ANIMAL SCIENCE AND GENETICS
Published by the Polish Society of Animal Production
vol. 18 (2022), no 2, 13-22
DOI: 10.5604/01.3001.0015.8567
Research Article ***Open Access***

The number, behaviour, and population indices of Mallard ducks (*Anas platyrhynchos* L.) in non-urban and urban environments of the Lublin region

Marian Flis[1], Piotr Czyżowski[1#], Bogusław Rataj[2], Jacek Piórkowski[3]

[1]Department of Ethology and Wildlife Management, Faculty of Biology, Animal Sciences and Bioeconomy, University of Life Sciences in Lublin
[2] Polish Hunting Association, Nowy Sącz District Board
[3]Department of Pathomorphology and Forensic Medicine, Faculty of Veterinary Medicine, University of Life Sciences in Lublin

SUMMARY

The paper presents indicators of the number, reproduction and behaviour of mallard ducks living in non-urban and urban environments in the Lublin region. The research carried out in urban and rural areas showed significant differences in the behaviour of birds reflecting their timidity in the presence of humans, measured as the distance from the observer at which they took flight and subsequently landed on the water surface. These distances were four times greater in the non-urban areas. Total numbers of birds and bird density indicators were significantly higher in the urban areas, as was the average size of the assemblages, by 2,0-3,2 birds, depending on the date of the study. There were no significant differences in sex structure or reproductive rates between the study sites, with male predominance in all study areas. The analyses indicate progressive adaptation to urban environments by mallard ducks. This is achieved through behavioural changes, which do not significantly affect the course of natural selection or breeding processes in birds present in these environments, which remain similar to those observed in non-urban or low-urbanized environments typical for this species.

KEY WORDS: Mallard duck, *Anas platyrhynchos*, reproduction, non-urban environment, urban environment, Lublin Upland

INTRODUCTION

The mallard duck (*Anas platyrhynchos* L.) is one of the most common species of wild ducks in many European, Asian, and North American countries, and is found in Australia and New Zealand as well (Tracey et al., 2008; Söderquist, 2012). It is also the ancestor of most domestic duck breeds.

[#]Corresponding author e-mail: piotr.czyzowski@up.lublin.pl
Received: 17.02.2022 Received in revised form: 15.03.2022
Accepted: 30.04.2022 Published online: 24.05.2022

It is a hunted species in many countries. In the United States, mallards were deliberately settled on hunting grounds (Smith and Rohwer, 1997). In Poland, it is the most numerous of the four game species of ducks and one of the most important species of game birds. Every year, Polish hunters shoot about 100 000 ducks, with mallards accounting for about 95% of this number (Książkiewicz, 2006; Biuletyn Czempiń, 2019).

This species is also commonly hunted in other European countries; data from the European Union show 4,5 million mallards shot per year in EU countries and in Norway and Switzerland (Hirschfeld and Heyd, 2005; Gunnarsson et al., 2012). In many societies, hunting not only provides for the needs of the community by supplying high-quality meat, e.g. venison, but also has cultural and recreational aspects. Moreover, hunting regulates the abundance and population structures of individual species as part of population management, which directly affects reproductive rates and animal survival rates and thus plays an important role in optimizing the functioning of individual populations (Borman and Mattson, 2012; Vrtiska et al., 2013; Ljung et al., 2015; Janiszewski et al., 2018; Flis and Brodzki, 2020).

Nevertheless, for several years a downward trend has been observed in the number of small game in Poland and in other European countries. This trend has also affected mallards, although the decline in numbers is less pronounced (Calbrade et al., 2010; Hornman et al., 2011; Virkkala and Lehikoinen, 2017). Anthropogenic transformations in water ecosystems are generally considered to be the main cause of this unfavourable phenomenon. They entail the loss of many valuable natural sites associated with the reproduction of waterfowl and the course of breeding processes in birds, from nest-building to rearing of young. Progressing climate change affects the condition of ducks expressed as carcass weight and their ability to cope with environmental pressure in the winter. It may also affect reproductive processes (Guillemain et al., 2010; Flis and Brodzki, 2020). In some countries, mainly in Northern Europe, the number of mallards is showing signs of stabilization, and there is even an upward trend in the population of this species (Dalby et al., 2013b). A similar trend was observed in Belarus (Kozulin et al., 2012).

In recent years, a specific trend of behavioural changes in mallards has been observed as well, manifested by mass appearance in urban areas, including large cities, in winter. The results of research conducted in Poland have shown that on average, among wild birds that spend the winter in large cities with a population of over 100 000, 855 000 are mallards. There is also a clear tendency of increasing numbers during cold winters (Meissner et al., 2012; Meissner and Markowska, 2009). The choice of habitat is determined primarily by factors related to temperature changes, food resources, and predation pressure (Møller, 2008; Polakowski et al., 2010; Palumbo et al., 2019). The climatic conditions in winter are quite important in this respect. Research conducted in four Polish cities has shown an increase in the density of mallards as temperatures decrease and water bodies located outside urban areas freeze (Meissner et al., 2015).

The aim of the study was to analyse variation between features of the biology, ecology, and behaviour of mallard ducks in non-urban (natural living environments) and urban areas in order to verify three research hypotheses:

1. Is there any variation in the number and size of the assemblages and sex structure of these birds?
2. Are there any behavioural differences in birds' timidity associated with the presence of humans?
3. Are there any differences in reproduction depending on the habitat?

The hypotheses were verified by field studies on selected sections of rivers located in the Lublin region, in both urban areas (rivers flowing through the city of Lublin) and non-urban areas (natural habitats located in the vicinity of Lublin).

MATERIAL AND METHODS

Study area

The research consisted in direct observations along 5-km sections of the rivers Bystrzyca and Czerniejówka, with the use of observation binoculars. Two study sites were located within the administrative boundaries of the city of Lublin. For the purposes of this study, these areas were designated urban area 1 and urban area 2. Another two research sites were located on the same rivers outside the city and designated non-urban area 1 and non-urban area 2 (Fig. 1). The research was conducted in 2019-2021.

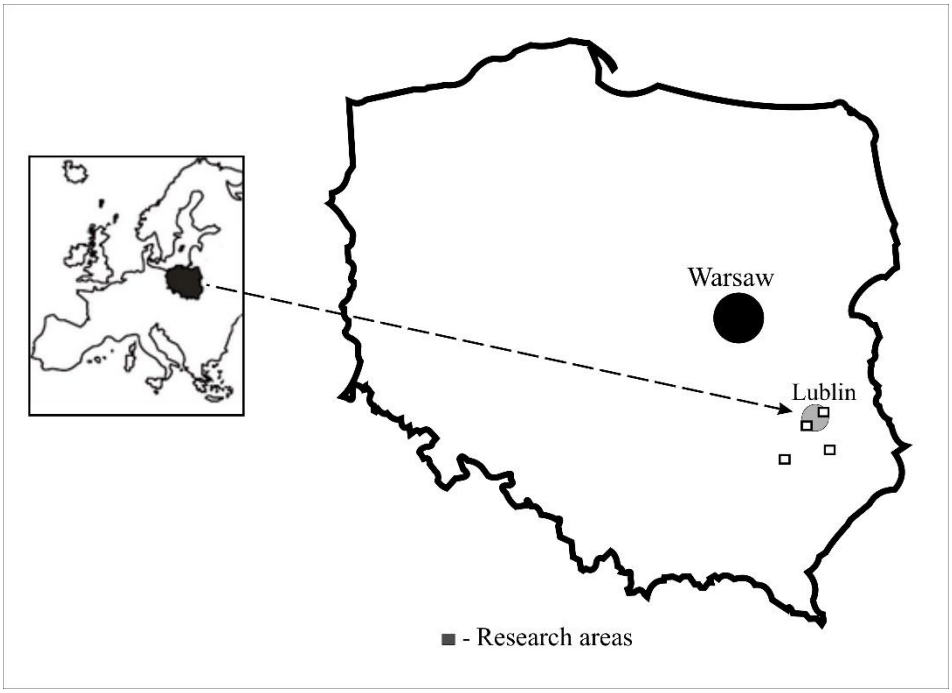

Fig. 1. Location of research sites

Material

The observations were made in winter (December 2020 - period I), at the beginning of March 2021 (period II), and in May 2021. The observations were carried out once in each period. All observations were made at the same time of day, i.e. between 8.00 a.m. and 11.00 a.m. In the first two observation periods (winter), the number of duck assemblages in the individual locations and the number of males and females in each assemblage were recorded to determine the sex structure. Additionally, a situational behaviour study was carried out, in which the distance from the observer

at which the ducks took off for flight and the distance at which they subsequently landed on the water were recorded using Leica Geovid 8x56 R laser rangefinder binoculars. On this basis, the timidity of the birds and the degree of their synurbization were determined for each habitat. During the research carried out in March, the number of breeding pairs of ducks, which were clearly predominant in each group, and the number of unpaired individuals were noted. The subsequent research carried out in May focused on the number of ducklings reared by individual females.

Statistical analysis

Statistical calculations were made with Statistica 13.1 software (StatSoft, Tulsa, OK, USA) using a database created in MS Excel. The normality of the distribution was verified using the Shapiro-Wilk test. As the data did not follow the normal distribution, the non-parametric Mann-Whitney U test was used to determine the differences between mean values of the analysed features. The influence of the living environment on the elements covered by the research was considered significant at $P \leq 0,05$.

RESULTS

The results showed that in the first period of research, the communities in the urban areas were more numerous by two individuals ($p = 0,05$). In the second study period, the difference was 3,2 and was also statistically significant ($p = 0,01$) (Table 1). The number of identified bird assemblages was also higher in the urban areas, but these values were not statistically significant. In both study periods, the difference in the total number of birds observed was higher in the urban areas. The calculation of the difference between populations by the Mann-Whitney U test showed that these values were statistically significant in both cases ($Z = -2,018$; $p = 0,04$; $Z = -2,373$; $p = 0,01$).

Table 1

Number, size and sex structure of duck assemblages in the study areas

Research area	Period I			Period II		
	n	$\bar{x}$	Male/Female	n	$\bar{x}$	Male/Female
Non-urban 1	19	6,2	0,88	15	6,8	0,79
Non-urban 2	16	7,4	0,93	16	7,5	0,77
Mean	17,5	$6,8^{a}$	0,89	15,5	$7,2^{a}$	0,78
Total birds		243^{x}			222^{x}	
Urban 1	13	10,1	0,81	10	11,8	0,74
Urban 2	18	7,9	0,78	15	9,5	0,76
Mean	15,5	$8,8^{b}$	0,80	12,5	$10,4^{b}$	0,75
Total birds		273^{y}			260^{y}	

a, b - mean values for the size of groups marked with different letters for non-urban and urban areas differ statistically significantly at $P \leq 0,05$

x, y - values for the total number of birds marked with different letters for non-urban and urban areas differ statistically significantly at $P \leq 0,05$

The average density of ducks in the non-urban areas in the first period of the study was 48,6 individuals per km of the watercourse. It was higher in the urban areas, i.e. 54,6 ind./km. In the second study period, irrespective of the environment, the density decreased to 44,4 and 52 ind./km of the watercourse, respectively.

The percentage of paired birds was slightly higher in the non-urban environments, but it was determined by the sex structure index (Fig. 2).

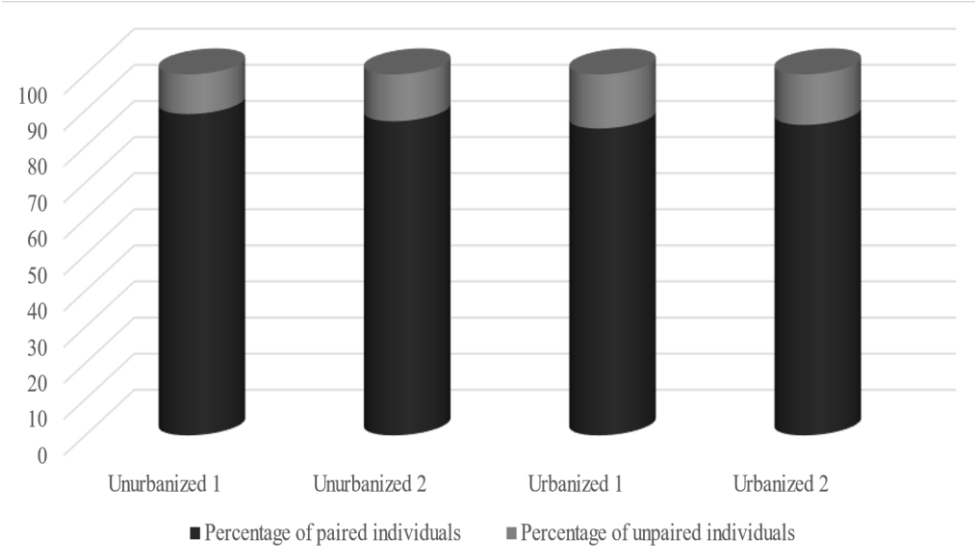

Fig. 2. Structure (%) of breeding pairs and unpaired individuals

The results of the research on the reproduction of ducks showed an average of 7 ducklings per female in the non-urban environments and 7,2 in the non-urban areas, with no statistically significant differences (Fig. 3). The standard deviations for individual study areas were similar and statistically insignificant, which indicates that the habitat does not have a significant impact on the breeding processes in these birds. However, a statistically significant difference was found in the number of females leading their ducklings depending on the habitat. There were 26 females leading their ducklings in the non-urban areas and 19 females with ducklings in the urban areas.

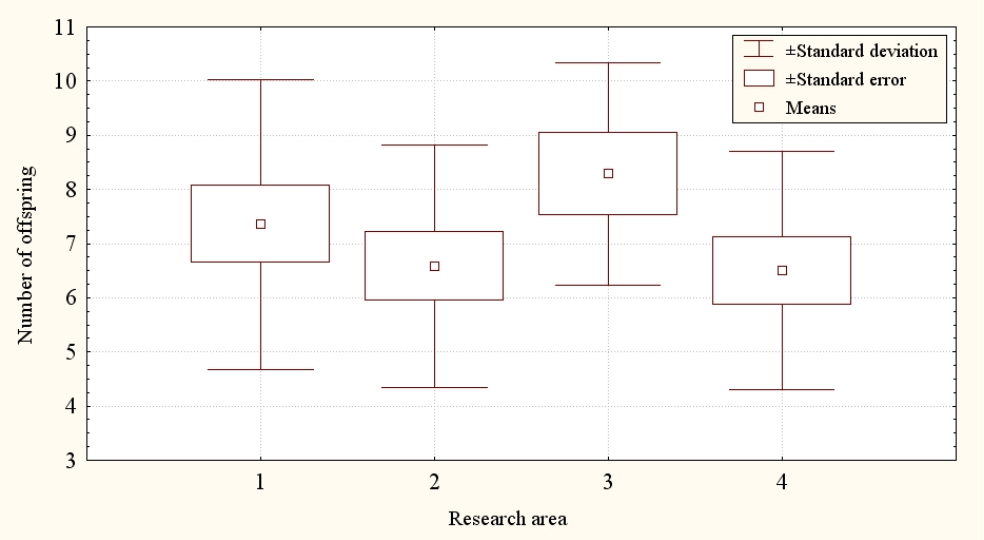

Fig. 3. Number of mallard duck offspring at each study site

The assessment of mallard behaviour in the presence of humans showed significantly lower timidity in birds living in the urban environments. In the non-urban environments, the average take-off distance from the observer was 102 m, which was over four times greater than in the urban environments, where it was 23,3 m (Fig. 4). These differences were statistically significant (Z = 7,017; p = 0,001). A similar relationship was found for the distance at which ducks landed on water after being frightened away. In the non-urban environments, this distance was on average 272,9 m, but in four cases the ducks moved beyond the range of observation. In the urban environments, the ducks landed at a distance not exceeding 72 m, on average 65 m. These differences were statistically significant (Z = 7,014; p = 0,001).

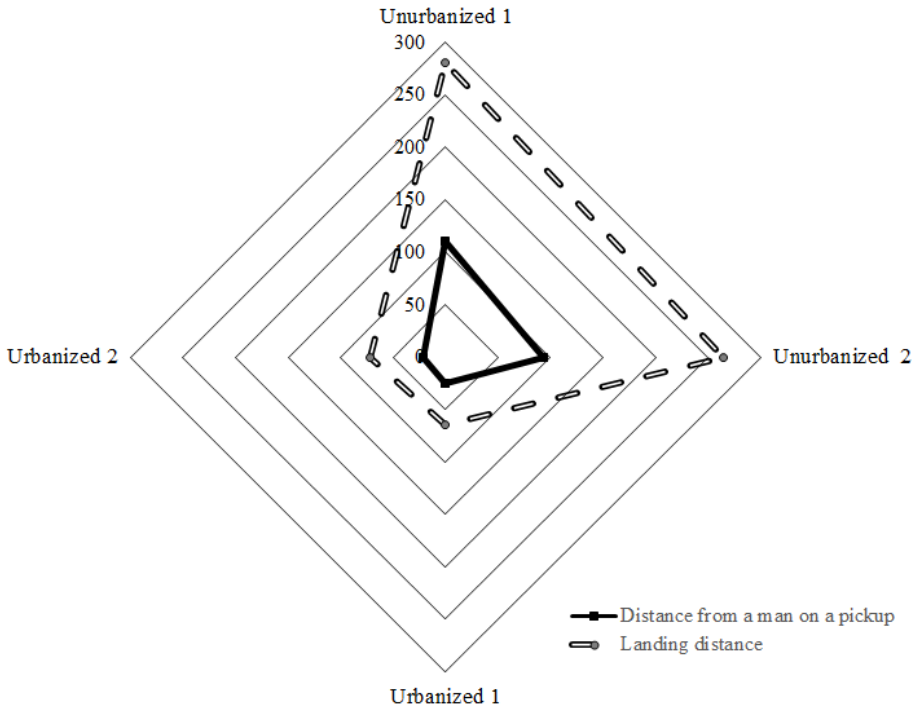

Fig. 4. Average distance of take-off and landing of ducks as a result of human presence in each habitat

DISCUSSION

In the last decade, wild animals have exhibited a growing tendency to colonize cities. This phenomenon has been termed 'synurbization', i.e. the existence of animals in a wild or near-wild state in areas with a high degree of urbanization. A special case is the mallard duck, whose populations have been recorded in urban areas for many years, which indicates high ecological and behavioural plasticity as well as specific microevolutionary changes in populations of these birds due to anthropogenic pressure (Luniak, 1996; Luniak, 2004; Møller, 2008). The present results regarding the fairly common presence of mallard ducks in urbanized areas confirm previous reports in this regard. Research conducted in Poland in 2007-2009 showed that mallard ducks were prevalent in urban areas, and the average number increased with the size of the city, while the mallard was not found in only 9% of the cities covered by the study (Meissner et al., 2012). The number of ducks in urban areas has also been shown to increase as temperatures fall and water bodies outside urban areas freeze (Meissner et al., 2015). This supports the argument that this species migrates to warmer places, as in its annual migrations to the south before winter, with the migration distance decreasing with progressive climate warming (Sauter et al., 2010). Dalby et al. (2013a) emphasize that it is not temperature but food resources that are the main factor determining the spatial distribution of mallard ducks. Kozulin (1995) showed similar relationships in the population of ducks living in Belarus.

Meissner and Markowska (2009) emphasize that the behaviour of ducks changes as a result of people feeding birds in urban areas in winter.

The indicators of the sex structure obtained in the study, with clear predominance of males, are similar to those obtained in western Norway, where, irrespective of the age of the birds, drakes were predominant (Håland et al., 1980). Similar studies conducted in the 1980s in Great Britain also showed a 25-50% predominance of males over females (Owen and Dix, 1986). Research carried out in Gdansk, Gdynia, and Sopot in 1980-2010 showed that the share of males in the urban populations of mallard ducks ranged from 51% to 66% (Meissner and Michnio, 2011).

CONCLUSIONS

The presented results indicate significant differences in the number of birds found in non-urban and urban areas, irrespective of the study period. This was confirmed by the significant differences in the average size of the bird assemblages, which were fewer in urban areas but consisted of larger numbers of birds. No significant differences were found in the sex structure of the birds, with a distinct predominance of males irrespective of the area and date of the research, which directly influenced the possibility of formation of breeding pairs. There was no significant difference in the number of ducklings between the non-urban and urban areas, which confirms that adaptation to a permanent or temporary stay in anthropogenic environments does not significantly affect reproductive processes. At the same time, the behaviour of mallards in terms of timidity in the presence of humans has changed dramatically. In the urban areas, the distance up to which ducks could be approached was reduced by more than 4 times compared to the non-urban areas. The distance at which they landed on the water surface after flying off was also reduced 4 times; moreover, in the non-urban environments, most flocks flew beyond the observation range.

REFERENCES

1. Biuletyn Czempiń (2019). Zestawienie danych sprawozdawczości łowieckiej 2018 rok. Stacja Badawcza Polskiego Związku Łowieckiego w Czempiniu, Czempiń
2. Borman M., Mattsson L. (2012). The hunting value of game in Sweden: Have changes occurred over recent decades? Scandinavian Journal Forest Research 27(7): 1-6, doi.org/10.1080/02827581.2012.683533
3. Calbrade N.A., Holt C.A., Austin G.E., Mellan H.J., Hearn R.D. Stroud D.A., Wotton S.R., Musgrove A.J. (2010). Waterbirds in the UK 2008/09: The Wetland bird survey. BTO/RSPB/JNCC in association with WWT, Thetford
4. Dalby L., Fox A.D., Petersen I.B., Delany S., Svenning J.C. (2013a). Temperature does not dictate the wintering distribution of European dabbling duck species. Ibis 155: 80-88, doi.org/10.1111/j.1474-919X.2012.01257.x
5. Dalby L., Söderquist P., Christensen T.K., Clausen P., Einarsson Á., Elmberg J., Fox A.D., Holmqvist N., Langendoen T., Lehikoinen A., Lindström A., Lorentsen S., Nilsson L., Pöysä H., Rintala J., Sigfússon A.P., Svenning J. (2013b). The status of the Nordic populations of the Mallard (Anas platyrhynchos) in a changing world. Ornis Fennica 90: 2-15
6. Flis M., Brodzki P. (2020). Carcass composition, spermatogenesis processes and pathogenic threats of male mallard ducks (*Anas platyrhynchos* L.). Applied Ecology and Environmental Research 18(1): 1489-1507, doi: 10.15666/aeer/1801_14891507

7. Guillemain M., Elmberg J., Gauthier-Clerc M., Massez G., Hearn R., Champagnon J., Simon G. (2010). Wintering French Mallard and Teal are heavier and in better body condition than 30 years ago: Effects of a changing environment? Ambio 39(2): 170-180. doi: 10.1007/s13280-010-0020-9
8. Gunnarsson G., Waldenström J., Fransson T. (2012). Direct and indirect effect of winter harshness on the survival of Mallards Anas platyrhynchos in northwest Europe. Ibis 154(2): 307-317, doi: 10.1111/j.1474-919X.2011.01206.x
9. Håland A., Kålås J.A., Løfaldli L., Byrkjeda I. (1980). Size, sex ratio and age composition of the urban winter population of Mallards Anas Platyrhynchos in Bergen, western Norway. Fauna Norvegica 3: 65-69
10. Hirschfeld A., Heyd A. (2005). Mortality of migratory birds caused by hunting in Europe: Bag statistics and proposals for the conservation of birds and animal welfare. Berichte zum Vogelschutz 43: 47-74
11. Hornman M., Hustings F., Koffijberg K., van Winden E. (2011). Waterbirds in the Netherlands in 2008/2009. SOVON monitoring report 2011/03. Waterdienst rapport No. BM 10.24. Nijmegen, the Netherlands. (In Dutch with English summary)
12. Janiszewski P., Murawska D., Hanzal V., Gesek M., Michalik D., Zawadka M. (2018). Carcass characteristics, meat quality, and fatty acid composition of wild-living mallards (*Anas platyrhynchos* L.). Poultry Science 97(2): 709-715, doi.org/10.3382/ps/pex/335
13. Kozulin A. (1995). Ecology of Mallards Anas Platyrhynchos wintering in low temperature conditions in Belarus. Acta Ornitologica 30(2): 125-136
14. Kozulin A., Schokalo S., Natikanets V., Ostrovski O., Sidorenko O. (2012). Numbers and distribution of wintering waterfowl in Belarus. Acta Zoologica Lituanica 11(3): 260-265, doi.org/10.1080/13921657.2001.10512458
15. Książkiewicz J.A. (2006). Mallard duck – Anas platyrhynchos L. means a flat-billed duck. Wiadomości Zootechniczne 1: 25-30
16. Ljung P.E., Riley S.J., Ericsson G. (2015). Game meat consumption feeds urban support of traditional use of natural resources. Journal Society & Natural Resources 28(6): 657-669, doi.org/10.1080/08941920.2014.933929
17. Luniak M. (1996). Synurbization of animals as a factor increasing diversity of urban fauna. In: di Castri, F., and T. Younes (eds.). Biodiversity, science and development: towards a new partnership. CAB International
18. Luniak M. (2004). Synurbization – adaptation of animal wildlife to urban development. - (In: Proceedings of the 4th International Symposium on Urban Wildlife Conservation, Eds: W.W. Shaw, L.K. Harris, L. Van Druff) – Tucson, Arizona
19. Meissner W., Markowska K. (2009). Influence of low temperatures on behaviour of mallards (Anas platyrhynchos L.). Polish Journal of Ecology 57(4): 799-803
20. Meissner W., Michnio B. (2011). Variability of the sex ratio of Mallards *Anas platyrhynchos* wintering in the Tricity (northern Poland). Urban Fauna. Studies of animal biology and conservation in European cites. Indykiewicz P. (eds.) UPT Bydgoszcz
21. Meissner W., Polakowski M., Wilniewczyc P., Rowiński P. (2015). Impact of temperature on the number of mallards, Anas platyrhynchos, wintering in cites. North-Western Journal of Zoology 11: 213-218

22. Meissner W., Rowiński P., Kleinschmidt L., Antczak J., Wilniewicz P., Betleja J., Maniarski R., Afranowicz-Cieślak R. (2012). Wintering of water birds in urban areas of Poland in 2007–2009. Ornis Polonica 53: 249-273
23. Møller A.P. (2008). Flight distance of urban birds, predation, and selection for urban life. Behavioral Ecology Sociobiology 63(1): 63-75, doi.org/10.1007/s00265-008-0636-y
24. Owen M., Dix M. (1986). Sex ratio some common British wintering ducks. Wildfowl Journal 37: 104-112
25. Palumbo M.D., Petrie S.A., Schummer M., Rubin B.D., Bonner S. (2019). Mallard resource selection trade-offs in a heterogeneous environment during autumn and winter. Ecology and Evolution 9(4): 1798-1808
26. Polakowski M., Skierczyński M., Broniszewska M. (2010). Effect of urbanization and feeding intensity on the distribution of wintering Mallards Anas platyrhynchos in NE Poland. Ornis Svecica 20: 76-80
27. Sauter A., Korner-Nievergelt F., Jenni L. (2010). Evidence of climate change effects on within-winter movements of European Mallards Anas platyrhynchos. Ibis 152(3): 600-609, doi.10.1111/kj.1474-919X.2010.01028.x
28. Smith D.B., Rohwer F.C. (1997). Perceptions of releases of captive-read mallards with emphasis on an intensive program in Maryland. In: Proceedings of the Transactions of the North American Wildlife and Natural Resources Conference 62: 403-411
29. Söderquist P. (2012). Ecological and genetic consequences of introductions of native species: The mallard as a model system. Introductory Research Essay No. 15 Department of Wildlife, Fish, and Environmental Studies Swedish University of Agricultural Sciences 901 83 Umeå, Sweden
30. Tracey J., Lukins B., Haselden C. (2008). Lord Howe Island Duck: Abundance, Impact and Management Options. A report to the World Heritage Unit. Lord Howe Island Board. Invasive Animals Cooperative Research Centre, Canberra
31. Virkkala R., Lehikoinen A. (2017). Birds on the move in the face of climate change: High species turnover in northern Europe. Ecology Evolution 7(20): 8201-8209, doi: 10.1002/ece3.3328
32. Vrtiska M.P., Gammonley J.H., Naylor L.W., Raedeke A.H. (2013). Economic and conservation ramifications from the decline of waterfowl hunters. Wildlife Society Bulletin 37(2): 380-388, doi: 10.1002/wsb.245

Funding information: There was no funding for this research.

Ethical approval: All applicable international, national and/or institutional guidelines for the care and use of animals were adhered to during the research. All animal testing procedures followed the ethical standards of the institution or practice where the testing was conducted. This article does not contain any human research.