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Are winter species composition and abundance censuses of birds in small urban green areas comparable?

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Brauze T., Zieliński J. 2006. Are winter species composition and abundance censuses of birds in small urban green areas comparable? Acta Ornithol. 41: 93–101.

Abstract. Wintering birds were studied in three plots (10.0–14.5 ha) in urban green areas in central Poland. Two observers independently counted the birds in each plot on six days evenly distributed between mid-December and mid-February. On the count day, each observer did two surveys: an early count, starting at 8 a.m., and immediately afterwards, a late count, finishing before noon. Using three-way ANOVA, the differences between densities, numbers of species and Shannon-Wiener diversity indices obtained in single counts were tested in relation to independent variables: the count time (early or late), the observer, and the plot. No effect of plot variable was revealed. An observer effect was, however, found in the number of species, as well as in the densities of the whole avifauna and of flocking species. Differences in the bird diversity indices were found only between the early and late counts. The results of the present study indicate that there are no means of definitively assessing the number of species, density, and species diversity of birds wintering in small parts of urban green areas.

Key words: bird census method, wintering birds, urban birds, *Parus*, *Corvus*, mixed species flocks

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INTRODUCTION

One of the basic problems in studies on species composition and numbers of birds is comparability of results. Results of such studies obtained even by the same methods but by different observers are often biased due to a number of reasons. One source of error, difficult to estimate, results from differences in experience, habits and perceptiveness of each investigator (Källander et al. 1977, Tomiałojć 1992, Rosenstock et al. 2002). Even when the results come from the same observer, obtaining comparable quantitative data may be difficult. In studies of winter avifauna, two main problems influence comparability of results. The first type relates to difficulties in determination of the real number of birds in the field, caused by high mobility of some species (e.g. Nilsson 1974, Tomiałojć 1974, Brewer 1978, Donald et al. 1997). The second problem stems from temporal changes of species composition and numbers of birds in small areas taking place during the course of winter (e.g. Källander et al. 1977, Jokimäki & Suhonen 1998). These factors may lead to significant differences found in species composition and bird numbers in winter in the same area by the same method.

Papers addressing effects of the problems listed above on results of studies on winter avifauna are scarce. The influence of the number of counts performed in winter on abundance estimates of some species and on the estimates of species richness has been described by several authors (Luniak 1981, Biaduń 1994, Nowakowski & Dulisz 2001, Brauze & Zieliński 2004). In a few papers only (Robbins 1970, Nilsson 1974, Robbins & Bystrak 1974, Källander et al. 1977, Brewer 1978) the applicability of methods has been presented, while Jokimäki & Suhonen (1998) defined detectability and changes in numbers of some species in winter for the single-visit plot method. The goal of the present paper is to determine if potential changes in species composition and bird numbers, difficulties in counting them and the skills of different observers have influence the results of studies of winter avifauna conducted during the same period in a small urban green area.

STUDY AREA

The study was conducted in three central Poland towns on plots that were fragments of urban green areas (city parks) in Bydgoszcz (the plot BYD), Solec Kujawski (SOL) and Toruń (TOR).

The plot BYD (14.5 ha, 53°12′N, 17°98′E) was part of a strip of urban green along the Bydgoszcz Channel, bordered at the south by a busy road with close urban housing. About a half of the area was covered by 100-year old alder carr *Alnus glutinosa* with dense undergrowth formed mainly by the European Elder *Sambucus nigra*, while the second part was overgrown by over 100-year old pine tree stand *Pinus sylvestris* with almost no undergrowth. The few grassy areas did not exceed 10% of the studied plot. In the centre there were a few small buildings. The area underwent strong human penetration, also outside existing paths.

The plot SOL (11.0 ha, 53°08′N, 18°21′E) was bordered by ruderal areas at the west and the south, the rest was adjacent to a road of a low traffic, behind which the remaining part of the park was located. The study area was a part of an inland dune covered almost entirely by an over 100-year old low pine stand *Pinus sylvestris*. A low and medium density shrub layer (mainly Black Cherry *Padus serotina*) covered over a half of the plot. A small part was an open area covered by herbaceous vegetation. Human penetration of low intensity was confined mainly to paths.

The plot TOR (10.0 ha, 53°00′N, 18°56′E) was a fragment of urban green areas adjacent to the flood terrace of the Vistula river. The northern part of the studied area was covered by over 100-year old pine tree stand *Pinus sylvestris* with scattered undergrowth. The lowest located fragment of the plot partly bordered an oxbow lake and was covered by ca. 70–100-year old mixed broadleaved woodland with dense undergrowth. The remains of a riverside carr with old specimens of poplars *Populus* sp. covered a small part of the area. A few ponds of a total area below 1 ha and a small grassy sports field were located in the park. Strong human penetration affected both park alleys and the remaining part of the studied area.

MATERIAL AND METHODS

Quantitative studies on winter avifauna were carried out from the second half of December 1999 to the beginning of February 2000. Bird counts were done independently by two observers (the authors, both of a similar experience in field studies). They did not exchange information about results of counts until the end of the study. Each of observers (B and Z) conducted counts in each plot on six days distributed evenly between mid-December and mid-February. During each count day an observer did two surveys — an early count, marked as E, started at 8 a.m., and a late count (L) begun immediately after the early one and finished before 12 a.m. The majority of winter counts of birds in wooded areas were conducted during this time interval (e.g. Górska & Górski 1980, Luniak 1981, Biaduń 1994, Jokimäki & Suhonen 1998, Jabłoński & Lee 1999, Clergeau et al. 2001, Nowicki 2001). In total, in all three study plots 72 single counts were done — 24 on each plot, where each observer performed 12 counts — 6 early counts (E) and 6 late counts (L). Like in the study of Biaduń (1996), count speed was standardised to 1.5 h/10 ha. During each count, all birds in the area were noted, except individuals passing over the study plot. Counts were not performed during intensive precipitation and strong wind.

Two groups of birds were distinguished based on discrepancies in their behaviour and different difficulties in estimating their numbers in field. The first group called "flocking species" included: tits *Parus* sp., Nuthatch *Sitta europaea*, Goldcrest *Regulus regulus* and treecreepers *Certhia* sp. Both species of treecreepers, due to difficulties with their visual identification, were treated in further analyses together as *Certhia* sp., similarly as in many other papers (e.g. Głowaciński & Weiner 1975, Hinsley et al. 1998). Problems in estimating numbers in this group were caused by the small size of the birds, which made them difficult to detect individuals foraging in tree canopy, forming mobile flocks. The second group called "corvids" included large, ground feeding species: Jackdaw *Corvus monedula*, Rook *Corvus frugilegus* and Hooded Crow *Corvus corone cornix*. Difficulties in assessment of numbers of these species were caused mainly by their nomadic movements over large areas.

Differences between densities (number of individuals/10 ha), numbers of species and Shannon-Wiener diversity indices, obtained for each avifauna in each of 72 single counts, were tested by a three-way ANOVA, where independent variables were the period of count (E or L), the observer (B or Z) and the plot (BYD, SOL and TOR). Analogously, differences between densities for distinguished ecological groups — "flocking species" and "corvids" were tested. Due to the low total number of "corvids" in plot SOL they were not included in statistical analysis considering this ecological group.

Variability of plots was the reason of the occurrence of obvious and statistically significant differences in densities, numbers of species and species diversity of bird assemblages of these areas. These differences were not subject to detailed analyses. Statistical inference was done at the significance level $p \leq 0.05$.

RESULTS

Number of species, densities and species diversity of the whole avifauna

In quantitative studies of winter avifauna on plots SOL, TOR and BYD, the occurrence of respectively 22, 32 and 34 bird species was recorded. During single counts only a part of the total number of species observed during 24 counts was recorded in each plot — from 13 to 24 species (38.2–70.6%) in plot BYD, 4–14 species (18.2–63.6%) in plot SOL and 13–19 species (40.6–59.3%) in plot TOR. New species were recorded in each plot almost until the end of the study (Fig. 1).

Numbers of species recorded by each observer (B and Z) differed statistically significantly, while there were no statistically significant differences between the number of species recorded in early E and late L counts (Table 1, Fig. 2). Statistically significant interaction was revealed between the period of a day (E and L counts) and observers (B and Z) which influenced the number of species within the whole avifauna (Table 1, Fig. 2).

Densities of avifauna recorded during a single count differed and were: 51.7–206.2 indiv./10 ha — plot BYD, 5.5–77.3 indiv./10 ha — SOL, 120.0–281.0 indiv./10 ha — TOR. Densities of birds obtained by each observer (B and Z) differed statistically significantly (Table 1, Fig. 3). There were no statistically significant differences between densities found in early E and late L counts (Table 1, Fig. 3).

The values of Shannon-Wiener species diversity indices for the whole avifauna in each count were within the range: 2.47–3.81 — in the plot BYD, 1.79–3.38 — SOL, 2.56–3.33 TOR. Statistically

Table 1. Differences between densities (number of individuals /10 ha), number of species and Shannon-Wiener species diversity indices (H') for the whole avifauna, and differences between densities of "flocking birds" and "corvids" obtained in all single counts, tested by three-way ANOVA for independent variables: two periods of counts — PERIOD, two observers — OBSER and three study plots — PLOT.

Variables	All avifauna									"flocking species"			"corvids"		
	Number of species			Density			H'			Density					
	F	df	p	F	df	p	F	df	p	F	df	p	F	df	p
PERIOD	1.19	1	0.3	2.62	1	0.1	5.64	1	0.02	1.20	1	0.3	2.16	1	0.1
OBSER	4.97	1	0.03	7.68	1	0.007	2.76	1	0.1	5.16	1	0.03	0.60	1	0.4
PLOT	80.04	2	> 0.0001	69.79	2	> 0.0001	14.93	2	> 0.0001	34.30	2	> 0.0001	56.97	2	> 0.0001
Interactions															
PERIOD/OBSER	7.56	1	0.008	0.02	1	0.9	3.09	1	0.08	0.02	1	0.9	0.06	1	0.8
PERIOD/PLOT	0.17	2	0.8	1.13	2	0.3	2.06	2	0.1	2.10	2	0.1	2.64	2	0.08
OBSER/PLOT	0.42	2	0.7	1.84	2	0.2	0.07	2	0.9	2.31	2	0.1	0.19	2	0.8
PERIOD/OBSER/PLOT	0.92	2	0.4	0.30	2	0.7	2.05	2	0.1	0.76	2	0.5	0.22	2	0.8

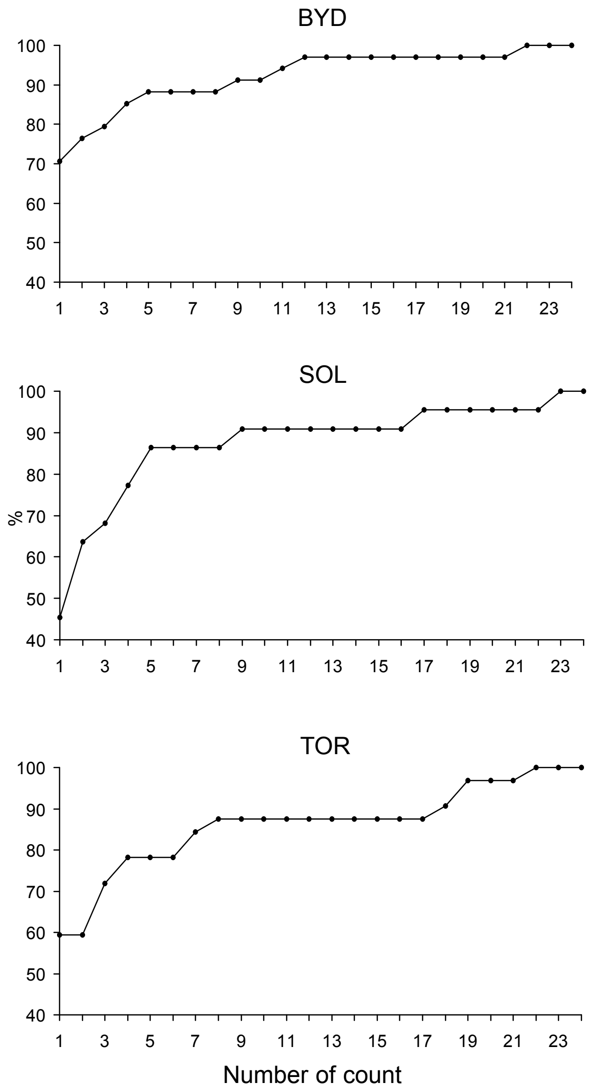

Fig. 1. Increase in the number of species in three study plots (%) resulting from including consecutive counts, arranged chronologically.

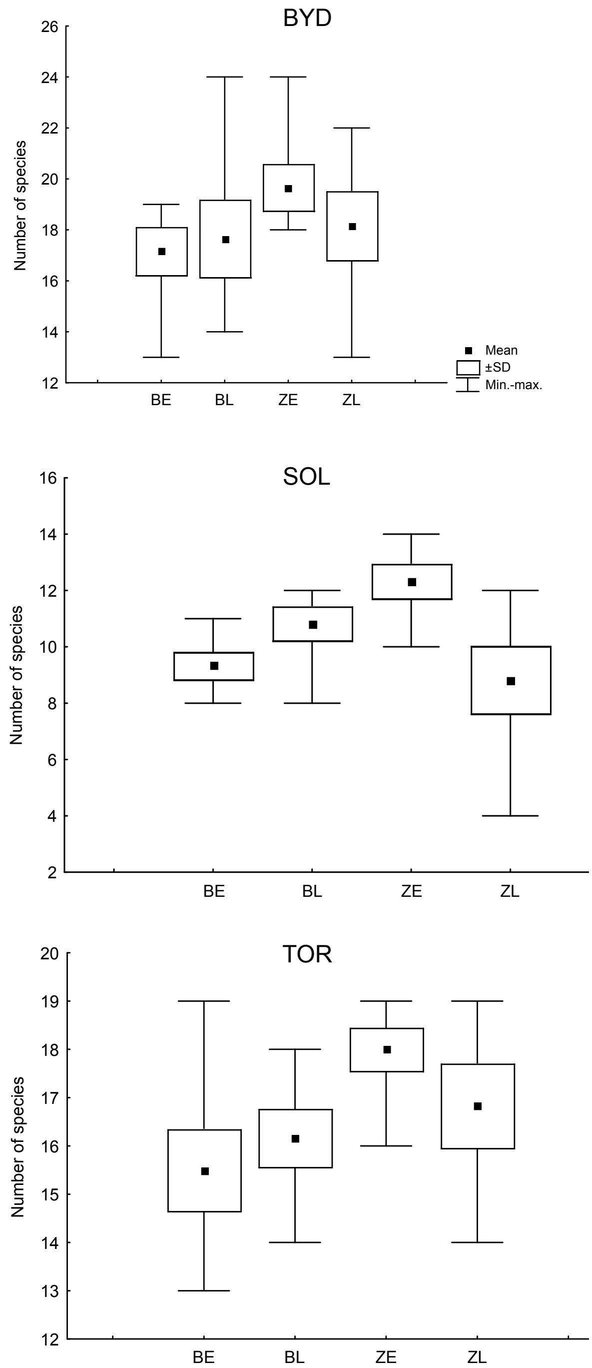

Fig. 2. The number of all bird species recorded by observer B in early (BE) and late (BL) counts and observer Z in early (ZE) and late (ZL) counts in three plots.

significant differences between the obtained indices of species diversity were recorded only between early E and late L counts, while no statistically significant differences were found between values of these indices obtained by the two observers (Table 1, Fig. 4).

Densities of "flocking species" and "corvids"

Densities of birds from the group of "flocking species" obtained during all counts of each single plot ranged from: 18.6–64.1 indiv./10 ha — BYD, 0.0–67.3 indiv./10 ha — SOL, 45.0–146.0 indiv./10 ha — TOR. Analogous ranges of densities for "corvids" were: 2.8–128.3 indiv./10 ha — BYD, 28.0–111.0 indiv./10 ha — TOR. Statistically significant differences in densities of "flocking species" were recorded between single counts conducted by the two observers (Table 1). Analogous differences were not found in this group of birds between counts performed at different times of

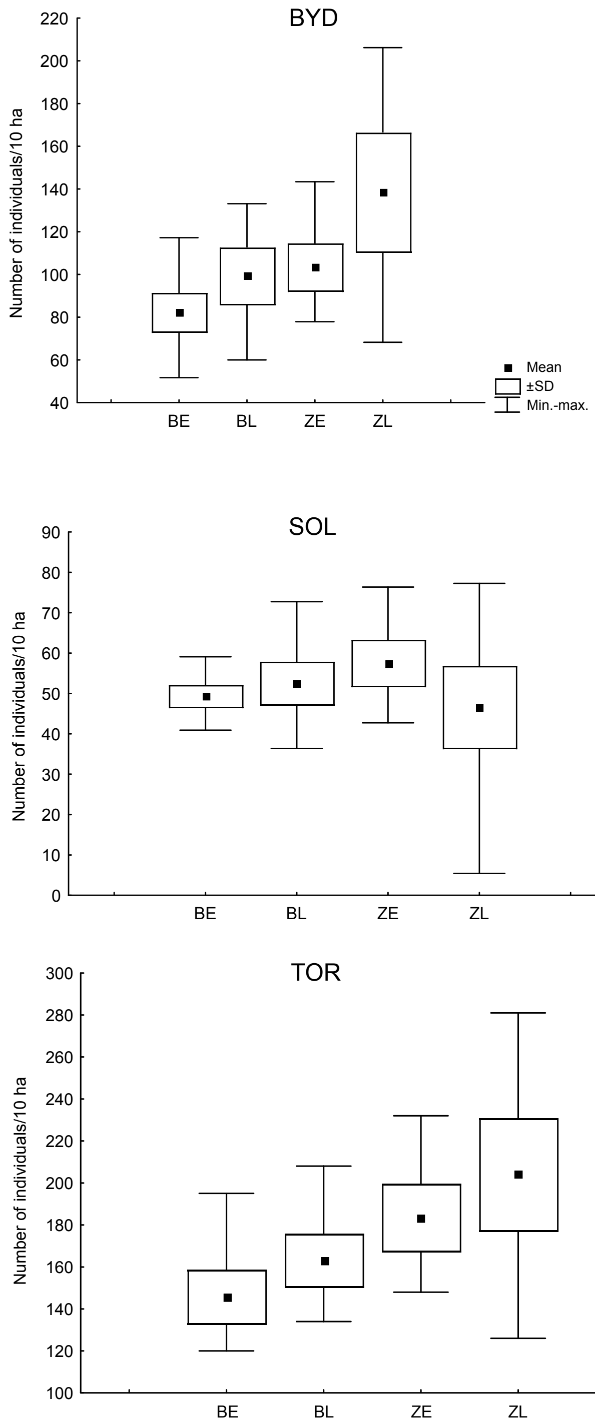

Fig. 3. Densities of birds (number of individuals/10 ha) recorded by observer B in early (BE) and late (BL) counts and observer Z in early (ZE) and late (ZL) counts in three study plots.

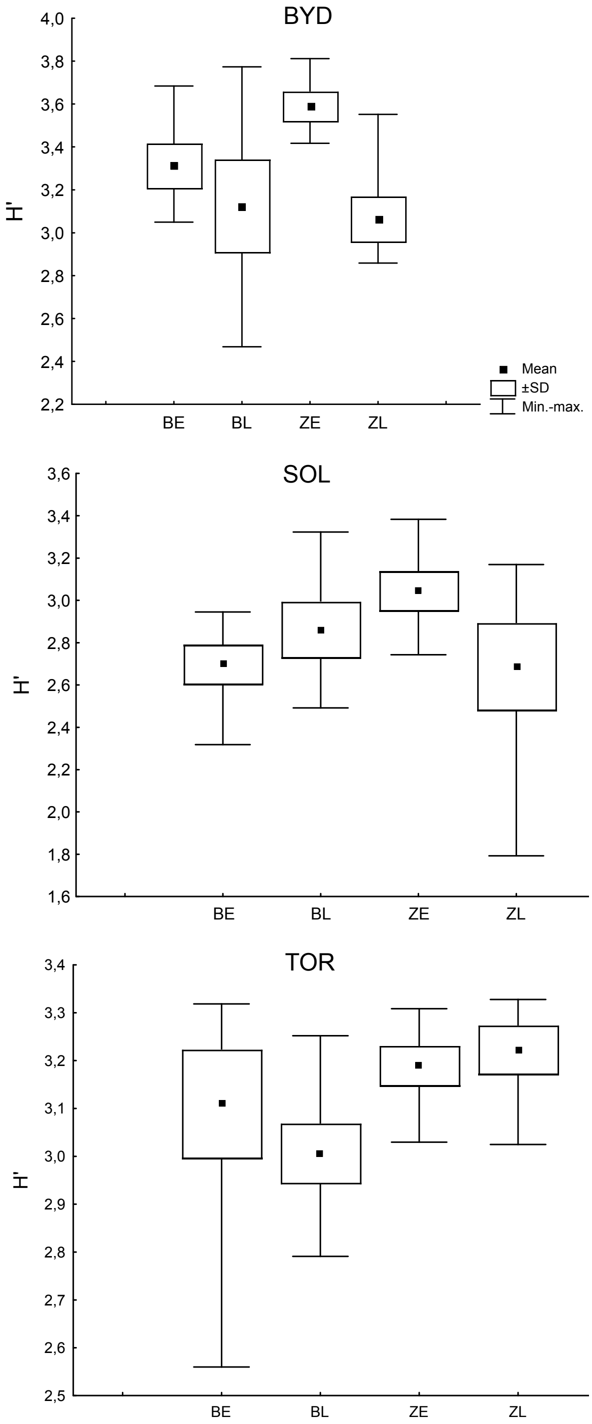

Fig. 4. Species diversity of avifauna (Shannon-Wiener index — H') recorded by observer B in early (BE) and late (BL) counts and observer Z in early (ZE) and late (ZL) counts in three plots.

the day (Table 1). There were no statistically significant differences between densities of "corvids" obtained by the two observers (Table 1). Relatively high differences in densities of "corvids" were found between different periods of a day (Table 1).

DISCUSSION

The long period in which the study was conducted and the relatively high number of six counts done by one researcher during a definite time of a day, according to Biaduń (1994) should be sufficient to obtain a representative number of species and species composition of the avifauna. The quoted author stated that after six counts the number of detected species exceeded 90% of the total number of species recorded during nine counts. In the present study the number of species found during 6 out of 24 counts did not exceed 90% in any plot. The lower detectability resulted from the phenomenon of the accumulation of records of new species on the same plot as the number of counts increases (Biaduń 1994, Nowakowski & Dulisz 2001) and as the number of observed individuals increases (Engstrom & James 1981). Large scatter in the detectability level of the number of species, obtained during our studies in different study plots (e.g. after the second count from 59.4 to 76.5% of the total species diversity, Fig. 1) impeded application of detectability indices used in the study of Jabłoński & Lee (1999) to define species diversity of winter avifauna based on small number of counts.

One of the probable reasons for statistically significant differences in the number of species between counts performed by different observers was due to species that perform nomadic movements in single-species flocks (e.g. Waxwing *Bombycilla garrulus*, Siskin *Carduelis spinus*) and those which occupy territories much larger than the studied plots (Buzzard *Buteo buteo*, Sparrowhawk *Accipiter nisus*, Goshawk *A. gentilis*). These birds occur in small study areas only irregularly. The increase in probability of recording a higher number of species with larger size of the area studied (Engstrom & James 1981) shows that the problem of differences in species composition could be solved by enlargement of the size of the census plots. However, most of the town green areas are small. Moreover, such a change would require an increase in the speed of a count or in its prolongation. The first could overlook species of small body size, while the changing activity of birds during a day (Brewer 1978) could cause differences in detectability if the duration of a single count is too long. The statistically significant interaction between the observer and the period of a day showed that the differences in the number of species recorded by the two observers were additionally modified by the time when count was done.

Nomadic movements of birds in numerous flocks could also influence revealed differences between counts in the assessment of densities and values of the species diversity index of avifauna. Brewer (1978) suggests that numbers of nomadic "flocking species" can be strongly over- or underestimated as these birds are found in large flocks or not encountered at all during a count. In the present study, this referred to the Waxwing and the Siskin, for which the percentage in the whole avifauna for subsequent counts on the plot BYD fell in wide ranges, respectively: 0–37.1% and 0–39.3%.

Nomadic movements of birds in an area larger than studied plots considered also "corvids" species, in which large and nearly statistically significant differences occurred between the counts at different times of a day (E and L). Characteristic behaviour of these species, associated with long movements between night roosts and foraging places, means that sites of their concentration are relatively extensive and can change with time (e.q. Nankinov 1977, Sonerud et al. 2002). Moreover, in urban parks these birds, which feed mainly on the ground, often move in different directions according to human disturbance. Characteristic behaviour and strong human disturbance were probably the main reasons for the above mentioned considerable differences. Thus, the presented results indicated that estimation of numbers of "corvids" in small areas can be ambiguous, which was indirectly shown by Nankinov (1977) and Mazgajski et al. (1997).

Great difficulties in the assessment of the actual number of birds present during each single count were caused by "flocking species". On the studied plots they most often fed high in the tree canopy. Combined with their small body size, constant movements and faint vocal activity on the part of some individuals, this caused a high probability of particular birds or flocks being either not noted or counted repeatedly. In consequence, an arbitrary decision whether or not an individual was counted earlier, different to what was suggested by Jokimäki et al. (1996, 2002), was often impossible or frequently referred to the whole flock as well. The described difficulties in the estimation of the numbers of wintering birds, in particular in coniferous woodland, were emphasised also by Nilsson (1974), Tomiałojć (1974), Brewer (1978) and Donald et al. (1997). For example, winter flocks of Goldcrests studied by Hogstad (1999) sometimes did not indicate vocally their presence for 2–3 minutes. Constant movements, small size and low vocal activity on the part of some individuals were probably one of reasons for the statistically significant differences in estimates of densities of "flocking species" between observers (B and Z). In such conditions, varied perception by both investigators probably played a great role in recorded differences.

Obtaining comparable results for "flocking species", in addition to difficulties in defining their actual number during a count, was probably by also affected changes in the size of flocks during the whole study period. One reason for this phenomenon is that the attachment of individuals to a location is much weaker in winter than in the breeding season and their tolerance of the close presence of other representatives of the same species is also greater in the winter season (e.g. Brewer 1978, Matthysen 1990, 1999, Báldi & Csörgő 1991, 1994, Lahti 1998, Hogstad 1999, Brotons 2000). The size of flocks formed by these birds is unstable also due to their social structure, in which young individuals, that have the lowest status in the dominance hierarchy (e.g. Lahti 1998, Haftorn 1999), often change flocks according to the strategy of "floaters birds" (Ekman 1989, Báldi & Csörgő 1991, 1994, Brotons 2000). Another reason for the statistically significant difference between the numbers of birds of "flocking species" only for results obtained by the two observers (B and Z) and a lack of such differences considering periods of a day (E and L) could be, (independently of the above mentioned difference in perception of observers), greater changes in numbers may occur in longer than in shorter periods of time.

Numerical estimates of avifauna could also be modified by weather conditions changing during the study, affecting foraging decision of certain species (Grubb 1975, 1977, Brotons 1999), and in consequence also the possibility of their observation. In the case of "flocking species" decreasing temperature and the presence of snow cover lead to stronger aggregation of birds in flocks (Stapanian et al. 1999, Brotons 2000, Brotons et al. 2000, Nakamura & Shindo 2001). Considering the whole avifauna, dominated by Rooks and Jackdaws, Górska & Górski (1980) found higher densities of birds in urban parks during unfavourable weather conditions.

The obtained statistically significant differences in Shannon-Wiener species diversity indices calculated for assemblages of birds studies at different times of a day (E and L) indicated large dynamics of winter avifauna even during a count day. This result, connected with the earlier described reasons of differences between densities and number of bird species show that some studies based on a low number of counts (Luniak 1981, Jabłoński & Lee 1999, Nowicki 2001) and even on a single count (Svensson 1974, Jokimäki et al. 1996, Jokimäki & Suhonen 1998, Clergeau et al. 2001) may provide bird numbers with a low precision and make comparison difficult. In the investigations of Jokimäki et al. (1996) and Clergeau et al. (2001) use of a single count was compensated by the large area (ca 30 ha) covered by the study.

The results of the present study indicate that there are no means to assess unambiguously the number of species, bird density, and species diversity of avifauna wintering in small fragments of urban green areas. The differences in estimates of numbers, especially considering "corvids", put in doubts comparisons of the biomasses of the whole winter avifauna, such as done by many authors (e.g. Luniak 1981, Biaduń 1994, Jokimäki et al. 1996, 2002).

Prerequisites that enable comparisons of bird assemblages and assessment of the level of their similarity are large stability of species composition and bird numbers in corresponding periods. The results of the present study show that effects of comparisons of winter avifauna from small areas reflect only temporary stages of a dynamic pattern of bird numbers and species composition, on which there impose additionally differences in assessing their actual values. Elimination of all these unfavourable factors at the same time is impossible, and means to counteract them are relatively limited. Results of studies on winter assemblages of birds should thus be compared only if they were conducted in a similar period, when high number of counts was conducted with a defined and stable pace of count.

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STRESZCZENIE

[Czy wyniki badań nad składem gatunkowym i liczebnością awifauny zimowej na małych powierzchniach zieleni miejskiej są porównywalne]

Celem niniejszej pracy było określenie czy zmiany składu gatunkowego i liczebności ptaków, trudności w ich policzeniu oraz odmienna percepcja obserwatorów wpływają na uzyskiwanie istotnych różnic pomiędzy wynikami badań awifauny zimowej. Badania ilościowe awifauny przeprowadzono zimą 1999/2000 na trzech powierzchniach — BYD, SOL i TOR będących fragmentami miejskich terenów zielonych w centralnej Polsce. Wielkość powierzchni wynosiła od 10.0 do 14.5 ha. Liczenia ptaków wykonywane były niezależnie przez dwóch obserwatorów (B i Z) — autorów pracy o zbliżonym doświadczeniu terenowym. Każdy z obserwatorów wykonywał liczenia na danej powierzchni podczas sześciu dni rozłożonych równomiernie, w okresie od drugiej połowy grudnia do połowy lutego. W dniu badań obserwator wykonywał dwa liczenia — wczesne (L) rozpoczynane o godzinie 8^{00} i następujące

bezpośrednio po nim późne (E) kończące się przed godziną 12^{00}. Tempo liczeń wynosiło 1.5 godz./10 ha. Badaniami objęto całą awifaunę oraz dwie grupy ptaków wyodrębnione ze względu na różnice w behawiorze i odmienne trudności związane z ustaleniem liczebności w terenie. Wyróżnionymi grupami były — „gatunki stadne" ("flocking species"), do których zaliczono sikory *Parus* sp., kowalika *Sitta europaea*, mysikrólika *Regulus regulus* i pełzacze *Certhia* sp. oraz krukowate ("corvids") — kawka *Corvus monedula*, gawron *Corvus frugilegus* i wrona *Corvus corone cornix*.

W pojedynczych liczeniach stwierdzono tylko część gatunków zaobserwowanych ogółem podczas wszystkich liczeń na każdej z powierzchni: 38.2–70.6% (BYD), 18.2–63.6% (SOL) oraz 40.6–59.3% (TOR). Na poszczególnych powierzchniach nowe gatunki stwierdzane były prawie do końca badań (Fig. 1).

Liczby gatunków całej awifauny różniły się istotnie statystycznie pomiędzy obserwatorami (Tab. 1, Fig. 2), nie stwierdzono ich natomiast pomiędzy liczeniami wczesnymi — E i późnymi — L (Tab. 1, Fig. 2). Stwierdzono istotną statystycznie interakcję pomiędzy porą dnia (liczenia E i L) i obserwatorami (B i Z) a liczbą gatunków awifauny (Tab. 1). Zagęszczenia awifauny otrzymane przez obu obserwatorów (B i Z) różniły się istotnie statystycznie (Tab. 1, Fig. 3), nie różniły się natomiast pomiędzy liczeniami wczesnymi — E i późnymi — L (Tab. 1, Fig. 3). Istotne statystycznie różnice pomiędzy otrzymanymi wskaźnikami różnorodności gatunkowej Shannona-Wienera stwierdzono jedynie pomiędzy liczeniami wczesnymi i późnymi, nie odnotowano ich natomiast pomiędzy wartościami wskaźników uzyskanymi przez różnych obserwatorów (Tab. 1, Fig. 4).

Istotne statystycznie różnice w zagęszczeniach „gatunków stadnych" stwierdzono pomiędzy liczeniami wykonanymi przez różnych obserwatorów, nie stwierdzono ich natomiast pomiędzy liczeniami wykonanymi w różnych porach dnia (Tab. 1). Istotnych statystycznie różnic nie stwierdzono pomiędzy zagęszczeniami krukowatych uzyskanymi przez różnych obserwatorów (Tab. 1). Stosunkowo duże różnice pomiędzy zagęszczeniami krukowatych stwierdzono w różnych porach dnia (Tab. 1).

Wyniki niniejszych badań wskazują, na brak możliwości jednoznacznej oceny liczby gatunków, zagęszczenia ptaków, a także różnorodności gatunkowej awifauny zimującej na niewielkich powierzchniach miejskich terenów zielonych. Rezultaty porównywania awifauny zimowej z niewielkich obszarów będą odzwierciedlały tylko chwilowe stany bardzo dynamicznego układu liczebności i składu gatunkowego ptaków, na które nakładają się dodatkowo trudności w ocenie ich rzeczywistych wartości. Wyniki badań zespołów zimowych ptaków powinny być porównywane tylko wtedy, gdy wykonywane były w zbliżonym okresie, w którym przeprowadzono dużą liczbę kontroli w określonym i stałym tempie przemarszu.