ACTA HYDROBIOL.	31	3/4	373—384	KRAKÓW 1989

Initial stage of bird settlement on the Dobczyce dam reservoir (Vistula basin, southern Poland)

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Manuscript submitted November 11, 1988, accepted December 21, 1988

Abstract — In the period 1986—1988, 48 bird species associated with a water environment were recorded on the Dobczyce dam reservoir in the first three years of its existence. Only 14 of them were identified as breeding or probably breeding. The dominating species included *Anas platyrhynchos*, *Larus ridibundus*, and *Podiceps cristatus* together with the change in the physical parameters of the environment a change in the structure of bird communities was observed.

Key words: dam reservoir, water birds, settlement, community structure.

1. Introduction

The emergence of a new habitat in always connected with its settlement by organisms and the gradual development of a new biocoenosis, i.e. with ecological succession. This process includes changes in species structure.

Relatively few data have appeared on the avifauna of Polish dam reservoirs; the scant information mainly concerns Lake Rożnów (Krzanowski 1950) and the Otmuchów (Dyrcz 1981), Goczałkowice (Bocheński 1986), and Włocławek (Nowysz-Wesołowska 1976) dam reservoirs. The creation of the new dam reservoir at Dobczyce permitted a study of the initial stage of its settlement by birds, the beginning of successive ecosystem changes.

The present work aimed at tracing its invasion by birds connected with a water environment after the creation of the reservoir.

2. Study area

The observations were carried out on the Dobczyce reservoir. It was built on the 60th km of the River Raba on the Wieliczka Plateau (Polish Western Carpathians) between the towns of Myślenice and Dobczyce, about 25 km south of Cracow.

The filling of the reservoir began at the end of February 1986 and lasted until December 1987. This caused instability in the environment. The

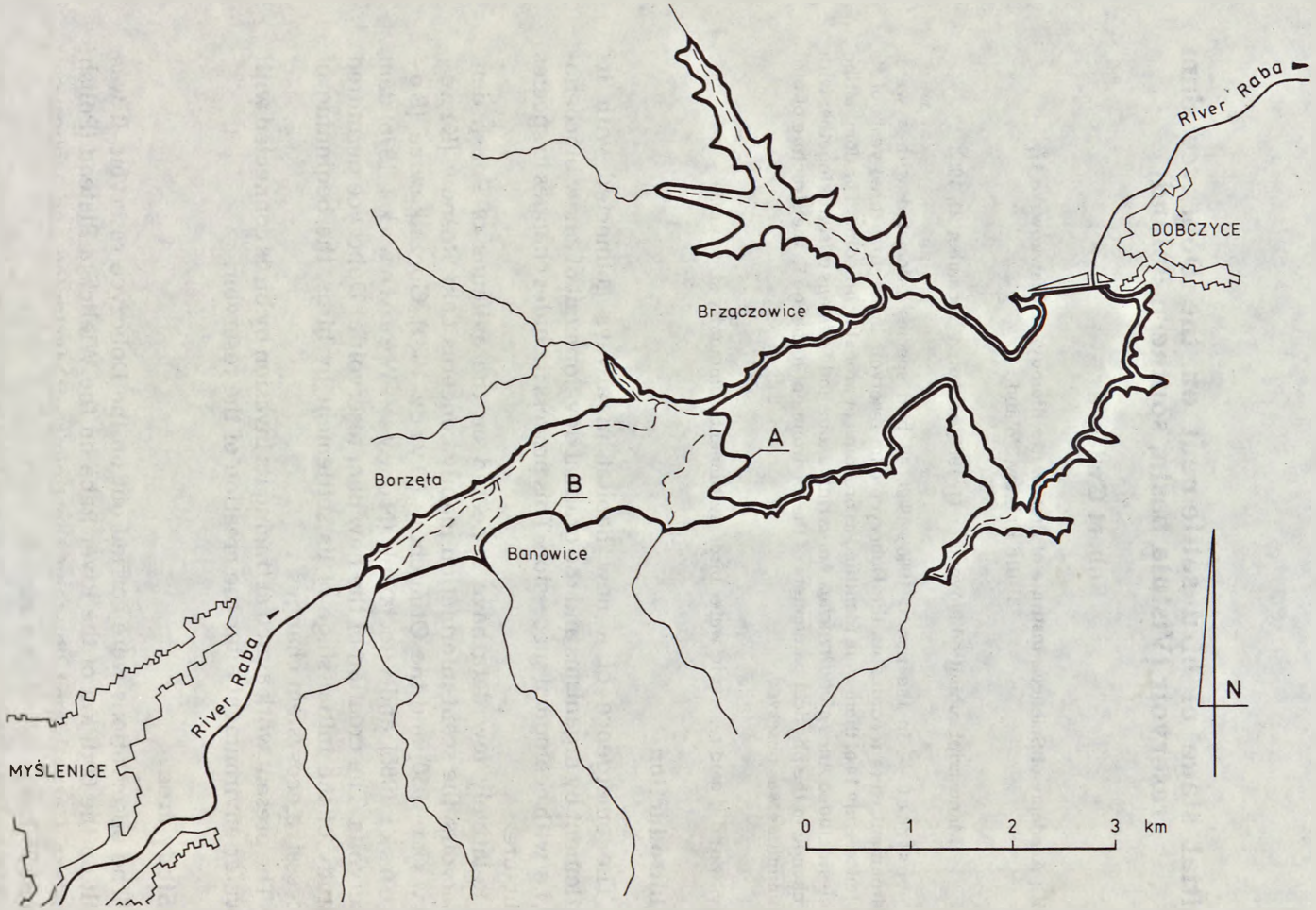

Fig. 1. Dobczyce reservoir. Area covered: A — Dec. 1986; B — Dec. 1987

flooded area included 791 ha of arable, 195 km of forest, and 53 ha of meadows and pastureland (Głodek 1985). The maximum area of the reservoir is c. 1120 ha, mean depth c. 11 m, length c. 10 km, and width c. 1 km (Pasternak 1980). A map of the reservoir is given in fig. 1. Its shores are differentiated, in places steep, especially the section between the villages of Brzączowice and Borzęta. They are covered with meadows and forest. The northern shore is steeper than the southern one. In the period 1986—1987 the bottom was always completely covered by water and no marshy ground appeared, owing to the constant increase in the surface. 1988 was the first year of a relatively stable environment. No important reed- and rush-covered areas have developed so far, hence the reservoir mainly constitutes an open water body environment.

3. Material and methods

Counting the birds was conducted by walking along the northern shore of the reservoir from Dobczyce towards the end the flooded area. The relatively small width of the reservoir permitted observation of the birds on both shores. The reservoir was not circumambulated, in order to avoid counting some of the birds twice and because of the considerable time differences between the observations from the two shores. This, however, may have prevented observation of specimens sitting among the shoreline vegetation on the southern side. Observations were also made from a boat in the third year of the study.

Counting of the birds took place as a rule once a month on clear mornings without precipitation. 10×50 binoculars and a 40×60 field glass were used. Six counts were made in 1986, 13 in 1987, and 14 in 1988. The total material included 33 observations.

The study took into account only birds connected with a water environment, hereon called water birds. Their classification is based on the work by Ferens and Wasilewski (1977).

The division of water birds into four morphoecological types was adopted after Dobrowolski (1969):

1. swimmers,
2. waders,
3. flight feeders,
4. creepers.

Four phenological periods were differentiated:

a) spring migration — March-April (60 days),
b) breeding — May-July (90 days),
c) autumn migration — August-December (150 days),
d) wintering — January-February (60 days).

The quantitative data were collected in from April-December 1986, March-December 1987, and May-December 1988. The observations of

wintering (February 1987, and January and February 1988) were not analysed quantitatively.

The birds' breeding status was determined on the basis of the following criteria. A species was considered a breeding one if its representative was observed on the nest or if its young were recorded. If birds of a given species were encountered during the breeding period and territorial behaviour was observed but nesting was not confirmed, the species was considered as probably breeding. All other cases were described as non-breeding.

A species was considered dominant or subdominant if its percentage share exceeded 5% of the total number of birds counted on the reservoir during at least one control observation.

Table I. Average area and depth of Dobczyce Reservoir in phenological periods of 1986 and 1987 (data of Biological Fishing Station at Brzączowice of the Institute of Freshwater Biology of the Polish Academy of Sciences)

Phenological period	Area ha	Depth m
Spring migration		
1986	131.9	3.1
1987	505.2	5.9
Breeding		
1986	277.8	4.2
1987	681.5	8.2
Autumn migration		
1986	470.9	5.5
1987	850.3	9.9

The density of birds was calculated for 10 ha of reservoir area. The mean surface and depth of the reservoir in the analysed phenological periods during filling of the reservoir is presented in Table I. In biocenotic analyses of the phenological periods, Menhinick's index was used, calculated according to the formula:

$$d = S/\sqrt{N}$$

where:
S — number of species,
N — number of individuals.

Differences in the numbers of dominant and subdominant species were studied using analysis of variance double classification without repetitions (Campbell 1971).

4. Results

During the three years of existence of the Dobczyce Reservoir, 48 bird species were observed there. Of this number, 7 were identified as breeding, 7 as probably breeding, and the remaining 34 as non-breeding. In terms of morphoecology, 23 species were counted as swimmers, 15 as waders, 8 as flight feeders, and 2 as creepers (Table II). Some rare species were observed there:

Table II. Occurrence of water birds on the Dobczyce Reservoir in phenological periods of 1986-1988. 1 - swimmers; 2 - waders; 3 - flight feeders; 4 - creepers. B - breeding birds; P - probably breeding birds; N - non-breeding birds. a - spring migration; b - breeding; c - autumn migration; d - wintering

Species	Type	Status	Phenological periods			
			a	b	c	d
Gavia arctica (L.)	1	N			+	
Gavia stellata (Pontopp.)	1	N			+	
Podiceps cristatus (L.)	1	B	+	+	+	
Podiceps grisegena (Bodd.)	1	N	+	+	+	
Podiceps nigricollis (Brehm.)	1	N	+	+	+	
Tachybaptus ruficollis (Pall.)	1	N	+	+	+	
Phalacrocorax carbo (L.)	1	N		+	+	
Ardea cinerea L.	2	N	+	+	+	
Egretta alba (L.)	2	N			+	
Botaurus stellaris (L.)	2	N		+		
Ciconia ciconia (L.)	2	B	+	+		
Ciconia nigra (L.)	2	P	+			
Cygnus olor (Gmel.)	1	N	+	+	+	+
Anas platyrhynchos L.	1	B	+	+	+	+
Anas strepera L.	1	N			+	
Anas penelope L.	1	N			+	
Anas querquedula L.	1	B	+	+	+	
Anas crecca L.	1	B			+	
Anas clypeata L.	1	N	+	+		
Aythya ferina (L.)	1	N	+	+	+	
Aythya nyroca (Guld.)	1	N			+	
Aythya fuligula (L.)	1	B	+	+	+	
Bucephala clangula (L.)	1	N	+		+	
Clangula hyemalis (L.)	1	N			+	
Mergus merganser L.	1	N	+			
Mergus serrator L.	1	B			+	
Circus aeruginosus (L.)	3	N			+	
Pandion haliaetus (L.)	3	N		+	+	
Gallinula chloropus (L.)	1	P		+	+	
Fulica atra L.	1	B	+	+	+	
Charadrius dubius Scop.	2	P	+	+		
Vanellus vanellus (L.)	2	P	+	+	+	
Philomachus pugnax (L.)	2	N			+	
Tringa hypoleucos L.	2	P	+	+	+	
Tringa ochropus L.	2	N		+	+	
Tringa glareola L.	2	N		+	+	
Tringa totanus (L.)	2	N	+			
Gallinago gallinago (L.)	2	N		+	+	
Numenius arquata (L.)	2	N			+	
Stercorarius parasiticus (L.)	3	N			+	
Larus ridibundus L.	3	B	+	+	+	+
Larus canus L.	3	N		+	+	+
Larus argentatus Pontopp.	3	N			+	
Chlidonias nigra (L.)	3	P	+	+	+	
Sterna hirundo L.	3	P	+	+	+	
Alcedo atthis (L.)	2	N			+	
Acrocephalus arundinaceus (L.)	4	N		+	+	
Emberiza schoeniclus L.	4	B		+	+	

— *Egretta alba* (17 Oct. 1988), 5 individuals observed feeding on the southern shore of the reservoir; observation from a boat at c. 100 m;
— *Clangula hyemalis* (19 Dec. 1987), 2 young birds, frequently diving; observation from the shore at c. 25 m;

Table III. Numbers (means and ranges), density, and Menhinick index of water birds in phenological periods of 1986-1988 (in brackets number of samples). x - no data

Parameter	Phenological periods		
	spring migration	breeding	autumn migration
Numbers			
1986	406 (1)	425 (2) 118-731	1074 (3) 147-1938
1987	400 (2) 186-614	271 (4) 194-369	739 (7) 434-1049
1988	x	577 (5) 379-853	1271 (9) 431-2265
Density indiv. 10 ha^{-1}			
1986	30.78	15.26	22.81
1987	7.92	3.98	8.69
1988	x	7.72	16.05
Menhinick index			
1986	0.74	0.73	0.27
1987	0.80	0.91	0.85
1988	x	1.08	1.12

Table IV. Average numbers and range of morphoecological types of birds in phenological periods of 1986-1988 (in brackets number of samples). x - no data

Phenological periods	Morphoecological types of birds			
	swimmers	waders	flight feeders	creepers
Spring migration				
1986 (1)	155	24	227	0
1987 (2)	179 121-237	13 8-18	208 57-359	0
1988	x	x	x	x
Breeding				
1986 (2)	193 25-360	78 10-147	154 83-224	0
1987 (4)	124 70-165	28 18-56	118 74-178	1 0-2
1988 (5)	146 88-324	24 9-53	407 262-691	1 0-2
Autumn migration				
1986 (3)	948 98-1717	0	126 49-221	0
1987 (7)	570 249-868	8 0-32	161 14-271	0
1988 (9)	1051 345-2119	21 0-68	198 28-495	1 0-4

— *Mergus serrator* (9 Nov. 1988), a group of 6 individuals swimming in the backwaters of the reservoir; observation from boat at c. 20 m;
— *Numenius arquata* (20 Sept. 1988), 1 individual observed flying over a meadow near the reservoir; observation from the shore at c. 25 m;
— *Stercorarius parasiticus* (20 Sept. 1988), 1 individual of the light form observed flying across the reservoir; observation from a boat at c. 15 m.

In all phenological periods of 1987, a smaller mean number of birds was recorded than in 1986, while in 1988 more birds were observed than in the previous two years (Table III). The greatest mean number of water birds

Table V. Mean numbers and range of dominant and subdominant species in phenological periods of 1986-1988 (in brackets number of samples). x - no data

Species	Year	Phenological periods		
		spring migration	breeding	autumn migration
Anas platyrhynchos	1986	133.0 (1)	168.0 (2) 9-327	807.0 (3) 64-1566
	1987	96.0 (2) 95-97	41.5 (4) 19-66	421.0 (7) 200-665
	1988	x	52.2 (5) 19-102	763.6 (9) 125-1780
Larus ridibundus	1986	217.0 (1)	142.0 (2) 72-212	125.7 (3) 49-220
	1987	207.0 (2) 57-357	101.8 (4) 53-165	153.6 (7) 5-252
	1988	x	389.4 (5) 259-638	189.6 (9) 20-491
Podiceps cristatus	1986	7.0 (1)	8.0 (2) 7-9	6.7 (3) 0-18
	1987	13.0 (2) 0-26	47.8 (4) 21-91	86.7 (7) 9-200
	1988	x	74.8 (5) 31-191	169.4 (9) 7-451
Aythya fuligula	1986	7.0 (1)	12.5 (2) 8-17	1.0 (3) 0-3
	1987	29.5 (2) 0-59	30.2 (4) 0-61	7.0 (7) 0-36
	1988	x	10.0 (5) 4-18	13.7 (9) 0-55
Aythya ferina	1986	2.0 (1)	2.0 (2) 0-4	0 (3)
	1987	29.0 (2) 17-41	3.0 (4) 0-12	10.3 (7) 0-71
	1988	x	2.8 (5) 0-7	17.6 (9) 0-98
Fulica atra	1986	1.0 (1)	0 (2)	131.3 (3) 10-235
	1987	2.0 (2) 0-4	0 (4)	32.9 (7) 0-112
	1988	x	2.0 (5) 0-5	59.3 (9) 2-219
Ciconia ciconia	1986	8.0 (1)	52.0 (2) 0-105	0 (3)
	1987	0 (2)	2.8 (4) 0-7	0 (7)
	1988	x	1.6 (5) 1-2	1.0 (9) 0-8
Vanellus vanellus	1986	4.0 (1)	13.0 (2) 0-26	0 (3)
	1987	11.5 (2) 8-15	16.5 (4) 2-45	0.6 (7) 0-4
	1988	x	4.2 (5) 0-9	1.0 (9) 0-7
Sterna hirundo	1986	8.0 (1)	8.5 (2) 8-9	0 (3)
	1987	1.0 (2) 0-2	16.0 (4) 13-21	5.1 (7) 0-27
	1988	x	16.4 (5) 2-52	0.1 (9) 0-1
Ardea cinerea	1986	1.0 (1)	3.0 (2) 0-6	0 (3)
	1987	0 (2)	0.8 (4) 0-2	6.0 (7) 0-22
	1988	x	7.0 (5) 0-29	10.0 (9) 0.23
Anas crecca	1986	0 (1)	0 (2)	0 (3)
	1987	0 (2)	0 (4)	0 (7)
	1988	x	0.8 (5) 0-4	15.2 (9) 0-50

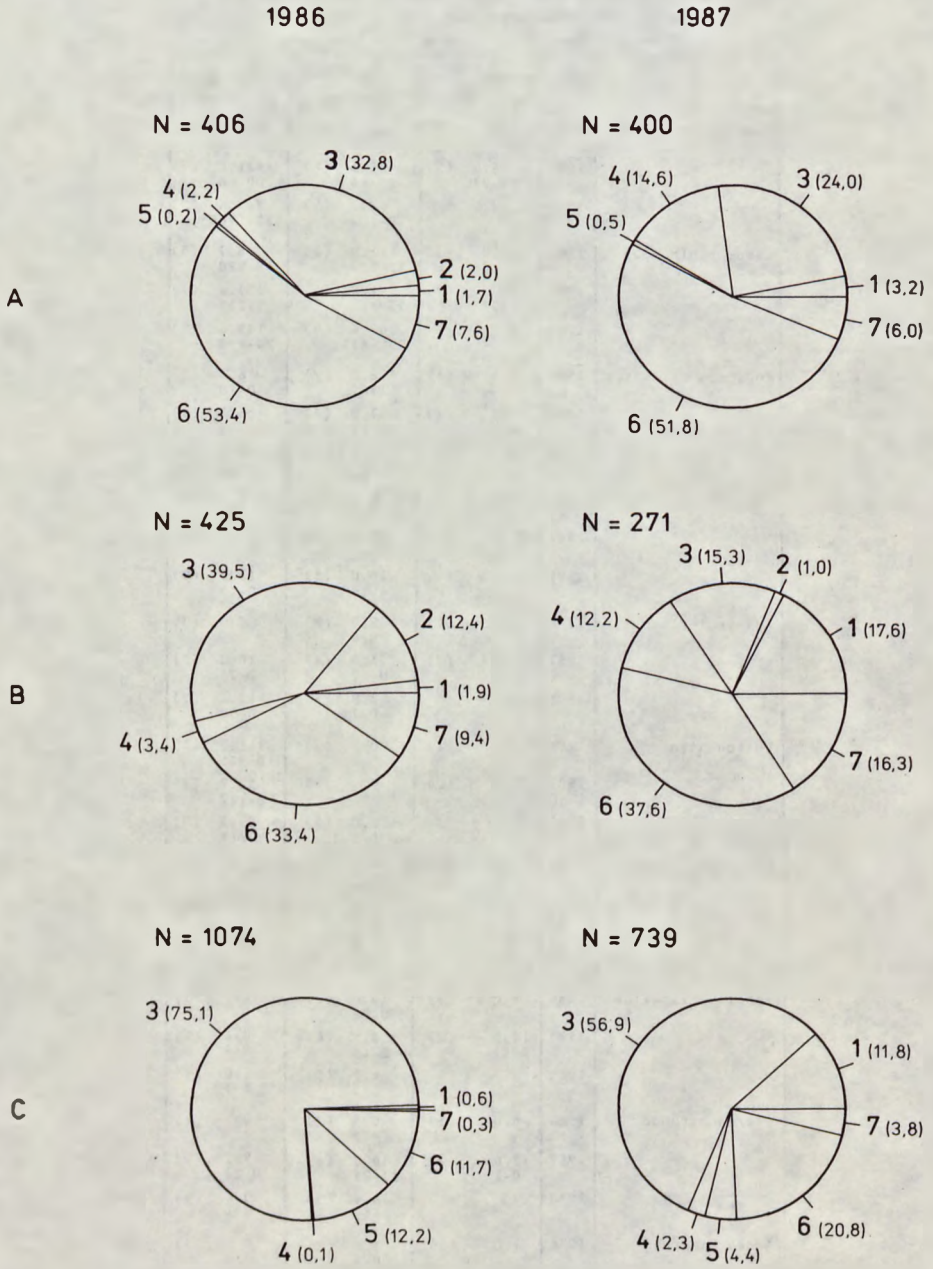

Fig. 2. Bird community structure in phenological periods of 1986 and 1987 (particular species' percentage participation in brackets). A — spring migration; B — breeding; C — autumn migration. 1 — *Podiceps cristatus*; 2 — *Ciconia ciconia*; 3 — *Anas platyrhynchos*; 4 — *Aythya ferina, A. fuligula*; 5— *Fulica atra*; 6 — *Larus ridibundus*; 7 — other

was recorded during the autumn migration. In all phenological periods, a clear majority was maintained by swimmers and flight feeders (Table IV).

During the spring migration, the greatest numbers were attained by *Anas platyrhynchos* and *Larus ridibundus*, which constituted 86 and 76% of the bird community in 1986 and 1987 respectively (Table V). Most numerous in the breeding period were *Anas platyrhynchos*, *Larus ridibundus*, and *Podiceps cristatus*. These constituted 75% of the bird community in 1986, 70% in 1987, and 90% in 1988. The same three species also dominated during autumn migration. Altogether they accounted for 88% of the bird community in 1986, 90% in 1987, and 88% in 1988 (Table V).

Of interest is the comparison of bird community structures between analogical phenological periods during the filling of the reservoir (fig. 2). In all periods, an increase in the percentage share of *Podiceps cristatus*, *Aythya ferina*, and *A. fuligula* was observed in 1987, while *Anas platyrhynchos* was on the decrease. In the case of *Podiceps cristatus*, the differences observed were of statistic significance ($F = 8.96$ for 1 and 5 degrees of freedom) at the significance level 0.05. A large percentage share of *Ciconia ciconia* (12.4%) was observed during breeding in the first year of study. The percentage participation of *Vanellus vanellus* in the total number of birds increased in all periods of the second year (Table V).

The density of most species decreased in the second year with the increase in reservoir surface (Table III). Only a few species increased their numbers: *Podiceps cristatus* during breeding and autumn migration and *Aythya ferina* and *A. fuligula* during passages.

5. Discussion

A relatively small number of water birds have been observed on the Dobczyce Reservoir. Much greater numbers were reported from Otmuchów (82 species — Dyrcz 1981), Orava (67 species — Ferianc o v á - M a s á r o v á 1962), Goczałkowice (62 species — B o c h e ń s k i 1986), and Włocławek (60 species — N o w y s z - W e s o ł o w s k a 1976) reservoirs. Only the species connected with a water environment were taken into account for quantitative comparison (F e r e n s, W a s i l e w s k i 1977). The great number of species on those other reservoirs is connected with their being older (more mature ecosystems) and larger than the one at Dobczyce; they also include shallows and rush-covered areas and are situated on the main migration routes along the Rivers Vistula and the Oder.

Not many breeding or probably breeding bird species were observed on the reservoir, most of them during passages. This indicates that the reservoirs are a "stop" during migration, while few species find favourable conditions for nesting there, possibly because of certain features of the reservoir (steep shores, no rush-covered areas). This seem to be further

supported by the fact that the greatest number of birds were observed during the autumn migration. The majority of *Anas platyrhynchos* and *Ciconia ciconia* recorded in the breeding period of 1986 were non-breeders; similarly, most *Larus ridibundus* during the 1988 breeding season did not nest on the reservoir. The Dobczyce Reservoir is used by birds mainly as resting place and feeding base during their migrations, just as is the case with the Otmuchów (Dyrcz 1981), Orava (Feriancová-Masárová 1962), or Włocławek (Nowysz-Wesołowska 1976) reservoirs.

The greatest numbers were attained by swimmers and flight feeders. The lack of marshy ground and temporarily uncovered bottom accounts for its being ignored by the Charadriformes during their migration. The absence of large stretches of rush or reed might similarly explain the absence of species connected with such habitats.

Anas platyrhynchos, the dominant on the Dobczyce Reservoir, also dominates on Czechoslovakian reservoirs, e.g., those of Orava (Feriancová-Masárová 1962) and Liptovska Mara (Feriancová-Masárová, Ferianc 1979). The numbers of this species on a reservoirs near Michalovce (Slovakia) reach 90% of all birds in autumn (Ferianc 1969). It also dominates on the Otmuchów Reservoir, especially during passages (Dyrcz 1981). *Larus ridibundus*, very numerous in the Dobczyce Reservoir, was less so in the compared reservoirs (apart from the Otmuchów Reservoir). In the open water body zone of the Otmuchów Reservoir, most numerous were *Anas platyrhynchos*, *Larus ridibundus*, and *Podiceps cristatus*, similarly to the situation in the Dobczyce Reservoir.

The differentiation of bird communities increases on the reservoir, as shown by the Menhinick index. The changes in the structure of bird communities in the first two years of the reservoir's existence was connected with variations in its area and depth. The numbers, density and percentage participation of birds varied according to the environmental preferences of the species. Thus the increase in the percentage participation of *Podiceps cristatus*, *Aythya ferina*, and *A. fuligula* becomes understandable as these diver species are able to obtain food from a greater depth. *Anas platyrhynchos* exhibited a reciprocal tendency because of its not being adapted to diver feeding, hence finding more favourable conditions in shallow and thickly overgrown reservoirs. The important participation of *Ciconia ciconia* during the breeding season of the first year was certainly associated with the large meadow area adjacent to the reservoir and constituting an excellent feeding place for those birds. The meadows rapidly became flooded with the damming of the river. The significant effect of the water level on the numbers of birds in a dam reservoir was already noted by Ferianc (1969). With a higher water level in May in the reservoir near Michalovce, Charadriiformes did not stop at all. The same conditions were of no importance to *Podiceps cristatus* and

Aythya sp. Similar tendencies have been observed on the Włocławek Reservoir (Nowysz-Wesołowska 1976), where in the conditions of a raised water level during the autumn a distinct decrease in the number of Charadriiformes was recorded, allegedly because of poor food availability.

The process of formation of a resting community of birds on the Goczałkowice Reservoir was described by Bocheński (1986). In the initial years after filling, the reservoir was settled by black-headed gulls, common terns, great crested and red-necked grebes, and ducks, along with several Charadriiformes and passerines. This was influenced by the fact that there is a system of fish ponds, with their characteristic ornithofauna, in its close vicinity. Thus the initial settlement of the reservoir was carried out by some of the birds from the nearby ponds in connection with the lack of competition in the new ecosystem. The settling of the Dobczyce Reservoir came about in a somewhat different way as there are no ponds in the neighbourhood. It was therefore most probably carried out by some individuals from among the birds flying over the valley of the River Raba during the spring migration of 1986 and by some of the breeding birds from that river in the vicinity of the new reservoir.

Acknowledgements — The author is indebted to Professor Janusz Starmach for making the research possible, to the late Professor Władysław Grodziński for methodical advice, and to Antoni Amirowicz M. Sc. for his valuable remarks during the preparation of the study.

6. Polish summary

Początkowy etap zasiedlania przez ptaki
zbiornika zaporowego w Dobczycach
(dorzecze Wisły, południowa Polska)

Praca opiera się na obserwacjach jakościowych i ilościowych ptaków związanych ze środowiskiem wodnym, na nowo powstałym zbiorniku zaporowym w Dobczycach (ryc. 1) w latach 1986—1988. W pierwszych dwóch latach był on napełniany wodą, przez co wzrastała jego powierzchnia i głębokość (tabela I). W sumie zaobserwowano 48 gatunków ptaków (tabela II). Jedynie 14 z nich zaliczono do ptaków lęgowych i prawdopodobnie lęgowych. Ta stosunkowo mała liczba jest związana z małą różnorodnością środowiska. Najwięcej ptaków zaobserwowano w czasie przelotu jesiennego (tabela III). Pod względem liczebności zdecydowaną większość stanowiły ptaki pływające i polujące w locie (tabela IV). Najliczniejsze były: krzyżówka, mewa śmieszka i perkoz dwuczuby (tabela V). Stwierdzono różnice w liczebności i zagęszczeniu ptaków w czasie piętrzenia zbiornika. Zaobserwowano zwiększenie udziału procentowego perkoza dwuczubego, głowienki i czernicy, zmniejszenie zaś udziału krzyżówki. Związane to było prawdopodobnie z różnymi preferencjami środowiskowymi ptaków (ryc. 2).

7. References

Bocheński Z., 1986. Development and structure of the Goczałkowice reservoir ecosystem. 16. Birds. Ekol. pol., 34, 523—535.

Campbell R. C., 1971. Statistische Methoden für Biologie und Medizin. Stuttgart, G. Thieme Verl., 154—161.

Dobrowolski K. A., 1969. Structure of occurrence of waterfowl types and morphoecological forms. Ekol. pol. A, 17, 29—72.

Dyrcz A., 1981. Ptaki Zbiornika Otmuchowskiego — Birds of the Otmuchów Water Reservoir. Acta Zool. Cracov., 25, 69—102.

Ferens B., J. Wasilewski, 1977. Fauna słodkowodna Polski. 3. Ptaki (Aves) [Fresh water fauna of Poland. 3. Birds (Aves)]. Warszawa-Poznań, PWN, 318 pp.

Ferianc O., 1969. Migrujúce vtáctvo na Podvihorlatskej vodnej nádrži. 1 časť [Migrating birds on Podvihorlatska water reservoir, part 1]. Biológia, 24, 813—838.

Fariancová-Masárová Z., 1962. Význam Oravskej priehrady pre tah a hniezdenie vodného vtáctva — Bedeutung der Stausperre Oravska Priehrada für den Zug und das Nisten der Wasservogel. Biológia, 17, 340—354.

Fariancová-Masárová Z., O. Ferianc, 1979. Vplyv novovybudovanej priehrady Liptovská Mara na postupné zmeny v druhovom zložení a v kvantite vtáctva Liptovskej Kotliny — The influence of the newly built barrage Liptovska Mara on gradual changes in the species composition and quantity of the avifauna of the Liptów Basin. Biológia, 34, 405—412.

Głodek J., 1985. Jeziora zaporowe świata [Dam reservoirs of the world]. Warszawa, PWN, 174 pp.

Krzanowski A., 1950. Ptaki Jeziora Rożnowskiego [The birds of the Rożnów Lake]. Ochr. Przyr., 19, 178—185.

Menhinick E. F., 1964. A comparison of some species diversity indices applied to samples of field insects. Ecology, 45, 859—861.

Nowysz-Wesołowska W., 1976. Obserwacje ptaków wodno-błotnych zbiornika zaporowego na Wiśle pod Włocławkiem w okresie wędrówek — Observations of the water and marsh birds of the storage reservoir on the Vistula near Włocławek during migration season. Acta Zool. Cracov., 21, 501—526.

Pasternak K., 1980. Charakterystyka zbiornika w Dobczycach — Characteristic of the Dobczyce dam water reservoir. Zesz. Problem. Post. Nauk Roln., 235, 201—203.