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Source: Acta Ornithologica, 36(1) : 65-71

Published By: Museum and Institute of Zoology, Polish Academy of Sciences

URL: https://doi.org/10.3161/068.036.0101

ACTA ORNITHOLOGICA
Vol. 36 (2001) No. 1

Waterfowl wintering in Moscow (1985–1999): dependence on air temperatures and the prosperity of the human population

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Avilova K. V., Eremkin G. S. 2001. Waterfowl wintering in Moscow (1985–1999): dependence on air temperatures and the prosperity of the human population. Acta Ornithol. 36: 65–71.

Abstract. Over fifteen years (1985–1999) waterfowl were counted during one day in January on 33 permanent routes with a total length of c. 310 km along the banks of all rivers and ponds throughout the city. 23 species (apart from gulls) were recorded. The number of species varied from 3 to 10 in different years and increased significantly during the study period. Mallard *Anas platyrhynchos* was the most numerous species (98–99% of individuals). The proportion of male Mallards varied from year to year within the range 54–63%. The number of Mallards gradually increased from c. 17 300 in the winter of 1984–1985 to c. 28 000 in the winter of 1989-90 but then declined to c. 7500 in the winter of 1997–1998. These changes appear to depend on both air temperatures during the winter and the prosperity of the city's inhabitants, who feed ducks with bread and scraps of food. It is highly probable that the change in the socio-economic situation has been the main cause of the decline in waterfowl observed during the 1990s.

Key words: waterfowl, Mallards, *Anas platyrhynchos*, population dynamics, air temperatures, economic prosperity, sex ratio, urbanization

Received — Sept. 1999, accepted — Oct. 2000

INTRODUCTION

It is a widely known phenomenon that many cities supporting non-freezing water bodies hold wintering populations or single individuals of some waterfowl species far from species' normal winter ranges. Although in some European countries and North America the total numbers and other demographic parameters of waterfowl populations have been monitored for decades (Jessen 1970, Bentz 1985), long-term patterns and processes in local urban populations and assemblages are poorly understood. The history of wintering wildfowl populations in Moscow has probably started in 1957 (although single individuals were recorded in 1940s) when young individuals of several species were intentionally released at 14 ponds and, in autumn, became attractors for migrating birds (Caletskiy 1960). The growth of the city and its human population in 1960–1980s led to an enormous increase in an influx of warm waters and waters saturated with inorganic/ organic matter to the river/pond system and resulted in a considerable extension of non-freezing water bodies (Likhacheva & Smirnova 1994). In parallel, the mean air temperature of the cold period (from November to March) showed a positive trend in the city (Abakumova et al. 1998). These changes were followed by an increase in the numbers of wintering waterfowl, especially Mallard *Anas platyrhynchos*. An extensive census conducted in 1981 revealed ca. 12000 wintering birds (inf. K. N. Blagosklonov).

This paper presents the results of 15-year censuses of wintering wildfowl, grebes, Coot *Fulica* *atra* and Moorhen *Gallinula chloropus*. Gulls were not included here. The aims were:

1) to examine the changes in species composition and numbers of wintering waterfowl; 2) to analyze population dynamics in the most numerous species, the Mallard, and to search for causes responsible for much of its long-term trends.

MATERIAL AND METHODS

Thirty three permanent routes with total length of about 310 km were established along the banks of almost all freezing and non-freezing rivers and ponds within Moscow. Each year, all census work was done in one day by 25 to 30 teams and single observers. The census date varied from 13 to 25 January in different years. The scheme of waterfowl counts in Moscow was started in 1985 (Avilova 1993). Counting was not conducted during the periods of the census day with poor visibility due to heavy snowfall or fog. However, the need never arose to cancel the census or to postpone it to another day due to such bad weather. There is only one non-freezing extensive water area in Moscow presenting visibility problems for counting waterfowl in winter. In frosty weather, however, several steaming parts of the Moscow-river became difficult to census.

Both volunteers and professional ornithologists took part in the fieldwork. Each team consisted of 1 to 6 persons and was led by at least one competent observer. Binoculars and sometimes also telescopes were used to locate birds and to identify them. During the census, any information coming from volunteers was checked carefully. Identification of species and estimating bird numbers were conducted by competent persons only.

As a rule, censuses were started at ca. 10 a.m. according to local time. Weather conditions, approximate proportions of water bodies of rivers and ponds covered by ice, species of birds, numbers of individual birds, their sex and behaviour were recorded. The sites with large concentrations of waterfowl were put on a map. As soon as possible after the census, primary data coming from different teams were discussed jointly and combined.

Year-to-year changes in Mallard numbers were analyzed separately for two major types of non-freezing water bodies:

1) the non-freezing „lower" segment of the Moscow-river (the central and south-eastern parts of the city), on an average 35–40 km long in different winters (called below „Moscow-river"), heavily polluted by industrial waste water and the influx of organic matter and inorganic chemicals from city water-cleaning stations, small rivers and streams;

2) non-freezing segments of small rivers and patches of open water in ponds, totalling about 128 km long in different winters, with many recreation areas along the banks regularly visited by humans which feed birds with the bread and scraps of food.

Mallard densities across nine administrative districts of the city were calculated as the numbers of individuals per 1 km of the river/pond (freezing and non-freezing combined) length. The greatest diameter or curvilinear length were taken for the ponds depending on their configuration.

The mean daily air temperature from 1 November of a previous year to 15 January of the given one (denoted below as MTEW) was used as a measure of weather harshness in late autumn and early winter. The data came from the Meteorological Station of Moscow State University, located in the south-west part of the city. The relationship between the mean salary and the mean price of 1 kg of bread in Moscow was used as a index of the welfare (WI) of city inhabitants.

RESULTS AND DISCUSSION

Species composition

Twenty three species were observed in winter (Table 1). The number of species recorded varied from 3 to 10 in different years and significantly increased during the study period (Spearman's rank correlation $r_s = 0.75$, $p = 0.001$, $n = 15$). No significant correlation was found with the mean daily air temperature (MTEW) for the period from 1 November of the previous year to 15 January of the given year ($r_s = -0.38$, ns, $n = 15$) as well as with such mean temperature for the period up to 31 March ($r_s = -0.33$, ns, $n = 15$). Mallard was far the most numerous species in winter (Table 1) as well as in the breeding season (Kontorschikov 1990). Tufted Duck *Aythya fuligula* and Goldeneye *Bucephala clangula* both having relatively small (less than 100 nesting females) breeding populations in the city, were found in low but increasing numbers ($r_s = 0.95$, $p < 0.0001$, $n = 15$ and $r_s = 0.80$, $p < 0.001$, $n = 15$, respectively) in 14 and 9 winters, respectively. Green-winged Teal *Anas crecca*, the common species in the Moscow Region, which did

Table 1. Species composition and number ($\bar{x}$ — means) of wintering waterfowl.

Species	1985–1989 $\bar{x}$ (min–max)	1990–1994 $\bar{x}$ (min–max)	1995–1999 $\bar{x}$ (min–max)
Anas platyrhynchos	19532 (17269–22632)	20104 (13635–27912)	9300 (7500–12265)
Aythya fuligula	5.8 (0–15)	21.4 (4–24)	45.2 (24–73)
Bucephala clangula	1.0 (0–5)	2.2 (0–7)	12.4 (5–18)
Aythya ferina	–	0.4 (0–1)	3.2 (1–10)
Anas crecca	14.2 (0–40)	7.4 (1–26)	6.8 (2–15)
Mergus albellus	–	1.2 (0–3)	1.2 (0–3)
Aythya marila	0.2 (0–1)	0.2 (0–1)	0.8 (0–2)
Anas acuta	0.2 (0–1)	–	0.4 (0–1)
Mergus merganser	–	0.2 (0–1)	1.4 (0–3)
Anas penelope	–	–	0.6 (0–2)
Netta rufina	–	0.4 (0–1)	–
Tadorna tadorna	–	4.6 (0–15)	–
T. ferruginea	0.6 (0–2)	–	–
Anser anser	–	0.2 (0–1)	–
Cygnus cygnus	0.4 (0–2)	0.8 (0–4)	–
Cairina moschata	–	0.2 (0–1)	–
Branta canadensis	–	–	0.4 (0–2)
Anser indicus	0.2 (0–1)	–	–
Podiceps cristatus	0.2 (0–1)	0.2 (0–1)	0.4 (0–2)
P. nigricollis	–	0.2 (0–1)	0.6 (0–3)
Tachybaptus ruficollis	–	–	0.4 (0–1)
Fulica atra	0.2 (0–1)	0.6 (0–2)	–
Gallinula chloropus	–	–	0.2 (0–1)
Total	19555 (17271– 22701)	20144 (13640 – 28000)	9374 (7534–12399)

not breed within the city but was recorded here in 14 out of 15 winters, showed no significant trend during the study period (r_s = -0.12, ns, n = 15). Other species were represented by a few individuals each and recorded in one to 9 winters. Among them, the Moorhen and Pochard *Aythya ferina* had relatively small breeding populations, whereas Black-necked Grebe *Podiceps nigricollis* (until 1996), Great Crested Grebe *Podiceps cristatus* (since 1995) and Coot were represented in the city by a few breeding pairs each. For all the species mentioned above, little is known about changes in the composition of individual birds between breeding and winter seasons.

Wigeon *Anas penelope*, Pintail *A. acuta* and, infrequently, Little Grebe *Tachybaptus ruficollis* bred in the Moscow Region but outside the city. Scaup *Aythya marila*, Goosander *Mergus merganser* and Smew *Mergus albellus* were regular transient migrants in the Moscow Region, whereas Whooper Swan *Cygnus cygnus* was only occasionally seen. Greylag Goose *Anser anser*, Bar-headed Goose *Anser indicus*, Canada Goose *Branta canadensis*, Common Shelduck *Tadorna tadorna*, Ruddy Shelduck *T. ferruginea*, Muscovy Duck *Cairina moschata*, Red-crested Pochard *Netta rufina* and, possibly, individual(s) of Whooper Swan were free-living birds from Moscow Zoo.

Wintering waterfowl were unevenly distributed across non-freezing water bodies. Major concentrations were found at the Moscow-river, in the Zoo, at large ponds located in extensive parks, and at some sections of small rivers surrounded by multi-storey blocks of flats. Goldeneye and Tufted Duck were observed mostly at the Moscow-river. A few free-living birds of the latter species were recorded also in the Zoo. The Zoo was an important feeding area for most wintering species. Individuals of the small free-living population of Ruddy Shelduck spent most of their winter time in the Zoo and only in spring spread out into the city for breeding.

WINTERING OF MALLARDS

Population dynamics

The wintering population in the city increased in the period 1985–1990 (r_s = 0.83, $p < 0.05$, n = 6), reached the maximum in 1989/90, and decreased in the period 1990–1998 (r_s = -0.95, $p < 0.0001$, n = 9) (Fig. 1). In the two major types of water body,

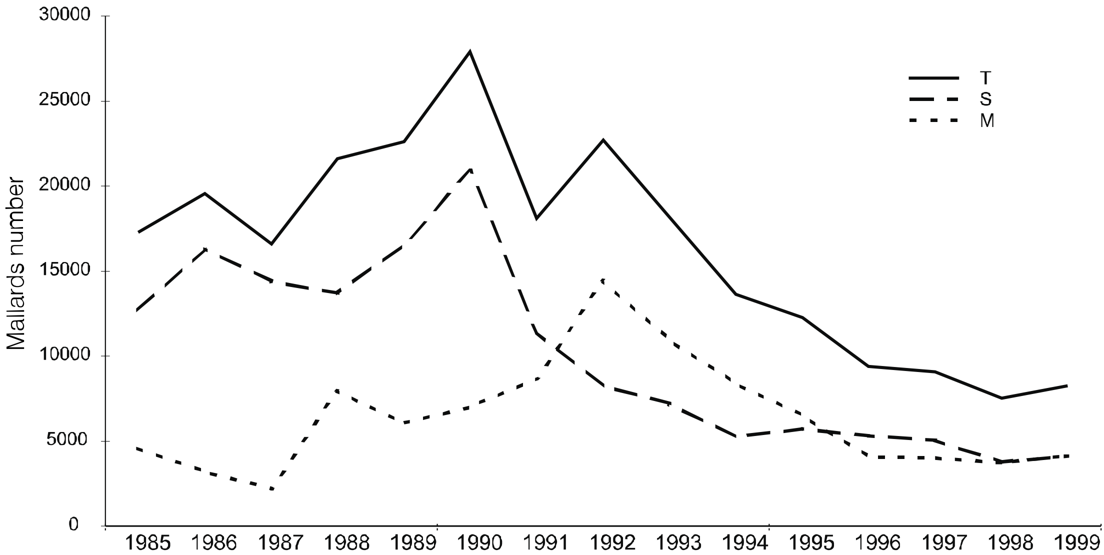

Fig. 1. Numbers of wintering Mallards in 1985–1999. T — total population, S — small rivers and ponds, M — Moscow-river.

however, the peaks were observed in different winters. For small rivers and ponds, the peak winter was the same one as for the whole city (for the periods 1985–1990 and 1990–1998, $r_s = 0.77$, ns, $n = 6$ and $r_s = -0.95$, $p < 0.0001$ $n = 9$, respectively), whereas at the Moscow-river the maximum number of ducks was counted with a two-year lag (for the periods 1985–1992 and 1992–1998, $r_s = 0.83$, $p= 0.01$, $n = 8$ and $r_s = -1.0$, $p < 0.001$, $n = 7$, respectively) and resulted in the second, lower peak for the total population. Until 1991, many more individuals were counted at small rivers and ponds than at the Moscow-river. From the winter 1990/91 to the winter 1991/92, the proportion in the numbers of Mallard between the two types of water body had changed and remained reversed till the winter 1994/95. No significant year-to-year changes in the areas of non-freezing water bodies were observed during the study period.

Air temperature factor. Comparatively high mean air temperatures in the winters 1987/88–1991/92 were accompanied by the peak in the Mallard numbers. Interestingly, population size was more closely correlated with MTEW for the same winter (total population: $r_s = 0.76$, $p = 0.001$, $n = 15$; small rivers and ponds: $r_s = 0.50$, ns, $n = 15$; Moscow-river: $r_s = 0.78$, $p < 0.001$, $n = 15$) than with the mean daily air temperature for the period from 1 November to 30 April of the previous winter (total population: $r_s = 0.64$, $p = 0.01$, $n = 15$; small rivers and ponds: $r_s = 0.48$, ns, $n = 15$; Moscow-river: $r_s = 0.66$, $p = 0.007$, $n = 15$). There are at least two not mutually exclusive explanations for these patterns:

1) considerable numbers of wintering Mallard gradually depart due to cold weather in late autumn and/or the first half of winter and the population size in mid-winter depends strongly on this departure;

2) at least some birds, „native" and/or coming from abroad, were able to „foresee" the harshness of the coming winter and migrated or did not migrate in accordance with their expectations. A positive correlation of the total population size with MTEW for the same winter seemed to be more pronounced in the period of population decline (1990–1999: $r_s = 0.77$, $p < 0.01$, $n = 10$) than in the period of increase (1985–1990: $r_s = 0.66$, ns, $n = 6$).

Feeding factor. The wintering population of Mallard started to decline in 1990, whereas the MTEW-values remained at relatively high levels in several following winters. The decrease in the number of wintering ducks in the early 1990 coincided with a drastic decline in the social well-being of city inhabitants after the transition from fixed prices to a „free" economy in the winter 1991/92 (Fig. 2). Most probably, the decrease in the feeding of ducks by humans began 1–2 years before this transition being the result of rapid inflation and food shortages in shops. In the period 1985–1996, the number of ducks counted at small rivers and ponds was positively correlated with welfare index — WI ($r_s = 0.67$, $p < 0.05$, $n =$

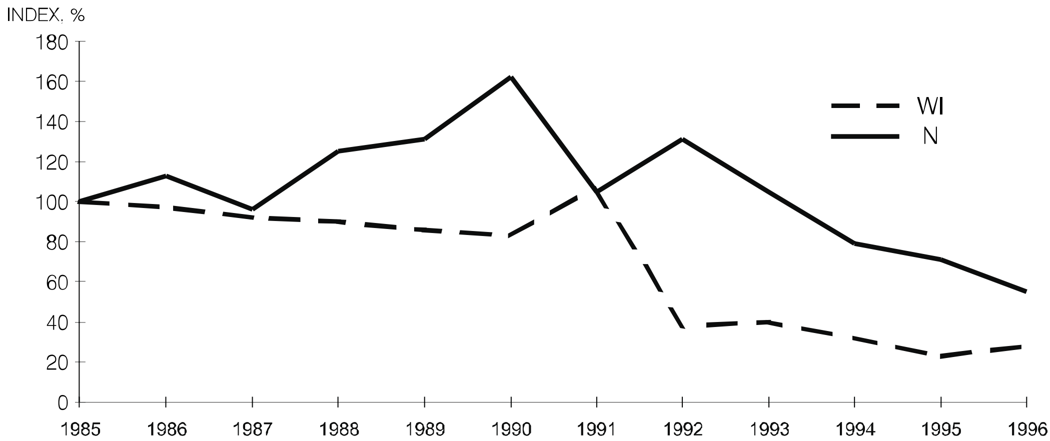

Fig. 2. Dynamics of wintering Mallard population (N) computed to welfare index (WI).

12) but no correlation was found for the Moscow-river (r_s = -0.17, ns) and the whole city (r_s = 0.38, ns). Unfortunately no data was available to calculate WI-values for the years 1997–1999.

The importance of artificial feeding is supported by the patterns in the distribution of Mallard densities across nine administrative districts of the city (Fig. 3). Until 1990/91, densities were more or less evenly spaced over the city, except the South-Western and North-Western Districts both having poor non-freezing river/pond systems. Concentrations of wintering ducks were heading due north, north-east and east which were the main directions of city growth and where the new multi-storey blocks of flats sprang up in this period. However, in the winter 1991/92 Mallards began to avoid small rivers and ponds, although no substantial year-to-year changes in areas of non-freezing water bodies were recorded there. Ducks concentrated mostly at the Moscow-river in the south-eastern part of the city, especially at the segment bordering with the Lublinskaya water-cleaning station and fields of filtration. This water-cleaning station which, among others, had discharged water saturated with organic/inorganic matter into the Moscow-river decreased its activity after 1992 and was closed in 1996, and replaced by filter-beds which have been gradually built ever since. That is possibly why, since the winter 1992/93, Mallard have become more evenly distributed across the city despite the continuing population decline. In other words, it looked as if, in the winters 1990/91 and 1991/92, the population shifted from small rivers and ponds (where artificial feeding was declining) to the non-freezing segment of the Moscow-river (probably furnishing ducks better with other foods owing to the influx of organic material and huge/high abundance of benthic invertebrates (Sokolova et al. 1997).

Sex ratio. In the period 1986–1999 the proportion of Mallard males varied from year to year within a relatively narrow range (range 54–63%, mean = 57.43%, SE = 4.3%, n = 14). Variation and especially the means were very similar between small rivers/ponds and the Moscow-river (range 54–65%, mean = 57.4%, SE = 2.0% and range 51–62%, mean = 57.6%, SE = 3.3%, respectively). No significant temporal trends in the sex ratio were observed in the whole wintering population and among birds counted in the two major types of water body. The correlation in the proportion of males between the two major types of water body was positive but insignificant (r_s = 0.42, ns, n = 14). No significant correlations between Mallard numbers and proportions of males were found (for the whole city, r_s = 0.42, ns, n = 14, for small rivers and ponds, r_s = 0.37, ns, n = 14). At the Moscow-river, however, the positive correlation was nearly significant (r_s = 0.49, ns, n = 14) being especially pronounced during the period of decline in this habitat type (1991/92–1997/98: r_s = 0.67, ns, n = 7). The proportion of males correlated neither with MTEW (r_s = 0.40, ns, n = 14), nor with WI (r_s = -0.51, ns, n = 7).

Sex ratios in Mallard in Moscow were close to the values reported in many other studies on the species conducted in winter or in the period of autumn migration (Clutton-Brock 1985, Pattenden & Boag 1989, Payevskiy 1993). The biased sex ratio on the wintering grounds with males predominating in the north is (considered to be) typical for

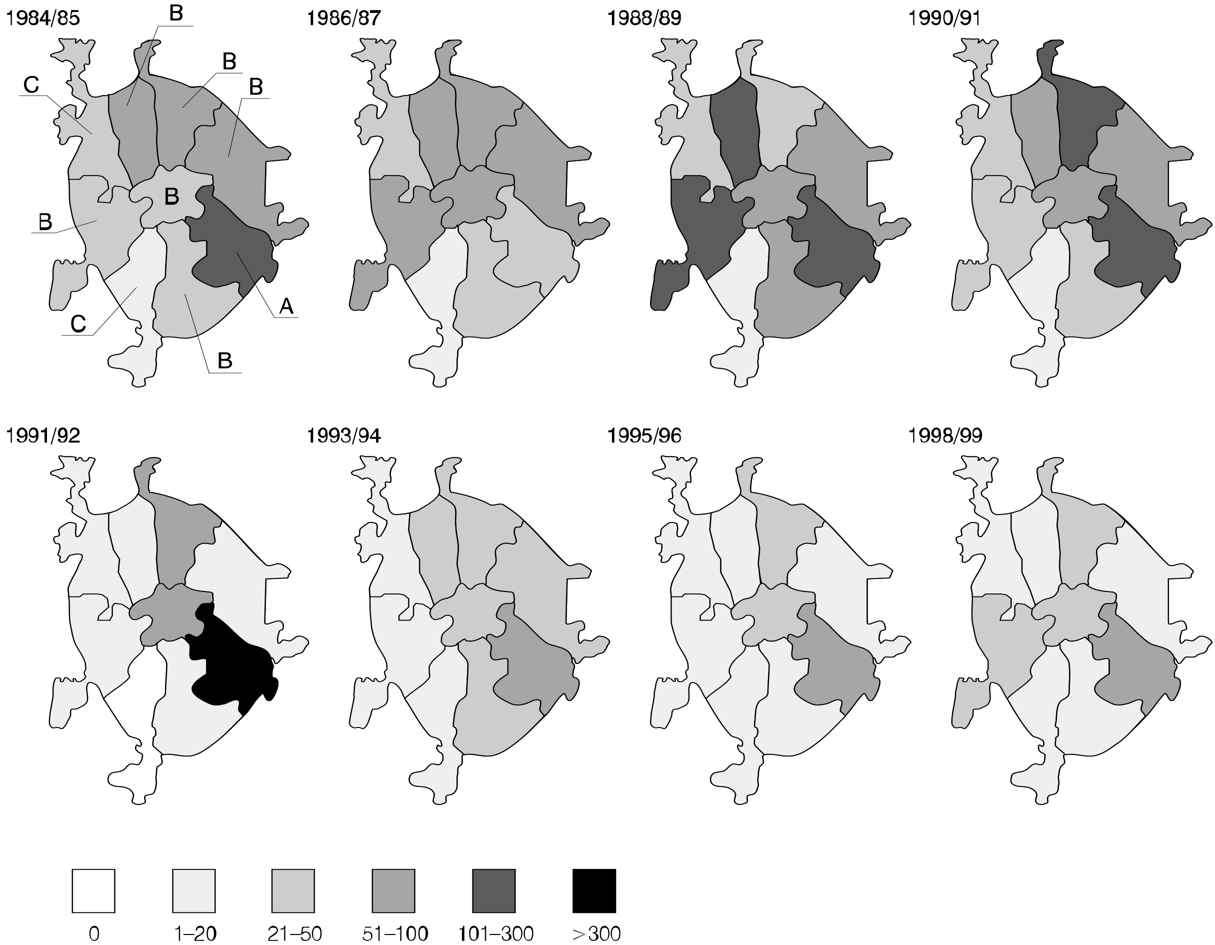

Fig. 3. Winter distribution of Mallard over nine districts of Moscow (ind./km of the river/pound lenght). A — district, where is the most attractive for wintering birds segment of Moscow-river, B — districts abundant in small water bodies, C — districts poor in small water bodies.

many species of ducks. The main hypotheses (e.g., Choudhury & Black 1991) are those relating this phenomenon with female physiology in winter, higher female mortality during the nesting and brooding periods due to predation, aspiration of males to winter closer to the breeding grounds to be on the spot earlier in spring, and competition for food in winter between sexes in which males are superior. Some tendency to a positive correlation between the proportion of males and the number of individuals in Moscow especially pronounced at the Moscow-river with little artificial feeding (and in the period of probable decline in such feeding elsewhere in the city) suggests that competitive interactions among sexes could be of some importance at least in some years.

Conclusions. The dynamics in the number of wintering Mallards in the city seems to depend both an air temperatures during the cold period and the social well-being of city inhabitants. It is highly probable that the economic/social situation has been the main factor in the decline observed during the 1990s.

ACKNOWLEDGMENTS

We are deeply indebted to professional ornithologists, especially N. P. Kharitonov and V. V. Korbut, and numerous volunteers which took part in the fieldwork. Our special thanks are to E. S. Ravkin for intellectual support and providing us with computer software. E. Chubarova kindly provided us with the data on the air temperature. V. N. Chernyshev helped with preparing the poster presentation. The English of the paper was kindly revised by N. S. Morozov and G. Barker. Financial support came from the project

„Universities of Russia: fundamental investigations”, the Ecological Committee of Moscow and the Independent Centre for the Research of Migratory Animals („Scaup“).

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STRESZCZENIE

[Zimowanie ptaków wodnych w Moskwie (1985–1999): zależność od temperatury powietrza i poziomu bytowego ludności]

W ciągu 15 lat jednego dnia w styczniu liczono ptaki wodne (z wyłączeniem mew) na 33 stałych odcinkach (310 km) wzdłuż wszystkich rzek i zbiorników wodnych miasta. Wyniki rozpatrywano w podziale na dwie kategorie niezamarzniętych wód: 1) dolny odcinek rzeki Moskwy, 2) niezamarznięte fragmenty innych wód — małych rzeczek i stawów. Jako miernik (MTEW) temperatury przyjęto średnią z okresu od 1 listopada do 15 stycznia, a jako miernik poziomu bytowego (WI) stosunek między średnią zarobków w danym roku a średnią ceną chleba.

Liczba gatunków obserwowanych podczas poszczególnych zim (3–10, łącznie 23) znacznie zwiększyła się w ciągu omawianego okresu (Tab. 1). Najliczniejszym gatunkiem była krzyżówka (98–99% wszystkich ptaków), u której udział samców wynosił 54–63%, a ogólna liczba stopniowo wzrastała od 17 tys. (1984/85) do 28 tys. (1989/90), po czym spadła do 7.5 tys (1997/98, Fig. 1). Zmiany te były warunkowane głównie temperaturą (MTEW) i poziomem bytowym mieszkańców (WI) — wskaźnikiem ceny chleba (Fig. 2), którym ludzie karmili zimujące kaczki. Spadek liczby zimujących krzyżówek zbiegł się z latami obniżenia stopy życiowej ludności, spowodowanego zmianą ustroju gospodarczego kraju. Zależność ta szczególnie uwidoczniła się (r_s = 0.67) w stosunku do ptaków zimujących na małych rzeczkach i stawach, gdzie były karmione przez ludzi, a nie było jej (r_s = -0.17) u populacji zimującej na otwartej przestrzeni rzeki Moskwy (Fig. 3). W ciągu zim 1990/91/92 znaczna część krzyżówek przeniosła się z małych wód na rzekę, gdzie znajdowały pokarm naturalny.