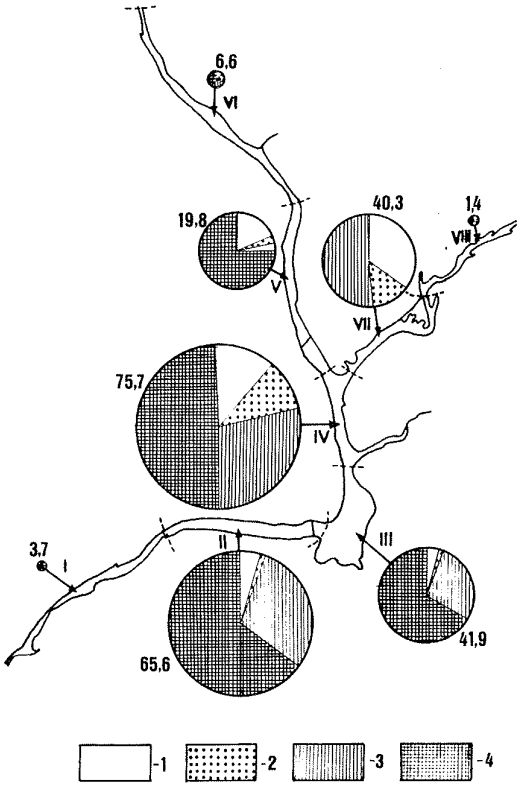

Fig. 5. The energy requirement (in 10^6 kcal year^{-1}) of benthivorous species in particular basins of Lake Zegrzyńskie during the non-breeding season. 1-4, groups as in Fig. 4.

Table 1. The estimated pressure of benthivores on molluscs as an energy requirement (in terms of mollusc biomass) in relation to their food supply.

	Basins							
	1	2	3	4	5	6	7	8
benthivorous guild energy requirement (10^6 kcal year^{-1})	3,7	65,6	41,9	75,7	19,8	6,6	40,3	1,4
A. benthivorous guild energy requirement in terms of mollusc biomass (10^6 g) during the non-breeding period	14,9	262,5	167,4	302,8	79,4	26,6	161,3	5,7
area of basins (km^2)	2,5	6,0	9,0	3,5	3,0	5,0	2,5	2,5
B. estimated mollusc biomass (10^6 g) in the basins	?	2520	10710	6650	2760	1250	800	2000
estimated benthivores pressure on molluscs as the proportion A/B	?	10,4%	1,6%	4,6%	2,9%	2,2%	20,2%	0,2%

Conclusion

The investigations revealed the selectivity of foraging places by benthivorous birds. These species foraged only in some places in spite of abundance of food (molluscs) in other parts of the lake. High activity of goldeneye was observed in the places of mass occurrence of *D. polymorpha* and Sphaeridae. In places of abundant occurrence of Sphaeridae tufted duck and goldeneye also foraged there. Coot, on the other hand, occurred in the region of *D. polymorpha* colonies. In most places where birds foraged *Viviparus viviparus* was abundant: however there were places where, in spite of mass occurrence of this snail, the birds did not forage. These observations corroborate the hypothesis of active selection of specific foraging places by these birds. A next step in this research must be the collection of diet data through gut analysis.

High variability of distribution and numbers of benthivores in Lake Zegrzyńskie during the annual cycle is important in influencing the changing pressure of birds on molluscan prey populations. This pressure is additionally complicated by the diverse abilities of collecting food by different species of birds (different depth for diving, anatomical differences in beak and stomach).

Moreover, fish living in the Lake also consume molluscs. Other investigations were carried out at the same time that aimed at evaluating quantitatively the food consumed by the dominant fish, namely roach and bream, which chiefly feed on molluscs. Molluscs were also often found in the guts of other fish living there (Terlecki, in prep.).

We hope that further investigations included in the Programme, in particular those aimed at examining the bioenergetic value of molluscs as food for birds, and those concerned with determining the influence of various other factors (e.g. fish) on the mollusc populations, will permit us to determine how they function in the ecosystem.

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