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SPATIAL DISTRIBUTION AND HABITAT PREFERENCES OF WINTERING WATERFOWL IN CENTRAL BOHEMIA

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A Winter Waterfowl Census in Central Bohemia was carried out in Central Bohemia in the seasons 2003/04 and 2004/05 once a month between the middle of November and the middle of March. 270 km of four rivers and 31 reservoirs were a subject of investigation. The course of temperature in the studied winters was very different and influenced total abundance as well as spatial distribution of particular species. We distinguished species assemblages characteristic for different types of winter sites. *Anas platyrhynchos* was a dominant species in all localities. *Cygnus olor, Larus ridibundus*, and *Fulica atra* were found on rivers within human settlements, especially on the Vltava River in Prague. *Aythya ferina* and *A. fuligula* were the other dominant species in Prague. A river section representing the largest river flow was characterized by *Bucephala clangula. Mergus merganser* were found on all rivers. The only little river was characterized with a high density of *Cinclus cinclus*. A deep and large drinking-water reservoir with rugged banks hosted northern diving species (*M. merganser*, *B. clangula*, *Melanita fusca*, *Gavia arctica*). Sand pit lakes were important resting sites (e.g. for *M. merganser, A. ferina*, *A. fuligula* and *A. platyrhynchos*). Fishponds were characterized by *A. platyrhynchos* and the largest fishpond also by *Anser fabalis* and *A. albifrons*.

Key words: waterbirds, waterfowl, wintering, Central Bohemia, Czech Republic

INTRODUCTION

The International Waterbird Census in the Czech Republic has been taken since 1966 (PELLANTOVÁ 1994, MUSILOVÁ *et al.* 2003). The Winter Waterfowl Census in Central Bohemia is a regional project, which monitors wintering water birds on a small area with a high frequency of observation. This project has been carried out since the winter of 1975–1976 in a variable extent and number of observations. Since 2003, it has been realized regularly once a month from the middle of November to the middle of March. Fifty members of the Czech Society for Ornithology were involved in this project, most of them volunteers. 270 km of four rivers and 31 standing water localities were analysed in this study. Ten observations on the localities in all were made in the winter seasons 2003/04 and 2004/05.

The general aims of this study were to record the quality and density of wintering water birds populations in Central Bohemia, to indicate important Central

Bohemian wintering sites, to assess their value, and to describe the habitats preferred by individual species.

MATERIALS AND METHODS

Localities

The rivers monitored in this project were divided into 10 sections: four sections of the Labe River, four of the Vltava River, one of the Berounka River, and one of the Litavka Rivulet.

The data concerning the flow, slope, turbidity, and types of surrounding habitats for each part of the river were collected. The sections were further characterized by elementary chemical parameters including COD (Chemical Oxygen Demand), a parameter describing the concentration of organic material in water, and a "nutrient level" of water specified by the concentration of nitrogen and phosphorus. Data measured by the Czech Hydrometeorological Institute (http://www.chmi.cz) were used.

In most cases, high values of inorganic N and P are caused by field fertilisation. There were no large differences in the vast of the majority of the localities observed (Table 1).

The standing water localities included one deep and large drinking-water reservoir, two sand pit lakes, two large fishponds, and two systems of smaller fishponds. Each water body was characterized by its altitude, depth, area, and the type of surrounding habitats. For the following analysis of the reservoir systems, average values were used. No other limnological data are available for sand pit lakes and the most of the fishponds.

Characteristics of studied localities include:

Labe I, Labe II, Labe III, Labe IV – all sections represent a large river in a flat, mainly agricultural land. Fields alternate with forests and agglomerations of different size. The river often gets partially ice-covered during wintertime. For purposes of this study, it was split into sections according to the character of surrounding habitats.

Vltava I – a large river in a deep valley with two smaller dams. In comparison to other sections, the water is relatively clean (with low concentrations of P and COD), and is partially ice-covered in hard winters.

Vltava II – a large river which flows through the city of Prague. Due to the dams upstream, Vltava II is hardly ever ice-covered in hard winters. It was largely ice-covered for the first time since 1957 in December 2004.

Vltava III – a large river in a valley downstream the city with a variable riverbed.

Vltava IV – a large river in a flat agricultural land. Both sections, Vltava III and IV, are partially ice-covered in hard winters.

Berounka – a medium large river which runs through a karstic area; the lower part of the river section flows through a flat agricultural land. It is regularly ice-covered during hard winters.

Litavka – a rivulet which flows through a flat agricultural land; the lowest part is in a karst valley. The rivulet has a much higher slope than other studied rivers.

Želivka – a drinking water reservoir surrounded by forest; it has an area of 1670 ha, maximum depth of 55 m, altitude 379 m.

Sand pit lakes – two relatively clean and shallow lakes located in an agricultural land; altitude 163 and 172 m.

Large fishponds (Žehuň, Vavřinec) – located in an agricultural land. Žehuň fishpond has an area of 312 ha, maximum depth of 4.5 m, altitude 202 m. The Vavřinec pond has an area of 72 ha, maximum depth of 3 m, altitude 385 m.

Table 1. The river sections and their characteristics

River section	Localization	Length [km]	% of surrounding habitats			Number of weirs	Average flow [m^3/sec]	Slope [%]	Average values			
			Forests*	Fields**	Human settlements***				Turbidity	N inorganic [mg/l]	COD [mg/l]	TP [µg/l]
Labe I	Chvaletice – Kolín	16	35	55	10	2	62.1	1	27.5	6.87	23.9	0.26
Labe II	Kolín – Nymburk	21	50	40	10	4	71.5	1	27	8.49	29.8	0.29
Labe III	Nymburk – Brandýs	31	10	80	10	2	99.7	1	16.9	6.46	23.3	0.24
Labe IV	Brandýs – Labe & Vltava confluence	28	20	65	15	2	100.2	0.5	31.5	6.32	28.9	0.29
Vltava I	Slapy – Chuchle	71	35	15	40	1	110.1	1	37	5.15	23.7	0.16
Vltava II	Praha (Prague intravilan)	21	10	0	90	5	147.8	0.5	59	5.12	22.8	0.19
Vltava III	Roztoky – Kralupy	15	35	40	25	1	149.2	0.5	39	5.68	27.4	0.25
Vltava IV	Kralupy – Horní Počáply	31	10	80	10	3	183	0.5	45.4	5.26	28.8	0.26
Berounka	Beroun – Berounka & Vltava confluence	34	20	50	30	4	37.2	1	69	5.21	30.5	0.29
Litavka	Lochovice – Litavka & Berounka confluence	17	15	50	35	-	2.6	6	116	5.77	21.4	0.23

* different types of forests and woodlands (flood plain forest, pine woodland, scree woodland)
** agricultural areas, meadows, ruderal formations
*** cities, towns, villages; industrial areas

Table 2. List of species. Categories: W1 – wintering species, maximum abundance up to 5 individuals, W2 – wintering species, maximum abundance up to 50 individuals, W3 – wintering species, maximum abundance up to 500 individuals, W4 – wintering species, maximum abundance over 500 individuals. The numbers indicate the maximum abundance found on the studied area in December, January or February. The dominant species are in bold. E – escapers; M – mainly migrants, the numbers indicate the maximum abundance found on the studied area in November or March.

W4		**W1**	
Phalacrocorax carbo	2970	*Podiceps auritus*	1
Cygnus olor	558	*Podiceps grisergena*	1
Anser fabalis	1675	*Phalacrocorax pygmaeus*	1
Anas platyrhynchos	28258	*Netta rufina*	1
Aythya ferina	581	*Aythya nyroca*	3
Aythya fuligula	1655	*Mergus serrator*	3
Fulica atra	4090	*Rallus aquaticus*	2
Larus ridibundus	3508	*Tringa ochropus*	2
W2		*Gallinago gallinago*	2
Tachybaptus ruficollis	115	*Larus fuscus*	2
Ardea cinerea	242	**E**	
Anser albifrons	372	*Branta canadensis*	1
Anas crecca	55	*Alopochen aegyptiacus*	1
Bucephala clangula	214	*Aix sponsa*	1
Mergus merganser	325	*Aix galericulata*	6
Gallinula chloropus	176	*Cairina moschata*	3
Larus canus	87	**M**	
W3		*Botaurus stellaris*	1
Podieps cristatus	16	*Ergetta alba*	16
Anser anser	11	*Anas querquedula*	10
Anas strepera	33	*Anas clypeata*	5
Anas penelope	28	*Anas acuta*	5
Aythya marila	12	*Grus grus*	2
Mergus albellus	16	*Vanellus vanellus*	992
Melanitta fusca	14	*Pluvialis apricaria*	264
Haliaeetus albicilla	7	*Philomachus pugnax*	3
Larus argentatus	12	*Larus minutus*	1
Larus cacchinans	33		
Alcedo atthis	32		
Cinclus cinclus	19		

Sedlčansko fishpond systems – 13 fishponds located in a hilly region with an altitude between 340 and 400 m. The area of the largest pond is 49 ha, four others are larger than 20 ha, and the remaining ponds are smaller; their maximum depth is not over 2 m.

Kladensko fishpond system – 13 small and shallow fishponds often situated near villages. Two of these fishponds have warmer water due to their closeness to sewerage plants. One fishpond has the area of 43 ha, all others are smaller than 20 ha. The maximum depth of all these fishponds is less than 2 m. The altitude is between 190 and 370 m.

Field methods

Five observations were taken in winter, each in the middle of winter months (November – March). The data from winters 2003/04 and 2004/05 are used in this paper. The census was realized by using a common method based on field-glass observation. The whole procedure was carried out in daylight period, mostly between 8 am and 4 pm. The running water localities were being watched along the whole bank of the river and the standing water localities from the same position every time.

Statistical analysis

The impact of limnological parameters, such as the flow, slope, turbidity, COD, TN, TP of the river, and the depth, area, and number of reservoirs for standing waters on spatial distribution of particular bird species was analysed. In this analysis, the types of surrounding habitats for both rivers and standing waters were involved. Simple linear regression (using the Statistical Package "Statistica") was used to characterize relationships between species and environmental parameters. RDA (Redundancy Analysis) standardized for species (using Canoco for Windows) was used to describe assemblages of wintering species and their relations to their environment. However, field knowledge has a decisive role for the interpretation of results.

RESULTS

In total, 53 species of aquatic birds were found on all the sites during the winter seasons 2003/04 and 2004/05 (Table 2). This number includes 18 regularly wintering species (which were registered on the respective sites every winter month). Only 4 species could be classified as the dominant species (The dominance over 5 % in the whole study area and every observed month). These species included: *Phalacrocorax carbo*, *Anas platyrhynchos*, *Fulica atra,* and *Larus ridibundus*. *Aythya fuligula* was another dominant species recorded in January 2004 (with the dominance of 5.6%).

Anas platyrhynchos was the most common species. The maximum abundance of this species during the studied winters was detected in January 2004 (28,258 individuals in all). The dominance of this species was higher than 50% in December, January, and February in both of the studied seasons and also in November 2004 (compare Fig. 1*e* & Fig. 2). *A. platyrhynchos* represented even between 60 and 85% of individuals within all species (Fig. 3) in standing waters.

The course of the temperature during the two studied winters was different and had an impact on spatial distribution of wintering birds. The proportion between the number of individuals on the rivers and on the reservoirs varied in relation to the extent of freezing of the reservoirs (Figs 2 & 3). While the number of individuals on the rivers did not strongly decrease in the time of low temperatures, the abundance on the standing water bodies rapidly decreased due to the freezing

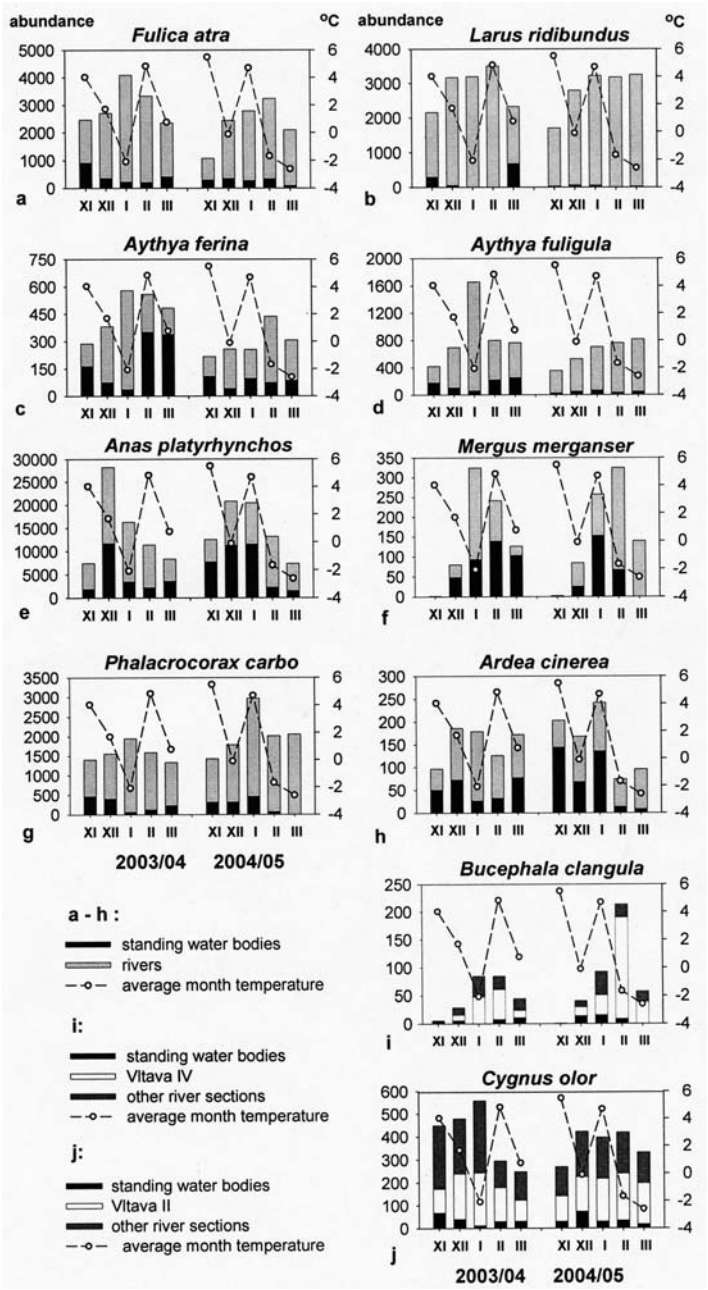

Fig. 1. Abundance of particular species on standing water localities and on rivers during the studied winter seasons. The river section Vltava II (Prague intravilan) is separately marked for *Cygnus olor*, the river section Vltava IV (the largest river flow) for *Bucephala clangula*. Values of average month temperature are included.

of the reservoirs. The majority of the observed species moved to rivers while reservoirs were frozen and the total abundance of the species was not clearly dependent on temperature. This fact can be seen on *Phalacrocorax carbo* (Fig. 1*g*), the amount of which was the highest in the middle of winter in both of the analysed seasons. *Aythya fuligula* (Fig. 1*d*) was a species having a maximum abundance on rivers, regardless of the freezing of standing waters. However, the decrease in number of the most dominant species, *A. platyrhynchos,* in the frozen reservoirs was not followed by the corresponding increase in rivers (Fig. 1*e*). Thus, the total abundance of the wintering birds was reduced in a freezing period (Fig. 2). *Fulica atra* showed no considerable fluctuations of abundance during the winter period. The majority of the population occurred on river localities throughout the whole winter (Fig. 1*a*). Rivers also represent a major wintering site for *Larus ridibundus*. There was only one case of increased abundance of this species on standing waters, which was recorded at the end of winter 2003/2004, at a time when this species was already migrating to nesting localities (Fig. 1*b*).

The maximum number of wintering birds under observation was found in December and January of both winter seasons (Fig. 2). The pie charts (Fig. 3) indicate another important fact: the proportion of occurrence of the most abundant species on rivers was similar in these months. The different proportion is typical for the standing waters, the total number of individuals increased in most species and there was an increase in the abundance of *Anser fabalis* when the reservoirs were not frozen (January 2005).

The number of species found on unfrozen water localities varied from 2 to 31 species in one control (Fig. 4). The numbers of species on rivers were relatively similar one another and were much smaller only on the rivulet Litavka. In contrast,

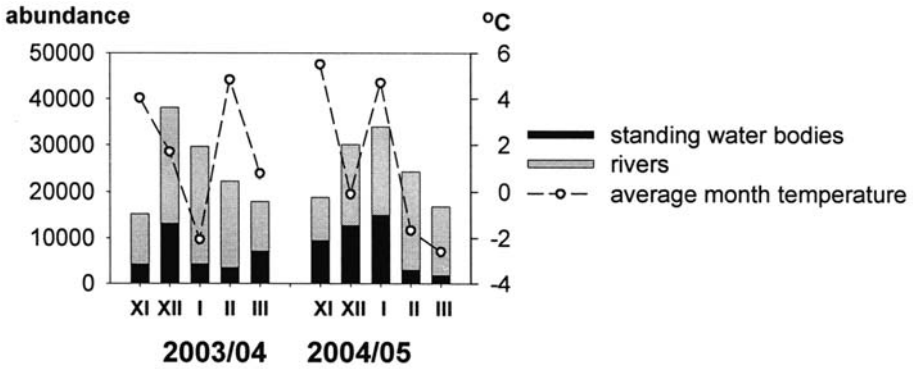

Fig. 2. Total abundance of wintering waterbirds on standing water localities and on rivers during the studied winter seasons.

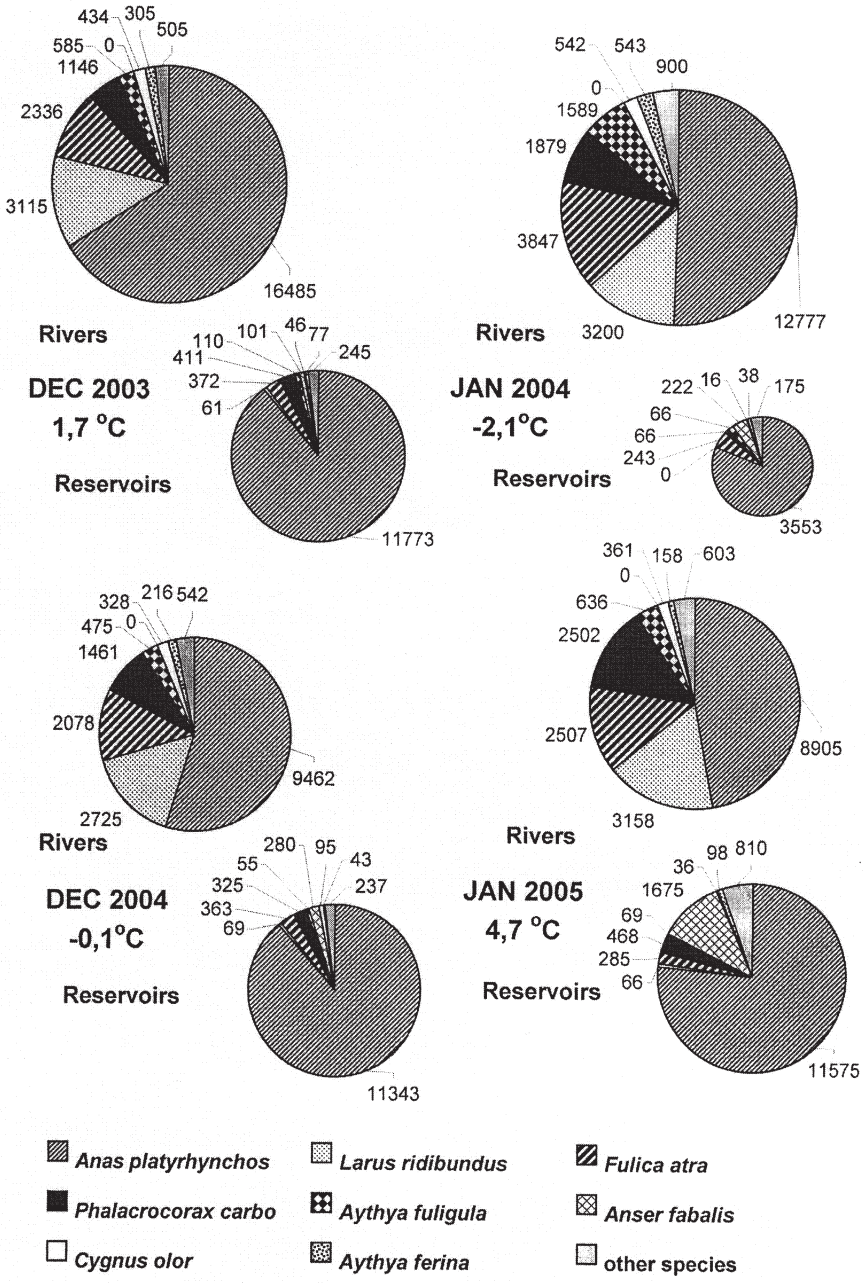

Fig. 3. Pie charts of waterbird assemblages in December 2003, January 2004, December 2004 and January 2005. Diameter of the graph depends on total number of individuals. Values of average month temperature are included.

relatively large differences in number of species were found in localities with standing water. A large variety of species was recorded in the Želivka reservoir during winter season. Large fishponds, namely the Žehuň pond and the Vavřinec pond, were rich in species only in some controls. Large fluctuations in the number of species on sand pit lakes occurred due to early freezing of these localities.

Assemblages of waterfowl wintering on rivers can be divided mainly according to their affinity to two main locality types (Fig. 5). The first group of birds are the most abundant on the Vltava river in Prague (Vltava II), especially *Larus ridibundus, Larus canus, Phalacrocorax carbo*, *Cygnus olor, Fulica atra*, *Aythya ferina* and *Aythya fuligula* (for *Cygnus olor*, see Fig. 1*j*). The second group was represented by the species occurring mainly on large rivers (*Bucephala clangula* typically occurred on the largest river flow (Vltava IV, Fig. 1*i*)). *Anas platyrhynchos*, *Ardea cinerea,* and *Gallinula chloropus* were especially common on rivers with a great flow, and they were tolerant of human settlements. There was a relative abundance of *Cinclus cinclus* on the high-sloped rivulet Litavka. *Mergus merganser* could be found almost everywhere.

The habitat preferences of particular species on standing waters strongly reflect a small number of tested localities. Nevertheless, the results of 10 controls indicate some relevant facts: *Phalacrocorax carbo*, *Bucephala clangula*, and *Fulica*

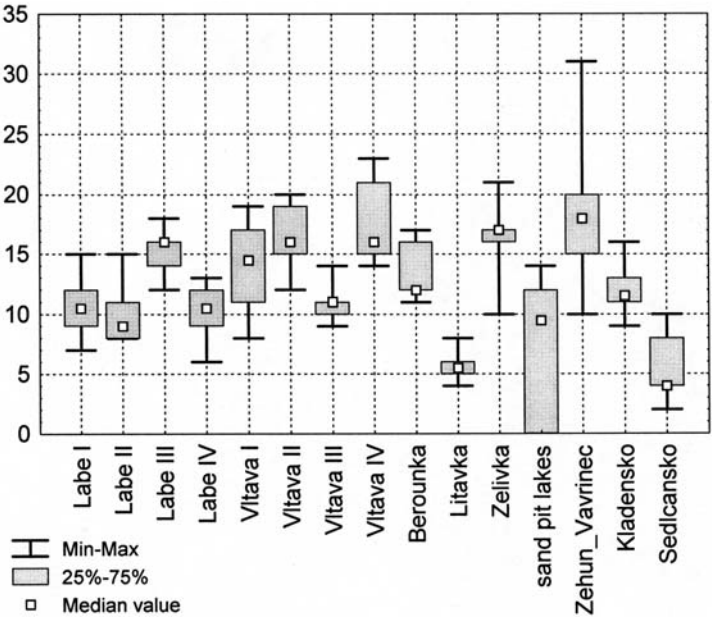

Fig. 4. Ten river sections and five groups of standing water localities: the numbers of species detected during the winter seasons 2003/2004 and 2004/2005.

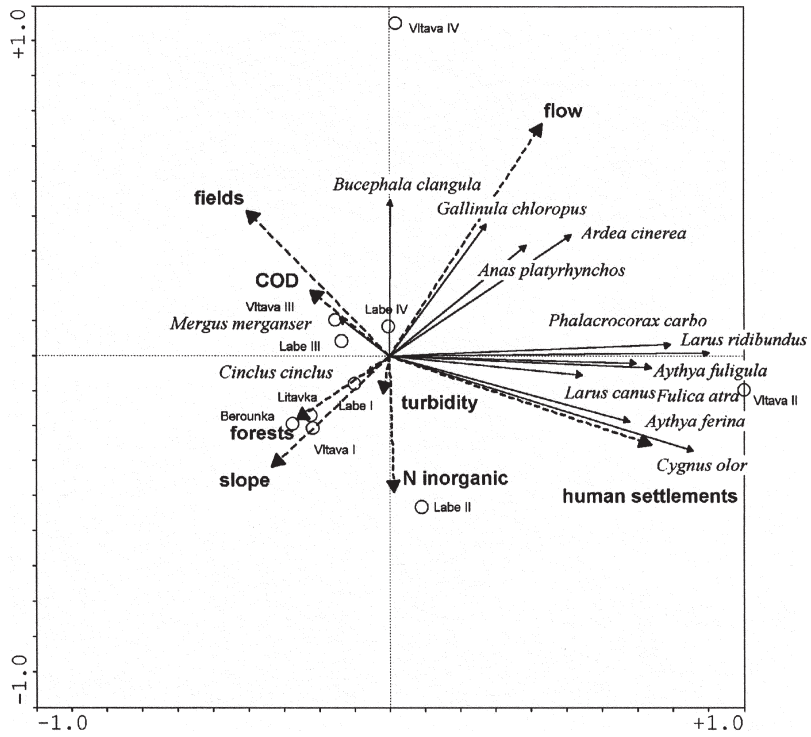

Fig. 5. Assemblage of wintering waterfowl on rivers: RDA diagram of 10 river sections with their characteristics.

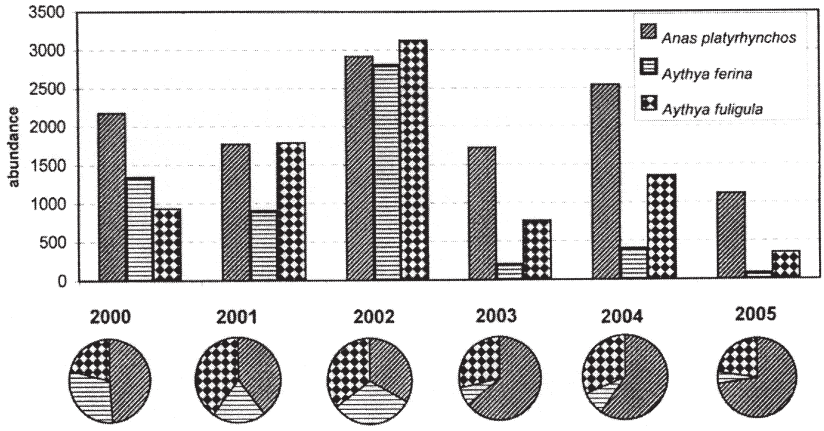

Fig. 6. Total numbers and proportions of abundance of *Anas platyrhynchos*, *Aythya ferina* and *A. fuligula* on the Vltava River in Prague during 6 winter seasons. Every values were detected in January. The assemblage was influenced by a great flood in August 2002.

atra are typical species for the large and deep Želivka reservoir. *Gallinula chloropus* and *Ardea cinerea* inhabit mainly small fishponds. *Aythya fuligula* and *Aythya ferina* are abundant on sandpit lakes and some of the Kladensko fishponds at a low altitude. The two largest fishponds (Žehuň, Vavřinec) were characterized with a high abundance of *A. platyrhynchos* and also hosted the species *Anser fabalis* and *A. albifrons.*

DISCUSSION

Importance of wintering sites in Central Bohemia

The total number of wintering water bird populations found in Central Bohemia in January 2004 and January 2005 were compared to the numbers of wintering populations from the whole Czech Republic. In the year 2004 it contained 134,074 individuals, while in the year 2005 this same number was about 176,000 individuals (MUSILOVÁ & MUSIL 2004, 2005). About ¼ of wintering birds reported in the Czech Republic were found in Central Bohemia. *Anas platyrhynchos* also shows a similar proportion (about 20% of the population). On the other hand, about 60% of the population of *Aythya ferina*, 50% of *Fulica atra*, and 60% of *Larus ridibundus* wintering in the Czech Republic were recorded in Central Bohemia in the winter seasons of 2004 and 2005.

Using the records of European wintering birds from the January 1997, 1998, and 1999 (GILISSEN *et al*. 2002), it should be possible to estimate that over 1% of water birds wintering in Central Europe were concentrated in Central Bohemia. The role of Central Bohemia can be higher for some particular species. Over 10% of Central European wintering population of *Larus ridibundus* was found in the Czech Republic in January 1998 (GILISSEN *et al*. 2002). If the ratio (Central Europe / Czech Republic) is the same in January 2004 as in January 1998, the number of occurrences of *L. ridibundus* in Central Bohemia could represent about 8% of the Central European wintering population. After BERGMANN (1996), even more than 17% of *L. ridibundus* wintering in Central Europe was found in the Vltava II sector (Prague intravilan) in January 1993. Central Bohemia is an important wintering place for *Anas platyrhynchos* as well, especially when the important wintering site of *A. platyrhynchos* (the Žehuň Pond) is not frozen (Figs 1*e* & 3).

The nesting localities of water birds wintering in the Czech Republic are not well known. Some results of the research concerning the origin of these populations are presented by HUDEC (1994) and HUDEC & Šťastný (2005). *Cygnus olor* and *Fulica atra* represented mainly a Czech breeding population (and in part also German and Polish). *Anas platyrhynchos* came mostly from the Czech Republic,

Poland, and Russia. On the other hand, *Larus ridibundus* originated mainly from other countries including Finland, Baltic countries, Poland, or Sweden. *Phalacrocorax carbo* originates from Germany, Denmark, Poland, and Baltic countries.

Occurrence of species on particular localities

The Vltava river section in Prague plays an important role in the wintering of waterbirds. The most important wintering site and roost of *Larus ridibundus* in the Czech Republic is on this river section; more than 50% of exemplars were found in Prague (MUSILOVÁ & MUSIL 2005). Food resources, including dumping grounds on the outskirts of Prague and non-freezing water, are probably the key factors in the abundance of this species. Similarly, in Berlin there was a high frequency of occurrence of *L. ridibundus* in urban biotopes (MÄDLOW 1990). *Phalacrocorax carbo* is another species with an important roost by the Vltava River in Prague. There was a close correspondence between this occurrence and the data from Slovakia, where the largest abundance was on large rivers (the Danube and Váh rivers – RIDZOŇ 2003). The attachment of this species to its traditional roost was described (VELKÝ *et al*. 2005). *Anas platyrhynchos, Cygnus olor,* and *Fulica atra* find both natural and artificial food resources on this river section. Other relatively abundant species *Aythya ferina* and *A. fuligula* prefer natural food resources (FOLK 1971). The frequency of occurrence of these two species on the Vltava River in Prague decreased strongly between the winter seasons 2001/02 and 2002/03 (BERGMANN & FIŠEROVÁ 2003, FIŠEROVÁ & BERGMANN 2004, Fig. 6). The great flood in August 2002 probably changed the river bottom structure and the benthos composition. The limitation of food supply can be the cause of the *Aythya* spp. decline.

Vltava IV (the largest river flow in our research study) represents another important river section. There is a very important wintering site of *Anas platyrhynchos* near the confluence of the Vltava and the Labe Rivers. *Bucephala clangula* was particularly abundant there in proportion to the frequency of occurrence of this species in the whole territory of the Czech Republic (MUSILOVÁ & MUSIL 2005). We found the same pattern in Central Bohemia as several authors have made known from other Central European areas. Large rivers in Slovakia and Poland host *B. clangula* (CZAPULAK *et al.* 1998, RIDZOŇ 2003), while large reservoirs represent a different type of habitat (CZAPULAK *et al.* 1998, VELKÝ *et al*. 2005). Rich riparian vegetation (especially *Salix* sp.) and slow river flow are responsible for the abundance of *Gallinula chloropus* in the Vltava IV section.

The occurrence of *Mergus merganser* on all types of rivers including the smallest ones corresponds to other data from Central Europe (CZAPULAK *et al.* 1998, RIDZOŇ 2003, 2005).

Žehuň fishpond belongs to the most important standing water localities. Large numbers of *Anas platyrhynchos* (up to 50% of the individuals wintering in Central Bohemia), *Anser fabalis,* and *A. albifrons* were wintering there. For *Anas platyrhynchos,* temperature is the major factor influencing the proportion of birds wintering on standing waters and rivers. Standing waters hosted between 35 and 60% of the population wintering in the Czech Republic in January during the years of 1990–1996. In the extremely cold winter of 1997, less than 10% was found on standing waters (PELLANTOVÁ 1993, 1994, 1996, 1997, 1998). Consistently with this data, 20% and 56% of wintering *Anas platyrhynchos* were found on reservoirs in Central Bohemia in January 2004 and 2005. Fluctuations of total numbers were caused in particular by the fact that these birds were leaving the freezing reservoirs. The same results are reported in CZAPULAK (1991) and CZAPULAK *et al.* (1998).

Deep, large, and steep banked reservoir Želivka hosted mainly northern diving species (*Mergus merganser*, *Bucephala clangula*, *Melanita fusca,* and *Gavia arctica*). *Phalacrocorax carbo* is a common species in that location. A place of similar importance is a reservoir in Slovakia (RIDZOŇ 2005). Sandpit lakes seem to be important resting sites (e.g. for *M. merganser, Aythya ferina*, *A. fuligula,* and *Anas platyrhynchos*). *A. platyrhynchos* and *Ardea cinerea* typically occurred in the Sedlčansko fishpond system. These localities are more important during spring and autumn migrations. Important wintering sites were recorded on some of Kladensko fishponds, which were non-freezing. This was caused by warmed water from sewerage plants. In the Kladensko fishponds, the occurrence of *Aythya ferina, A. fuligula, Anas creeca,* and *Gallinula chloropus* is relatively high. Similarly, in Poland, a large part of *Aythya* spp. wintering populations was recorded on warm artificial water bodies, and another part was found on a large river – the Odra (CZAPULAK *et al.* 1998). In the Slovak Republic, these species were the most abundant on large reservoirs and channels (RIDZOŇ 2005).

The course of temperature in winter was the major factor in the movements of wintering species. Each species differed in their reactions to temperature. *Aythya fuligula* and *Fulica atra* preferred large rivers during mild winters, while *Anas platyrhynchos* and *Aythya ferina* preferred standing water bodies in such winters. *F. atra* was attracted to large rivers. In January 1990–1997, between 93 and 99% of the wintering *F. atra* population was found on rivers (PELLANTOVÁ 1993, 1994, 1996–1998). In Poland, important wintering places were on rivers, as well as on lakes through some winter seasons (CZAPULAK 1991, CZAPULAK *et al*. 1998).

Influence of water birds on aquatic localities

High abundance of wintering birds is supposed to have a large impact on the locality. In this context, the impact of *Phalacrocorax carbo* is particularly discussed (HUDEC 1994). The deplanation of mussels was recorded in Lake Constance for *Aythya fuligula, A. ferina, Fulica atra* (WERNER *et al*. 2005). *Fulica atra*, *Anas platyrhynchos,* and *Anser* spp. are supposed to have a large influence on plants and the import of nitrogen and phosphorus (BIRD *et al*. 2000, POST *et al*. 1998, RODRÍGUEZ-PÉREZ & GREEN 2006, RÖNICKE *et al.* 2006). These questions are a great impulse for future research on our study localities.

*

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