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THE INFLUENCE OF HABITAT VARIABLES AND INTERSPECIFIC RELATIONS ON WATERBIRD COMMUNITIES OF LOWLAND GLACIAL LAKES IN BELARUS

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INTRODUCTION

The study of waterbird species diversity and number in different habitat types and also the elaboration of general theoretical criteria for estimation of habitat's biological capacity and elucidation of habitat variables determinating this capacity for protected and hunting species are essential for their effective protection and wise use.

Many investigators were devoted to this problem. Habitat variables influence on waterbirds was studied in different directions, including multiple regression analysis (Gibbs *et al.* 1991, Monda *et al.* 1988, Nilson and Nilson, 1978, Sillen and Solbreck, 1977, Utchick, 1980). The classification of lakes as waterbird habitats was elaborated (Kaupinnen, 1993).

MATERIAL AND METHODS

The investigations were carried out in 45 glacial lakes representing different lake types in Belarus (**Table 1**), 272 km^2 of lake surface area (about 20 % of the whole area of Belarussian glacial lakes) were studied.

Waterbird species composition and numbers were estimated using absolute count method with the inspection of all lake surface in kayak (Haldin and Ulfvens, 1987, Kauppinnen *et al.* 1991). Absolute nest census was carried out in 1989-1993. Habitat variable description was made on the ground of aerial photographs interpretation (scale 1:5,000) and large scale maps (scale 1:50,000). The following groups of habitat variables were determined (**Table 2**):

Table 1: Occurrence of waterbirds in glacial lakes (% in the total number of lakes)

Species	Oligo-trophic	Maso-trophic	Slightly eutrophic	Eutro-phic	High eutro-trophic	Hyper-trophic	Dis-trophic	All lakes
	n = 5	n = 2	n = 12	n = 10	n = 2	n = 3	n = 11	n = 45
Gavia arctica	60	-	16,6	-	-	-	-	11
Podiceps cristatus	20	100	33,3	100	100	66,6	-	47
Botaurus stellaris	-	-	-	40	100	33.3	-	15
Cygnus olor	-	100	-	20	50	-	-	11
Anas plathyrhynchos	20	100	33,3	100	100	100	18.2	53
Anas crecca	20	-	25	30	100	-	-	20
Anas strepera	-	-	8,3	-	50	-	-	4
Anas acuta	-	-	-	-	50	-	-	2
Anas querquedula	-	-	-	60	100	-	-	18
Anas clypeata	-	-	-	-	50	-	-	2
Aythya feryna	-	50	-	40	100	-	-	15
Aythya fuligula	-	50	-	30	100	-	-	13
Bucephala clangula	80	100	91,6	30	50	66,6	81,8	71
Mergus serrator	20	50	-	10	-	-	-	4
Mergus merganser	-	-	8,3	-	-	-	-	2
Circus aeruginosus	-	50	-	60	100	66,6	-	24
Fulica atra	-	-	-	30	100	-	-	11
Larus ridibundus	-	50	-	10	100	-	-	9
Larus canus	-	50	-	20	50	-	-	9
Chlidonias niger	-	-	-	40	100	-	-	13
Chlidonias leucopterus	-	-	-	-	50	-	-	2
Sterna hirundo	-	50	-	-	50	-	-	4
The whole number of waterbird species	5	11	7	15	20	5	2	

- percentage of surface area with different types of submerge and surface vegetation;
- percentage of shore types from the whole shore line;
- water basin (percentage of different biotopes from shole basin area on the 5 km distance from lake shore);
- other lake description were taken from reference book on Belarussin lakes (Yakushko *et al.* 1988): mineral matter content, water transparency and colour.

Table 2: Estimated number of waterbirds in glacial lakes

Species	Oligo-trophic	Maso-trophic	Slightly eutrophic	Eutro-phic	High eutro-trophic	Hyper-trophic	Dis-trophic	All lakes
	n = 5	n = 2	n = 12	n = 10	n = 2	n = 3	n = 11	n = 45
Water surface area (ha)	602	7986	1682	8085	7395	1420	127	27297
Gavia arctica	6	-	6	-	-	-	-	12
Podiceps cristatus	22	152	28	372	250	16	-	840
Botaurus stellaris	-	2	-	20	62	8	-	92
Cygnus olor	-	11	-	11	6	-	-	28
Anas plathyrhynchos	14	161	34	682	1900	24	9	2824
Anas crecca	4	-	14	13	92	-	-	123
Anas strepera	-	-	2	-	2	-	-	4
Anas acuta	-	-	-	-	2	-	-	2
Anas querquedula	-	-	-	201	78	-	-	279
Anas clypeata	-	-	-	-	6	-	-	6
Aythya feryna	-	4	-	102	950	-	-	1056
Aythya fuligula	-	74	-	74	310	-	-	458
Bucephala clangula	23	16	80	26	8	12	43	185
Mergus serrator	-	4	-	2	-	-	-	6
Mergus merganser	-	-	2	-	-	-	-	2
Circus aeruginosus	-	2	-	20	62	4	-	88
Fulica atra	-	-	-	94	500	-	-	594
Larus ridibundus	-	800	-	240	3800	-	-	4840
Larus canus	-	40	-	45	50	-	-	135
Chlidonias niger	-	60	-	310	260	-	-	630
Chlidonias leucopterus	-	-	-	-	60	-	-	60
Sterna hirundo	-	6	-	-	20	-	-	26
Whole estimated number	69	1364	168	2188	8498	64	52	12380

Simple correlation coefficients were calculated between habitat variables and waterbird densities. Calculations were made in the Computer Centre of the Mathematical Institute (Belarussian Academy of Sciences).

On the strength of species composition and density of waterbirds in correspondence with mean values of main habitat variables, we have identified seven lake groups mostly coinciding with generally accepted lake classification based on trophic levels (**Table 1, 2**).

RESULTS AND DISCUSSION

The numbers of bird species nesting in the lakes with different trophic level were different (**Table 3**). The number of bird species increased in the lake series from oligotrophic to distrophic with maximum species number in highly eutrophic lakes (21 species), and than decreased again.

The least number of waterbird species nested in lowly mineralized distrophic lakes situated in peat bogs and also in oligotrophic forest lakes.

Dominant species Mallard (*Anas plathyrhynchos*) and Goldeneye (*Bucephala clangula*) were registered in all types of lakes (**Table 3**). These species were not restricted to only in low mineralized distrophic waterbodies.

Table 3: Environmental variable correlation coefficients with species densities (%)

Environmental variables	CIR AER	POD CRI	BOT STE	BUC CLA	AYT FER	AYT FUL	ANA PLA	ANA CRE	ANA QUE	FUL ATR	LAR RID
Surface area, ha	40	0	18	-24	33	36	2	-4	5	47	63
Submerge vegetation, %	34	20	0	-13	58	57	43	-3	7	50	60
Whole vegetation, %	44	29	26	-22	41	27	21	-11	5	42	42
Mosaic vegetation, %	49	0	62	-17	47	90	17	-1	20	71	51
Unbroken veg. grows, %	34	40	24	-16	17	9	0	-5	5	33	20
Shore line, m	39	0	22	-39	19	32	0	-8	19	33	45
Open shore, %	1	41	20	-17	29	26	40	-13	-3	7	-2
Forest shore, %	-35	-21	-24	15	-30	-23	-20	23	-7	-27	-21
Islands, %	53	-4	19	-13	52	20	0	3	-1	67	80
Water basin: Forest, %	-38	-29	-17	33	-36	-23	-27	0	-8	-24	-26
Marshes, %	27	8	56	-12	42	85	30	-3	6	53	31
Agricultural lands, %	41	41	21	-30	47	21	35	-11	0	30	30
Mineral matter cont., mg/l	49	31	21	-53	25	25	23	-21	34	22	18
Water transparence, m	-28	3	-23	21	0	-15	9	33	-16	-18	-5
Water colour, grad.	24	-7	34	-30	13	46	0	-15	5	32	16
Phytoplankton, g/m^3	54	0	38	-27	23	46	11	-10	14	30	21
Zooplankton, g/m^3	27	-7	74	-25	6	54	-4	-5	24	33	0
Zoobenthos, g/m^2	24	-4	10	0	21	16	2	-2	6	29	34

Large group of species (Eurasian Bittern - *Botaurus stellaris*, Common Teal - *Anas crecca*, Garganey - *Anas querquedula*, Pochard - *Aythya ferina*, Tufted Duck - *Aythya*

fuligula, Coot - *Fulica atra*, Black Tern - *Chlidonias niger*) occurred only in 6-9 lakes during the nesting period. The others were occurred in 5 and less waterbodies.

Analyses of results from investigations of waterbird numbers in different lake types used to determine dominant species group (Black-headed Gull, Mallard, Pochard, Great Crested Grebe) with their different occurrence. If Mallard and Great Crested Grebe occurred in majority of different lakes, Pochard and Black-headed Gull nested only in some high eutrophic lakes, but with very high density.

Subdominant group consisted of Coot, Tufted Duck and Black Tern. This species group also nested in small number of waterbodies but with high density.

Separate group was formed by Goldeneye, Eurasian Bittern and Marsh Harrier. They occurred in large number of lakes, but with low density. Their low density was attributed to their biological peculiarities and not to the bad environmental conditions.

Common Teal, Garganey, White-winged Black Tern and Common Tern despite of their ordinary occurrence and high abundance in Belarus, were revealed only in few lakes with low density. It was explained by their breeding in river floodplanes.

The rest of species (Black-throated Diver, Northern Pintail, Gadwall, Northern Shoveler, Red-breasted Merganser and Goosander) were rare as in estimated number as in occurrence.

The analysis of different environmental factors influence on ecological capacity of lakes for different waterbird species allowed to distinguish three species groups with similar environmental demands.

The first group consisted of Goldeneye and Black-throated Diver. They preferred to breed in small unproductive lakes situated in forest tracts or in peat bogs. Low content of mineral matter, high water transparency and sparse surface vegetation are distinguishing features of such lakes.

The second group of species with the same environmental demands consisted of Pochard, Tufted Duck, Eurasian Bittern, Black-headed Gull and Marsh Harrier. Their densities positively correlated with majority of variables connected with highly eutrophic lakes. Different vegetation communities, the presence of vegetation-floe and islands formed high environmental mosaicity, so large quantity of species utilized such areas with high density.

Positive correlations between densities of such species showed not only the same environmental demands of them, but also the absence of interspecific competition. Low interspecific competition were explained by as well as ecological niches interference, as also food abundance and good protective properties, that also lowered the competition.

The third group consisted of Mallard and Great Crested Grebe. They occurred in majority of lakes with rather high density. The absence of high positive correlations with analysed environemntal factors was expalined by the high plasticity of these species. They can use for nesting the lakes with different surface area and trophic level. The same reasons led to the lack of close relationships with densities of other species.

Interspecific correlation indices between densities were also indicated the presence of three species group with high interspecific positive correlation within group and correlation lack between species from different groups.

Analysis of species distribution and estimated number allowed us to conclude that populations of species nesting with high density in small number of high productive lakes were in the most unstable conditions. We can attribute to such species group Pochard, Tufted Duck, Coot, Eurasian Bittern, Marsh Harrier. Instability of their populations can be explained by first of all with small quantity of natural lakes with high productivity (there are only ten such lakes in Belarus now) and secondly - rapid decreasing of lake productivity because of anthropogenic eutrophication.

Mallard and Great Crested Grebe were in best conditions because of their ability to populate different types of waterbodies. The estimated number of Goldeneye was also rather stable because of stability of lake ecosystems in early and late stages of development.

We can conclude that increase in the hunting of waterbirds and the conservation of rare species will be impossible if only a few lakes will be protected. It is necessary to develop guidelines (or rules) for all Belarussian natural waterbodies for wise use and protection. It will not only improve conservation of natural lakes, but also increase the ecological capacities of natural waterbodies.

Other, more effective way of protection is the development of waterbird reproduction centre network in artificial waterbodies.

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