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Impact of temperature on the number of mallards, *Anas platyrhynchos*, wintering in cities

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Abstract. The mallard, *Anas platyrhynchos*, is a widespread waterfowl species that commonly winters in urban areas. The abundance of mallards wintering in four Polish cities: Warsaw, Białystok, Kielce and Szczecin was analyzed for a 10-year period, between 2003 and 2012. The highest mean number of mallards was recorded in Warsaw (> 18,000) and the lowest in Kielce (approximately 600). In Warsaw, Bialystok and Szczecin, where wintering of this species was documented over the period of 1950-1960, the number of birds fluctuated considerably during 2003 - 2012 but showed no significant trend. In Kielce, where mallards only began wintering in the 1990's, there was an increase in their numbers over time. Moreover, the number of mallards wintering in Szczecin was not correlated with mean temperature. In much more severe winter conditions, such us Warsaw and Białystok, the number of mallards increased when the water bodies outside the urbanized areas were frozen. Thus, as cities offered suitable conditions for wintering, part of the mallard population moved to urbanized areas instead of moving towards regions of milder weather.

Key words: mallard, synurbization, weather, urban areas, winter trends

Introduction

The mallard, *Anas platyrhynchos* is one of the most abundant waterfowl species in the world. Its population in North-Western Europe is estimated at 4.5 million individuals (Wetlands International 2014). This species shows strong tendency for synurbization, as cities offer excellent conditions for wintering due to large amount of anthropogenic food, higher winter temperatures and lower predation pressure (Luniak 2004). Hence, mallards became an important component of the urban avifauna (Figley & VanDruff 1982, Engel et al. 1988, Luniak 2004). In the beginning of the 20th Century this species wintered in many cities and towns in the Central Europe (Zimmer 1908, Schalow 1919, Pulliainen 1963), however, only small flocks or single birds were observed at that time (Robien 1920). Nowadays, thousands of individuals winter every year, for instance, in cities like Berlin (Berliner Ornithologische Arbeitgemeinschaft 1996). In the 1950's-1960's, the mallard was the most numerous water bird species wintering in many Polish towns (Jurczyk 1959, Kozłowski 1967, Dyrcz 1971, Kupczyk 2000).

Majority of mallards breeding in urbanized areas are sedentary (Håland et al. 1980, Heusmann 1981). However, late in autumn the number of mallards in cities increases due to arrival of birds representing migratory populations (Figley & VanDruff 1982, Engel et al. 1988). Their number in January exceeds 10,000 in some European cities (Berliner Ornithologische Arbeitgemeinschaft 1996, Meissner et al. 2012) and urban wetlands become important wintering sites for this species in Europe and North America (Heusmann & Burrell 1984, Meissner et al. 2012). Currently in Poland, mallards concentrate in high numbers in urbanized areas during the winter. In January 2009 about 108,000 of mallards were recorded in 210 Polish cities, which constituted at least 20% of the total number of these ducks wintering in the whole country (Meissner et al. 2012). Thus, in winter the urban waterfowl habitats seem to play a significant role for the mallard population at both local and flyway levels.

Recent studies showed that thermoregulation costs did not play a conspicuous role in shaping the winter distribution of dabbling ducks in Europe, which was especially prominent in the

case of the largest species – the Mallard (Dalby et al. 2013a, b). Other factors, however, such as those related to food availability, predation pressure or local weather conditions seem to be more important than sole effect of mid-winter temperature (Dalby et al. 2013a). Urbanized areas play an important role as wintering sites of this species offering rich sources of anthropogenic food. Hence we hypothesized that the decrease in winter temperature did not cause a decrease, but an increase in the number of mallards in the cities, when more birds arrived during harsh winters to stay in suitable sites for overwintering.

This paper aims to analyze the changes in the number of mallards wintering in four Polish cities and the possible correlation between bird numbers and mean air temperatures.

Materials and Methods

The surveys of wintering mallards were conducted between 2003 and 2012 in four Polish cities: Warsaw, Białystok, Szczecin and Kielce (Table 1; Fig. 1). Within each city mallards were counted once in the winter season in all water bodies and rivers in highly urbanized areas. Birds were regularly fed by people and concentrated in high number at all these sites. The surveys were conducted in mid-January, while in Kielce between 11 and 26 December.

Numbers of mallards differed between years and cities. The number of birds recorded each year was natural-log transformed, which allowed direct comparison of changes in the number of mallards among various cities.

In Warsaw the exhaustive counts were conducted since January 2007. Between 2003 and 2006 only some water bodies were included in the wintering waterbird survey for this city. According to the 2007-2012 data, all these sites held a quite constant proportion of all mallards wintering in Warsaw (ranging between 24 and 30% (mean 26.3%). Hence, the total number of mallards wintering in Warsaw in 2003-2006 was estimated using the mean percentage of birds, which stayed in those water bodies.

Changes in the number of mallards were correlated with mean temperature of the longer (15 December – 20 January) and shorter (1– 20 January) periods to distinguish between potential effect of temperature in two different periods prior to the results of January counts. In case of Kielce, where birds were counted between mid- and late December, we also used the mean temperature of December. We obtained the data on daily temperatures (recorded at the weather station localized within the shortest distance from the city center) from an on-line database (Tutiempo 2014). Statistical analyses followed methods presented by Zar (1996) and were performed with STATISTICA 10 (StatSoft 2011).

Results

The highest number of mallards was recorded in Warsaw; with a maximum number of 18,700, recorded in January 2006, and a mean number of wintering birds much higher than in any other city (Table 2). Kielce had the lowest number of wintering birds, where the maximum number was about 1,000 individuals in 2012 and the mean was only 618 (Table 2).

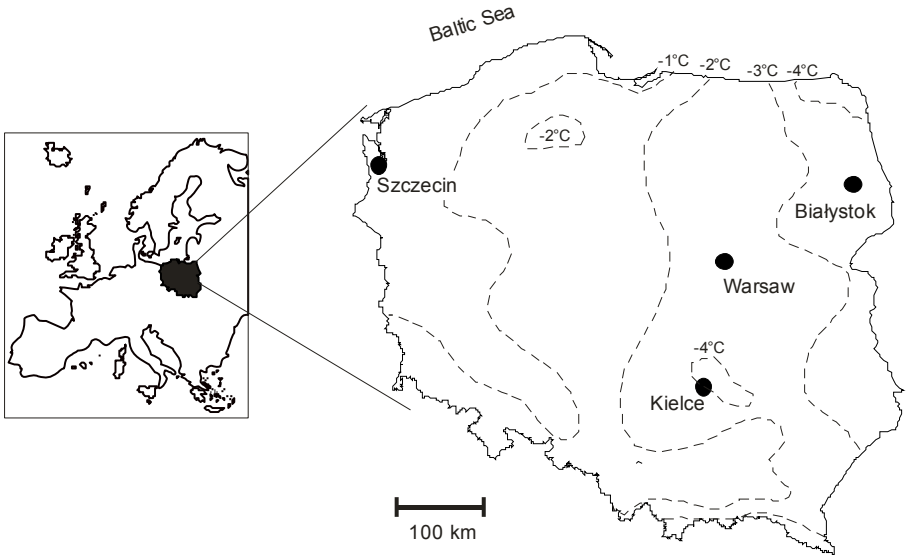

Figure 1. Localization of the studied cities. January isotherms (Lorenc 2005) are shown as broken lines.

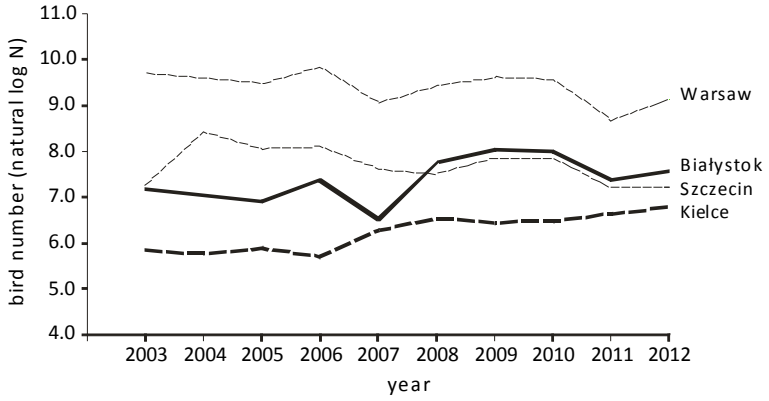

Figure 2. Changes in the number of mallards wintering in the Polish cities in 2003-2012.

Table 1. Characteristics of the studied cities (data according to Central Statistical Office 2011).

City	Population (thousands)	City area (km²)	Number of water bodies (except rivers)	Total length of rivers (km)
Warsaw	1720.4	517	54	78.0
Białystok	295.2	102	0	27.3
Szczecin	405.6	301	30	60.0
Kielce	203.8	110	11	16.7

Table 2. Mean, maximum and minimum number of mallards wintering in the surveyed cities in 2003-2012.

City	Mean	Maximum		Minimum	
		Number	Year	Number	Year
Warsaw	12,746	18,700[a]	2006	5,925	2011
Białystok	1,643	2,567	2010	674	2007
Szczecin	2,424	4,605	2004	1,400	2012
Kielce	618	1,022	2012	308	2005

[a] estimation (cf. Methods)

The number of mallards fluctuated considerably over the years and only in Kielce their number showed a clear positive trend (slope: 0.13; $p<0.001$) (Fig. 2). No significant trend was noted in other cities (non-significant slope of linear regression; $p>0.05$ in all cases).

The number of mallards wintering in Szczecin was not correlated with the mean air temperatures, neither short nor long period, i.e. 1–20 January and 15 December – 20 January ($r=-0.29$; $p=0.42$ and $r=-0.05$; $p=0.89$, respectively). There was also no significant relationship between mean temperature in December and the number of mallards in Kielce ($r= 0.15$; $p=0.68$). In Warsaw and Białystok significant negative correlation was found between the number of birds and the mean temperature of the 1–20 January period ($r=-0.70$; $p=0.03$ and $r=-0.68$; $p=0.03$ in Warsaw and Białystok, respectively). However, the number of mallards wintering in these two cities was not correlated with mean temperature of the longer period (15 December – 20 January) ($r=-0.52$; $p=0.13$ and $r=-0.63$; $p = 0.06$ in Warsaw and Białystok, respectively).

Discussion

Urban environment is characterized by a milder climate and a higher average winter temperatures than rural areas. This fact is particularly important for wildlife (Luniak 2004, Chace & Walsh 2006). Moreover, people feed waterfowl in cities and birds can have lower energetic costs of finding food than in their natural habitats (Sears 1989, Polakowski et al. 2010). Presence of high amount of

anthropogenic food causes mallards wintering in urban areas less likely to respond to depletion of food resources after frosts. Whereas frost in natural wetlands causes waterfowl to leave the wintering sites due to inability to obtain food (Nilsson 1983). When taking into account whole provinces or whole countries in Central Europe, the number of mallards is much lower during harsh winters than in mild seasons (Harengerd & Kölsch 1990, Dombrowski et al. 1997). Negative relationship between temperature and the number of mallards was observed in urban areas, i.e. the increase in the number of mallards during harsh winters (Hansson 1966, Nilsson 1975, Engel et al. 1988). In the present study relation between temperature and the number of mallards was found only in Warsaw and Białystok. These two cities are situated close to each other (ca 170 km apart) within the similar zone of mean January temperatures ranging between -2 and -4°C. Hence, similar changes in the number of mallards caused by weather conditions could be expected. Szczecin is located in the milder climatic zone and there are plenty of water bodies and rivers around it, including internationally important bird area: the Szczecin Lagoon, which holds thousands of wintering waterfowl. During harsh winters these large water bodies and the Odra river, situated close to the city, rarely ice completely and thus, they remain available to waterbirds. A substantial arrival of mallards to Szczecin was recorded in extreme low temperatures, when the suburban section of the Odra river and adjacent lakes were frozen (Marchowski & Ławicki 2011, Marchowski et al. 2013). However, when analyzing long-term data, the relationship between the number of mallards and temperature was not observed, because winters in the north-western Poland are much milder than in the central and eastern part of the country (Lorenc 2005). Thus, birds are rarely forced to move from frozen wetlands to urban water bodies. Therefore, it seems that the number of mallards in cities increases during harsh winters, but it is not the ultimate rule and it can depend on the availability of unfrozen natural habitats outside the urban area.

Temperature is an important factor influencing the number of wintering mallards (Jeske 1993, Meissner et al. 2012), their movements (Nichols et al. 1983, Sauter et al. 2010) and behavior during the non-breeding period (Meissner & Markowska 2009). There is a negative correlation between the number of mallards wintering in Warsaw and Białystok and the mean temperature of the shorter (1–20 January) period. This indicates that the arrival of birds to these cities occurs directly after the water bodies outside of the urban areas were frozen. It corresponds with the results of Engel et al. (1988) who found the relationship between temperature on the day of the survey and the number of wintering birds in Warsaw.

The number of mallards showed a significant increase over time in Kielce, however birds were counted there 3-4 weeks earlier than in other cities, and this might have influenced the results. In Central Europe mallards reach their wintering sites in December (Cramp and Simmons 1977) and usually there is only a slight difference in the number of birds staying at a given site between December and January (Wahl & Sudfeldt 2005, Bergmann et al. 2006, Vránová 2010, Kavka 2011, Meissner et al. 2013, 2014). This is consistent with the finding of Dalby et al. (2013a) that in Europe wintering mallards adopt a 'sit and wait' strategy, even during harsh weather conditions. The analysis of ringing recoveries showed mid-winter movements of mallards, but only during very cold winters. The extent to which mallards undertook within-winter movements decreased in later decades because winters are getting warmer and the frequency of cold days has decreased (Sauter et al. 2010). The increment of mean January temperatures from year to year varied between -8.7 and 4.8°C in Białystok (the coldest among surveyed sites), but even in the coldest winter (2010) birds found unfrozen water to stay in the city.

December and January counts were carried out in Kielce in 2006/2007, 2007/2008 and 2010/2011. The results show that the number of mallards in these two months differed only by 1.3%, 4.6% and 2.3% in the following winters, respectively. Hence it may be assumed that mid-December individuals are mostly wintering birds and that increasing number of mallards in Kielce reflects a real growth of the wintering populations. In the mid-nineties of the last Century about 50 mallards wintered in this city (Wilniewczyc, Kielce, pers. comm. 2014), while their number reach 1,000 individuals nowadays. In other studied cities regular wintering of mallards started much earlier and the number of birds is rather constant, but shows noticeable fluctuations. These fluctuations are also observed in many sites in Europe and are usually attributed to variation in weather conditions (Schwab et al. 2001, Avilova 2008, Dalby et al. 2013b).

The negative correlation between temperature and the number of mallards wintering in Warsaw and Białystok suggests that some birds move into urban areas instead of migrating towards the regions of milder climate or staying outside cities, where food sources become limited after the expansion of ice and snow cover on wetlands and agricultural lands.

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