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The use of nest-boxes for the management of breeding avifauna in urban parks – studies in Warsaw and Poznań (Poland)

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The paper summarises the results of a joint programme of research on the use of nest-boxes in specific conditions of urban parks. Basic results are presented in 4 other works in this issue of *Acta Ornithologica* (vol. 27, No 1).

In Warsaw 3822 nest-boxes × years were investigated in 21 areas, during 1–7 years, and in Poznań – 2635 boxes × years, mainly in 2 parks during 12 years. Eight types of boxes were tested.

Breeding of 14 species (13 in each of cities) have been recorded in boxes. Small and medium-sized boxes were occupied in 48% (Warsaw) and 73% (Poznań). Other kind of boxes – meant for particular species were occupied in low percentage. Breeding results of the 5 most frequent species were not worse than those from non-urban areas. The use of boxes in new parks with young trees introduced 2–5 new species and increased breeding population by up to 100%. In old parks it increased mainly the number – by up to 60 pairs/10 ha. The use of boxes in urban parks, in comparison to that in forestry, requires a greater variety of box types and more skill in their application.

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INTRODUCTION

The paper is based on the results of a joint programme of research on use of nest-boxes in specific conditions of urban parks. The results of the individual works within that programme, carried out by A. Haman, P. Kozłowski, T. Mizera, W. Nowicki and M. Luniak are found in 4 papers in this issue of *Acta Ornithologica* (vol. 27, no. 1).

As a method of conserving and managing bird life, nest boxes have been widely used in Poland for over 60 years (Sokołowski 1928). They have much used in fore-

stry, and their usefulness and application in woods have been well studied (e.g. Borczyński & Sokołowski 1953, Dobrowolski *et al.* 1975, Mizera 1990, numerous papers of R. Graczyk and his fellow-workers). Large numbers of boxes have also been put up in gardens and urban parks, but their real value in the management of the bird communities there can be gleaned only from fragmentary data (e.g. Graczyk 1964). Little information on this is to be found in foreign papers, despite the fact that the nest boxes have been applied in many towns and cities. In Moscow, for instance, several thousand have been put up annu-

ally in the city's green areas since 1956, e.g. ca 10 thousand in 1958 (Rakhmanov 1975).

Experiences with nest-boxes in forestry are only partially applicable to urban parks because the different composition of the hole nesters guild living in cities and the environmental conditions there are substantially different from those in forests.

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THE STUDY

The results upon which this paper is based come from studies done in Warsaw (central Poland) and in Poznań, 300 km to the west. The detailed results of these research works are published in separate papers describing the use of nest-boxes by breeding birds in parks of Warsaw (Kozłowski 1992) and Poznań (Mizera & Kozłowski 1992), the results of broods in boxes studied in both cities (Luniak *et al.* 1992), and the effect of putting up nest boxes on the bird communities in Warsaw parks (Nowicki 1992). Table 1 gives an idea of the range of these studies.

In Warsaw, boxes were sampled in many (Tab. 1) and diverse areas during 1–7 years, but the changes in number and types of boxes made the results from parti-

Table 1. Data on studies carried out in Warsaw and Poznań.

Tabela 1. Dane o badaniach wykonanych w Warszawie i Poznaniu.

	Warsaw 1983-1990	Poznań 1979-1991
Main areas of study: number (area in ha) Główne tereny badań: liczba (powierzchnia w ha)	21 (ca 300)	2 (ca 14)
– new parks nowo założone parki	2 (35)	
– small squares małe skwery	4 (11)	
– old parks from 10 ha stare parki od 10 ha	5 (ca 175)	1 (10)
– forest parks parki leśne	2 (ca 75)	
Number of nest-boxes × years Liczba skrzynek × lat		
– inspected kontrolowanych	3822	2635
– occupied (broods) zajętych (legi)	1648	1531
Breeding results – number of broods investigated Liczba lęgów w których badano wynik lęgu	626	1302

cular years not comparable. In Poznań the main study was done in 2 parks only, where nest-boxes were inspected during a 12-year period. Elsewhere in that city, short period observations of only a small number of boxes were made.

SPECIES COMPOSITION

The studies in Warsaw and Poznań (Kozłowski 1992, Mizera & Kozłowski 1992) showed that a total of 14 bird species bred in nest-boxes, 13 in each city (Tab. 2). Of these 14 species, one – Willow Tit *Parus montanus* – was found exclusively in forest parks on the outskirts, whereas 3 others – Pied Flycatcher *Ficedula hypoleuca*, Robin *Erithacus rubecula* and Redstart *Phoenicurus phoenicurus* – adopted nest-boxes there

more frequently than in city parks. For the remaining 10 species, these parks were the typical environment in which they nested in boxes.

The species list of box-nesters in the two cities is very similar. The difference lay in two occasional components (Tab. 2). High degree of dominance of 2 or 3 species (Tab. 2) was typical in both cities. Only in two forest parks in Warsaw the frequency proportions of box-nesters were more evenly balanced. The differences in species nesting in boxes, between the two cities, were mainly due to the different sets of box types used (see „Types of nest-boxes”) and to the greater diversity of biotopes studied in Warsaw (Tab. 1).

The number of species inhabiting boxes in particular parks was mainly dependent

Table 2. Bird species breeding in nest-boxes investigated – % of the total number of broods recorded in each city; N – number of broods; () – sp. recorded in one city only.

Tabela 2. Gatunki gnieźdzące się w badanych skrzynkach lęgowych – % ogólnej liczby lęgów stwierdzonych w każdym z miast; N – liczba lęgów; () – gatunki stwierdzone tylko w jednym mieście.

Warszawa 100% N = 1638			Poznań 100% N = 1567		
<i>Passer domesticus</i>	34%	77%	<i>Sturnus vulgaris</i>	44%	75%
<i>Sturnus vulgaris</i>	24%		<i>Passer montanus</i>	31%	
<i>Passer montanus</i>	19%				
<i>Parus caeruleus</i>	12%	17%	<i>Parus major</i>	12%	19%
<i>Parus major</i>	5%		<i>Anas platyrhynchos</i>	7%	
<i>Ficedula hypoleuca</i>	2%		<i>Parus caeruleus</i>	2%	
<i>Phoenicurus phoenicurus</i>	1%		<i>Muscicapa striata</i>	2%	
<i>Anas platyrhynchos</i>	N=10		<i>Sitta europaea</i>	N=3	
<i>Erithacus rubecula</i>	8		<i>Phoenicurus phoenicurus</i>	2	
<i>Muscicapa striata</i>	4		<i>Erithacus rubecula</i>	1	
<i>Sitta europaea</i>	1		<i>Ficedula hypoleuca</i>	1	
<i>Strix aluco</i>	1		<i>Strix aluco</i>	1	
			<i>Passer domesticus</i>	1	
(<i>Parus montanus</i>)	3		(<i>Corvus monedula</i>)	1	

on the age of the tree stands and the extent of the ecological deterioration of the area. This was found in Warsaw, where a wide variety of areas were studied. The smallest number of species (2–3) took over nest-boxes in small squares and in newly established parks with young, poor tree stands. More (4–6) species were found in medium-sized parks with 30–40-year-old tree stand, and 5–6 – in forest parks of the same age. There were 6–8 species in large old parks.

Besides birds, nest boxes were often inhabited by insects of the *Vespidae* family and, several times, by squirrels. The occasional bat and also mouse were also found.

EXTENT OF NEST-BOX OCCUPATION

Fewer nest boxes were occupied in Warsaw than in Poznań (Tab. 3). This could be due to the differences in the areas studied and the composition of their bird communities, the types of nest boxes put up, and

that boxes in Poznań were inspected more frequently. The only data available so far on the percentage occupation of nest boxes in urban green areas in Poland are from Jasło (M. Stój, *in litt.*), where the percentage of small and medium-sized boxes inhabited (57% of 242 boxes × years inspected) lay between those of Warsaw (48%) and Poznań (73%). The figure for Moscow was 67% (Rakhmanov 1975). In Polish forests 40–70% of nest boxes occupation was recorded (e.g. Borczyński & Sokołowski 1953, Cielecka & Jedraszko 1976, papers by R. Graczyk and fellow-workers). The present results from urban parks are therefore at satisfactory level.

In particular areas the percentages of boxes occupied (with the exception of special types of boxes for ducks and owls) varied widely: from 16% to 75% in Warsaw (21 areas) and in Poznań (2 areas) – 49% and 82%. These differences are mainly a measure of the numbers of common spe-

Table 3. Nest-boxes types used in study and percentage of their occupation.

Tabela 3. Typy skrzynek legowych użytych w badaniach i procent ich zasiedlenia.

	Warsaw	Poznań
Number of boxes × years inspected and % of occupied Liczba kontrolowanych skrzynek × lat oraz % zajętych	3822 (44%)	2635 (58%)
– small and medium size e.g. for Tits and Starling (types A and B) – małe i średnie np. dla sikor i szpaka (typy A i B)	3444 (47%)	1801 (73%)
– small open e.g. for Spotted Flycatcher (P) – półotwarte np. dla mucholówki szarej (P)	56 (7%)	302 (9%)
– medium/large for Jackdaw (D) – większe dla kawki (D)	258 (8%)	103 (72%)
– large on trees – for owls and ducks (E and K) – duże na drzewach – dla sów i kaczek (E i K)	64 (6%)	213 (8%)
– „dog houses” on the ground – for ducks (type „Anas”) – „psie budy” na ziemi dla kaczek (typ „Anas”)		160 (58%)
– flat boxes for Treecreepers – płaskie skrzynki dla pelzaczy		36 (0%)

cies inhabiting them, i.e. both Sparrows and Starling. Data from the 21 various areas in Warsaw show that such a broad range in the percentage of boxes inhabited was not directly connected with the size of the area, the age of the tree stands, the intensity of human penetration or the area's location in the city centre or outskirts. Both high (over 55%) and low (below 35%) percentages were recorded in areas representing various combinations of these features. The extent and dominance structure of nest-box occupation was similar only in the 2 forest parks studied.

The two areas of Poznań studied for 12 years (Mizera & Kozłowski 1992) supplied long-term data on the extent of occupation of small and medium-sized boxes (types A, B, D) under comparable environmental conditions. In one of them (the Sołacki Park) the number of boxes was kept fairly constant (8–10 per ha, $n = 78–105$), of which 66–96% (mean 88%) were inhabited in particular years. In the other (Ogród Dendrologiczny). 63–83% (mean 70%) of boxes (8–11 per ha, $n = 37–43$) were inhabited during the first 5 years. However, after doubling the number of boxes (20 per ha, $n = 78–82$), the percentage inhabited during the next 7 years fell to 26–64% (mean 40%). This change was due both of the excessive number of boxes and to the periodic fall in the numbers of Starlings. In both areas the percentage of boxes inhabited was already approaching the maximum in the second year following their putting up. In neither area during 12 years was there any discernible trend in the percentage. Other long-term (8–12 years) studies in forests and country parks (e.g. Brendt 1949, Michocki 1974, Pfeifer & Keil 1961) did not reveal any regular trends in the numbers of boxes occupied. In urban parks, where the proportion of boxes inhabited depends mainly on changes in the

numbers of 2 or 3 very common species, the amplitude of occupation changes may be greater than in non-urban areas. The above example from the Ogród Dendrologiczny in Poznań is evidence of this. In all cases known a high degree of occupation was recorded already in the second year after the boxes have been put up. That shows the possibility for forthcoming effect of management measures by use of nest-boxes.

TYPES OF NEST-BOXES AND THEIR USE BY BIRDS

Descriptions of 8 basic types of nest-box used in this study (Tab. 3) were given by Kozłowski (1992) and Mizera & Kozłowski (1992). The small and medium-sized boxes used in Poznań were made of sawdust-concrete, all others in both cities – were made of wood. Most of the boxes were small and medium-sized ones (Tab. 3), and these enjoyed the highest percentage occupation. These traditional types, commonly used in forestry, is thus also useful in urban parks. In both Warsaw and Poznań 10 bird species including all of the most common hole-nesters, nested in these boxes.

Despite the fact that these types of box were found to be so generally usefull, Kozłowski's (1992) study in Warsaw indicated two possibilities of modifying their construction for particular species. This is of immense importance for avifauna management:

- 1) Using the smaller entrance hole (28 mm) prevents birds of the size of Tree Sparrow from using them, and enables species like Pied Flycatcher, Blue Tit and other small tits, which usually come out second best in competition with larger species for nest sites, to nest in them. In Warsaw at least 62% ($n = 199$) of Blue Tit broods were found in such boxes (type A1). Blue

Tits thus inhabited far more boxes in Warsaw than in Poznań (Tab. 2) where no such modification had been carried out.

2) Deepening medium-sized boxes by 5 cm (measured from the lower edge of the entrance hole) from 20 cm (type B) to 25 cm (Bm) made them much more attractive to Starlings, and excluded Sparrows from them. In Warsaw only 15% of Starling broods, but 32% House Sparrow broods were found in traditional (type B) boxes ($n = 914$). By contrast, the proportions in modified (Bm) boxes ($n = 416$) were 83% and 1% respectively. These results are in agreement with those of Moed and Dawson (1979), who showed that although Starlings will nest in boxes only 20 cm deep, they prefer boxes much deeper (up to 55 cm).

Both the above modifications, allowing control of the competitive dominance of very common species, could be particularly useful in urban parks.

Unlike the universal small and medium-sized boxes tested in Warsaw and Poznań, the other types of box, intended for narrow groups of species, were largely occupied in low degree (Tab. 3). The reasons for this included the low numbers of the species concerned and little experience in using such boxes in Poland. Studies in Warsaw and Poznań brought experiences concerning 5 kinds of boxes:

1) Special boxes for Treecreepers *Certhia* sp., lying flat against the tree trunk, were tried out in 4 areas in Poznań where Short-toed Treecreeper *Certhia brachydactyla* occurs. Only one attempt of nesting in them was made by this species, whereas in the forest near Poznań about half the number of such boxes were used by Treecreepers *Certhia* sp.

2) Small open boxes (type P) put out for Spotted Flycatchers *Muscicapa striata* and Black Redstarts *Phoenicurus ochruros* were

hardly used at all in both cities (Tab. 3), and then only by Spotted Flycatchers. In the Solacki Park in Poznań it was discovered, however, that this species preferred these open boxes to the natural nest holes which it had occupied previously. The Black Redstarts inhabiting residential districts did not make use of such boxes – the existing buildings probably offered better breeding sites.

3) Medium-large size boxes (type D), intended mainly for Jackdaws *Corvus monedula* were not inhabited by them, even though they had been put up at the considerable height and there were Jackdaws in the area. In fact Starlings took these boxes over (Tab. 3). In Poland Jackdaws have been recorded nesting in such boxes (Mizera & Kozłowski 1992), and in towns as well. Jackdaws would probably prefer not so shallow (22 cm from the entrance hole) boxes and the nest sites in nearby buildings could be more suitable for them. Mizera (1990) reported successful use (73% of 98 boxes) of this box type by Goldeneye.

4) Large boxes (type E and type K – chimney box) placed high up in the trees for Tawny Owls *Strix aluco* and lower (tilted) near water for Mallards *Anas platyrhynchos* were not used much by these birds. Trials in Poznań showed that filling such boxes with straw and placing them low down in horizontal position made them more attractive to Mallards. Tawny Owls have nested in such boxes in several places in Poland, in towns as well (Mizera & Kozłowski 1992). The reasons for their failure in Warsaw and Poznań could have been their poor concealment, their placement in already occupied territories or simply in not attractive sites. In Poznań, one of these boxes was adopted by Tawny Owl pair after the branch containing their nest hole had been blown down.

5) Doghouse boxes were placed on the ground on inaccessible islands in ponds. These boxes were filled with straw and Mallards took them in large numbers (Tab. 3) and achieved a high breeding success in them (see „Breeding succes”). So this kind of box turned out to be the most usefull for Mallards, however its placement on the ground requires precautions to be taken to safety of broods. Engel *et al.* (1988) reports that dutch baskets had been put up low down on trees in the park in Warsaw and 61% (n = 26) were adopted by Mallards.

THE CONDITION, PLACEMENT AND DISTRIBUTION OF NEST-BOX

Numerous studies (e.g. Karlsson & Nilsson 1977, Moed & Dawson 1979, Van Balen 1984, Gustafsson & Nilsson 1985) have shown that enlarging boxes (within limits) has had a positive effect on the breeding results. Merely deepening the boxes makes more attractive to Starlings and probably also to tits and Jackdaws. On the other side it also has the effect of eliminating both species of Sparrow.

The depth of boxes depends on whether old nests remain in them. The study in Warsaw showed that boxes with old nests were quite attractive to House and Tree Sparrows, but were avoided by Blue Tits and probably by Great Tits *Parus major* too. Starlings were indifferent to the presence of old nests in boxes.

In Warsaw it was also found that damaged boxes, e.g. with craks or loose roofs, were avoided. House Sparrows were least sensitive in this respect.

The sawdust-concrete boxes used in Poznań were at least as good as the traditional wooden ones used in Warsaw. They were resistant to damages by woodpeckers, the breeding success in them was

good (Luniak *et al.* 1992), and they were occupied in high degree (Tab. 3). The microclimate inside them was found to be no different from that in wooden boxes (Olszewski 1971).

In urban green areas, where birds may nest in artificial objects, the experiments of Graczyk (1974) and Blagosklonov (1991) are of importance: they showed that the colour of a nest-box played no part in whether it was adopted or not.

The study in Warsaw (Kozłowski 1992) did not reveal any preference for nest-box entrance holes facing in a particular direction. This finding is in agreement with the result of a similar study by Michocki (1974) and of another one (Wesołowski 1989) of the occupation of natural nest-holes. It was also found in Warsaw that boxes tilting forwards were preferred to those tilting backwards. A forward-tilting box could provide better shading of the interior or better concealment (in shadow) of the opening.

In one of areas studied in Poznań (Ogród Dendrologiczny) the height at which a small boxes were hung was varied (Mizera & Kozłowski 1992). It was found that a height of 1–2 m (as opposed to 3–4 m) stopped Tree Sparrow from occupying the boxes, when to Great Tits the box height was immaterial. An analysis of the positions of House Sparrow nests in urban environment (Indykiewicz 1990) showed that this species does not normally build its nests below a height of 3 m. The same dependence was found by Michocki (1967) for Starling. In industrial orchards rarely visited by man, the Sparrow commonly nest in boxes at the height below 2 m (Mizera & Kozłowski 1992).

In Warsaw (Kozłowski 1992) House Sparrow preferred boxes in areas with little tree cover, whereas Tree Sparrow avoided such spots. Neither did Tree Sparrow

use boxes hidden among the branches in tree crowns, unlike Blue Tits, which used such boxes most often.

Cieślak (1990) analysed radiesthetic conditions of 127 nest box sites (82 occupied by Starlings, Blue Tits, Great Tits, House Sparrows and Spotted Flycatchers) in 3 Warsaw parks and found their occupation to be unrelated to underground veins or the geobiological grid.

The distribution density of the traditional small and medium-sized boxes of about 10 per ha in the 2 Poznań parks (1979-1983), both with propitious natural conditions and a rich bird life, was probably close to the ecological and practical optimum (88% and 70% of occupation). Then (1985-1991) in one of the parks (Ogród Dendrologiczny) the density of boxes was increased to 20 per ha. The result of this was a considerable fall in the extent of occupation (from average of 70% to 40%). One of the reasons for this was the excessive number of boxes. In Warsaw the considerable and irregular differentiation in the extent of occupation of boxes in particular areas (see „The extent of occupation”) does not point to an exact optimum of the density of boxes. In large wooded areas about 5 small and medium-sized boxes per ha seems to provide adequate nesting possibilities for birds. In smaller wooded areas of only a few ha, especially if they are adjacent to green areas without natural or artificial nest-holes, a density of 5–10 boxes per ha seems more appropriate. In areas with scarce or very young tree stand the density of nest-boxes could be lower.

BREEDING RESULTS IN NEST BOXES

Here, the question tackled was whether, in the peculiar conditions of city parks, nest boxes provide birds with a safe place for breeding, or whether, by exposing them to

excessive losses, these boxes are ecological traps destroying bird populations.

The answer are provided by studies (Luniak *et al.* 1992) of the 5 species most frequently occupying boxes in Warsaw and Poznań: Tree Sparrow (739 broods), Starling (672), House Sparrow (280 broods in Warsaw), Great Tit (178 broods in Poznań) and Blue Tit (58). Their breeding results (chiefly their productivity – fledged pull./nest/year) in parks were compared with those given in papers dealing with these species in forest and rural areas in regions of both cities. The comparability of this material is reduced by differences in methodology of studies or insufficient information about it. Apart from this, most broods of both Sparrow species in Warsaw and of Great Tit in Poznań were studied in a way increasing the risk of the birds' abandoning the nest.

Even so, there is no doubt that in none of these 5 species were their clutch sizes and brood productivities distinctly worse in the parks studied than in the nearby non-urban areas. In both Sparrows these results were compared with those from a wider European or Palearctic range and were found to be within the averages indicated for these species.

Also available are data on the breeding results of Mallards on open ponds in the ZOO park in Poznań (Mizera & Kozłowski 1992) in doghouse boxes (see „Types of nest-boxes”) and in dutch baskets placed on trees in the Łazienki Park in Warsaw (Engel *et al.* 1988). In Poznań hatching was successful in all 31 nests in doghouse boxes placed on islands, and a bulk majority of chicks were raised, which is a very good result. In Warsaw, the mean clutch size in 81 broods in baskets and tree holes was 8.9 and the hatching success – 81% (8.3 chicks per nest). But chick survival was there poor at 20–30% (1.6–2.1 reared juv. per brood).

In both cases, then the actual breeding site (nest box, basket or hole) fulfilled its part by ensuring a high hatching success. However the overall breeding successes in these two cases were diametrically different, depending on the situation outside the nest. This indicates that when installing artificial breeding sites in urban parks for Mallards and other nidifugous birds, not only must the nest itself be a safe place, but conditions must be provided for the successful rearing of the hatched chicks.

The reasons for losses of broods in nest-boxes studied are not really known. In Warsaw Engel *et al.* (1988) found that direct interference by people was responsible for destruction of about 20% of Mallard nests and probably caused a number of others to be abandoned. The high losses among chicks were put down by the authors cited to rats and to ducklings becoming detached from their mothers. This happened especially where the broods density of Mallards on park ponds was too high. The paucity of the natural food supply could also have been important. As regards the other 5 species studied in Warsaw and Poznań, direct human interference, the presence of people near the boxes, also predation and interspecific competition, did not have any apparent effect on breeding results. In Poznań, where the study was carried for 12 years, no increase in losses was noted as the result of local predators gradually turning to penetrate boxes, despite the presence of numerous Jackdaws, Magpies *Pica pica*, woodpeckers, domestic cats and mustelids. The sawdust-concrete boxes were difficult for predator to enter. In non-urban areas predation is reported (e.g. Ciolecka & Jędraszko 1976, Gromadzki 1980, Soerensen *et al.* 1990) as one of the main causes of nest losses in boxes.

Probably a whole complex of habitat and intrapopulation factors affected breeding results in boxes to a greater extent: a limited food supply, infections, brood disturbance in the high nesting densities of urban populations. Examples illustrating that concern Starling in Warsaw (Luniak 1977) and Great Tits in Frankfurt (Berressem *et al.* 1983). An example of this is the way Mallard ducklings get lost in Warsaw parks as a result of too close presence of many family groups on the pond.

The collected data none the less shows, that nest-boxes in urban parks do generally assure birds a successful breeding. They are less exposed to predation than in non-urban areas, and the close presence of people do not cause any serious losses. Significant factor which should, however, be taken into consideration when putting up boxes in parks are the environmental and intrapopulation factors mentioned earlier.

THE EFFECT ON BIRD COMMUNITIES

This question has been studied many times in forests in Poland (e.g. Borczyński & Sokołowski 1953, Dobrowolski *et al.* 1975, Graczyk 1966, Graczyk *et al.* 1966a, 1966b, Graczyk & Rauchut 1967, Oko 1974), and in Germany (e.g. Dornbusch 1972, Pfeifer & Keil 1961, Pfeifer & Ruppert 1953) and also in rural areas (e.g. Graczyk & Michocki 1967, Graczyk & Mroczkiewicz 1967, Michocki 1967, Sikora 1974). All these papers show that the introduction of nest-boxes into an habitat with poor bird life, e.g. young tree stands, high culture orchards, encourages considerable increase in the numbers of birds. Nest-boxes also attract some new species, some of them in large numbers. Where there had already been a rich bird life, nest boxes usually raised the

numbers, sometimes considerably, but the species composition did not change much.

Studies in Warsaw (Nowicki 1992) and in Poznań (Bereszyński & Mizera 1987, Mizera 1988, Mizera & Kozłowski 1992) show that putting up nest-boxes in urban green areas has had much the same effect. In Warsaw, boxes had the effect of attracting 1–5 species to areas where they had previously never nested. One example in that city is the breeding of Blue Tits in 6 parks and of Pied Flycatchers in 6, among other places in the central part of the city, where the latter had not nested before. In Warsaw in majority cases increased the total density of breeding birds population – by up to 40 pairs per 10 ha. In particular parks, this increase made up to 30% of the total number of birds breeding there. In newly-established parks with trees up to ca 30 years old, 80–100% of the hole-nesters breeding there did so in the nest-boxes provided. For these birds the boxes were the only possibility to nest there. In old parks in Warsaw, where natural holes were plentiful, 20–50% of hole-nesters used boxes, these were in majority Starlings and the two species of Sparrow. Putting up boxes in a similar park in Jasło increased the density of Tree Sparrow by over 20 pairs per 10 ha (M. Stój, *in litt.*). In both old parks in Poznań, the provision of boxes did not attract any new species but did raise the total density of birds by 50 and 70 pairs per 10 ha, i.e. by ca 30–50% of the previous figure. In one of these parks (Sołacki) about 60–70% of the local hole-nester population used the nest boxes, in the other one (Ogr. Dendrologiczny) – even 90%.

The study in Poznań revealed that as nesting sites, boxes were preferred to natural holes. Gustafsson (1988) demonstrated it experimentally in forest in the case of Great Tits, Blue Tits and Collared Flycatchers *Ficedula albicollis*. After boxes had

been put up in the Sołacki Park in Poznań, the number of nests of various species in natural holes actually decreased, despite the increase in the numbers of breeding hole-nesters. In two other areas of Poznań it was found that Mallards and Spotted Flycatchers settled exclusively in boxes, but it did not cause any increase of these species there. These examples show that providing nest boxes in parks not only enriches their bird life, but also creates better breeding conditions for the hole-nester population already existing there.

Studies from woodland (e.g. Dobrowolski *et al.* 1975, Pfeifer & Keil 1961, Pfeifer & Ruppert 1953) and from rural areas (e.g. Graczyk & Mroczkiewicz 1967, Michocki 1967) indicate, that while introducing nest-boxes brings about an increase in the numbers of hole-nesters, it does not appear to have any effect on the composition of the remainder of the bird community in an area. This was reflected by studies in Warsaw and Poznań in respect to urban parks. In none of the 23 areas studied in the two cities was the change in the dominance structure of the bird community, brought about by the raise of the number of hole-nesters, in any way connected with an impoverishment of the guild of birds buildings open nests. Furthermore, there was no evidence in any of the areas of an excessive number of the population nesting in boxes.

THE POSSIBILITIES OF USE IN MANAGEMENT

In a primaeval forest of the temperate zone, such as the Białowieża national park in Poland, the availability of natural holes as breeding sites is not limiting factor for the rich (25 species) guild of secondary hole-nesters occurring there (Walankiewicz

1991). However, in city parks, the trees are usually poor in holes, which restricts the occurrence of 10–20 bird species. Making up this deficit by providing nest boxes could be an effective method of managing the bird communities there. Luniak (1983) formulated 3 general objectives which such action should aim at:

- 1) Enriching or conserving the specific and ecological diversity of the given bird community;
- 2) Raising the numerical level of the community to its ecological and practical optimum;
- 3) Adapting bird community to existing, or expected, biocoenotic conditions and to practical needs of man.

Blagosklonov (1980, 1991) and Ilichev (1989) suggested similar aims in the management of urban bird communities. The results of studies in Warsaw and Poznań demonstrate that nest-boxes offer a wide range of possibilities of attaining these objectives in the management of urban bird life in Poland.

The installation of nest-boxes affected quite a large number of species in general, and also in the relation to the species composition in particular areas. But much greater possibilities exist for enriching in this way the diversity of bird life, both by introducing new species and by improving its quantitative parameters – general level and proportions between particular components. This requires greater diversity of box types used and greater skill in using them. Examples here are restricting the competitive prevalence of the two Sparrow species in Warsaw by using boxes with smaller entrance holes (encouraging Blue Tit and Pied Flycatcher), and in Poznań by placing the boxes low down (to improve the chances of Great Tit). By varying the box depth, particular species can be attracted. Deepening the various box

types makes them more attractive to tits, Starling and Jackdaw, and eliminates both Sparrow species. Reducing the depth and making larger entrance hole attracts Redstart and Robin. The Warsaw study showed that competition from Sparrows could be minimised by concealing the boxes in the dense canopy cover and in out-of-the-way spots.

Large boxes meant for Jackdaw, Tawny Owl and ducks present opportunities for enriching the specific and ecological composition of the bird communities in parks. Although tests in Warsaw and Poznań brought success only to the doghouse type, examples are known that different versions of such large boxes have been adopted by a number of species, in the urban environment as well. Particularly important here is where and how the box is placed – in accordance with particular needs of the species in question. Examples of settling Goldeneye *Bucephala clangula* on urban water estuaries in Poland (Mizera 1992), in Germany (Rogge 1984) and in Moscow (Rakhmanov 1975) – shows new possibility of use boxes of this size.

Studies in Warsaw and Poznań indicated that the open boxes used hitherto, intended for Spotted Flacatcher and Black Redstart, are not of much use in conditions of parks. Their construction should protect their inhabitants from corvids and cats. A similar box, only larger and with the same precautions, would probably be successful with Blackbird *Turdus merula*. In city parks, this species sometimes nests in traditional boxes (e.g. Volkmann 1957). But its broods in natural holes or in damaged medium/large size nest boxes (e.g. type D in Warsaw) indicate that it prefers a more open box with a shallower interior. A similar type of box would probably be useful at the waterside for Moorhens *Galinula chloropus*.

The increase in the numbers of birds in the parks of Warsaw and Poznań, up to 100% in areas poor in birds, and up to 60% elsewhere, testifies to the possibilities of increasing the numbers of bird communities by the use of nest-boxes. At the same time, in none of the areas studied did the guild of hole-nesters or any of its component species increase its numbers to an extent that could be regarded as ecologically excessive. Only in particular circumstances might the use of nest-boxes in urban parks cause undesirable overpopulation, e.g. Mallard broods in small ponds. Normally, the environmental factors operating in a park should adequately regulate its population.

Results of study discussed indicate that the nest-boxes put up in urban parks must be more diversified in type and more skillfully placed than it is in forestry. It is required by the broad range of differentiation of the urban environment, its ecological degradation and public needs as concerns managing the presence of birds in cities. The traditional methods of employing nest-boxes applied in forestry are quite successful in newly-laid out parks, where bird life is poor, because they attract some number of common birds. But the richer the natural (existing or potential) conditions of the area, the more diversified in type the boxes must be and the greater the skill required in placing them. They must selectively satisfy the requirements of particular species, create the desired species composition and also serve other animals, such as squirrels, martens or bats. The studies in Warsaw and Poznań show that to a great it is possible to achieved the desired effect, but also there is a need to know more about the problem.

CONCLUSIONS

Nest boxes in urban parks studied were used by a relatively considerable number of species (14 in all, 13 in each of both cities). The species composition and the frequencies of box occupation by particular species were similar in both cities. About 75% of broods in boxes were of 3 dominant species – Starling, Tree Sparrow and – in Warsaw – House Sparrow.

The percentage of occupation in small and medium-sized boxes – 47% in Warsaw and 73% in Poznań – were within the range of the figures recorded in forests. These boxes were most universal – 10 species used them, including all most numerous ones. Other kinds of boxes meant for particular species (open boxes, or large ones for owls and ducks) in general were occupied in low degree.

No long-term (12 years) trends of changes in box-occupation were noted. A high percentage of occupation was achieved already in the second year after putting up, which is the possibility of forthcoming effect in management.

The preferences of particular species as regards box dimensions (depth, entrance hole diameter) or placement (height, surrounding by trees, concealment among branches) make it possible to limit the competitive prevalence of both Sparrow species and Starlings with respect to tits and Pied Flycatchers.

The breeding results (clutch size, productivity) of the five species occupying the boxes most frequently, were in parks studied not worse than those given in the literature for non-urban areas. Nest-boxes (and dutch baskets as well) also ensured a high hatching success in the Mallard, although the final results of broods depended on conditions after ducklings leave the

nests. Predation and human interference were not a significant factor in brood losses in boxes.

The use of boxes in parks with young tree stands significantly increased the species diversity (2–5 new species) and the number of breeding population (even by 100%). In old parks it led mainly to an increase in numbers – up to 60 pairs per 10 ha. In such parks 20–90% of hole-nesters used the boxes provided. The increase in numbers of hole-nesters caused by the presence of boxes did not visibly affect the composition of the remainder of the bird communities in these parks.

Nest-boxes make it possible to increase the diversity and abundance of avifauna in urban parks, but in contrast with management in forestry, their use in urban areas requires a greater variety of box types and greater skill in their placement.

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STRESZCZENIE

[Przydatność skrzynek lęgowych dla kształtowania awifauny lęgowej parków miejskich – badania w Warszawie i Poznaniu]

Praca jest podsumowaniem wyników zespołowego programu badań nad zastosowaniem skrzynek lęgowych w specyficznych warunkach parków miejskich. Szczegółowe wyniki tych badań zostały przedstawione w pracach Kozłowskiego (1992), Kozłowskiego i Mizery (1992), Luniaka *et al.* (1992) oraz Nowickiego (1992) – zamieszczonych w niniejszym zeszycie *Acta Ornithologica* (vol. 27, No 1).

Przydatność i sposoby stosowania skrzynek lęgowych, jako metody ochrony i wzbogacania awifauny, zostały dość dobrze zbadane i są praktycznie wykorzystywane w leśnictwie. Doświadczeń tych nie można jednak odnosić bezpośrednio do parków i ogrodów miejskich – ze względu na znaczną odmienność składu awifauny i warunków środowiskowych.

Dane o zakresie wykonanych badań zestawiono w tab. 1. W Warszawie prowadzono kontrole skrzynek na licznych i różnorodnych terenach (w ciągu 1–7 lat, natomiast w Poznaniu – głównie na 2 terenach (Park Sołacki i Ogród Dendrologiczny) w ciągu 12 lat, a na innych prowadzono krótkotrwałe obserwacje niewielkiej liczby skrzynek.

S k ł a d g a t u n k o w y . Skrzynki na badanych terenach były wykorzystywane przez stosunkowo znaczną liczbę gatunków – ogółem 14, po 13 w każdym z badanych miast (tab. 2). Dla 10 z tych gatunków wielkomiejskie parki były typowym biotopem lęgowym, a 3 (mucholówka żałobna, rudzik, pleszka) częściej wykorzystywały skrzynki w peryferyjnych parkach leśnych. Skład gatunkowy oraz proporcje częstości zasiedlania skrzynek przez poszczególne gatunki – były dla obu miast podobne (tab. 2). Charakterystycznym zjawiskiem była tu silna dominacja ilościowa mazurka, szpaka i w Warszawie wróbla (tab. 2), która nie występowała jednak w parkach leśnych. W nowo założonych parkach z młodym ubogim drzewostanem w skrzynkach gnieździły się 2–3 gatunki, w parkach z drzewostanem średniowiekowym (30–40 lat) – 4–6 gatunków, podobnie (5–6) w średniowiekowych parkach leśnych, a w dużych starych parkach – 6–8 gatunków.

S t o p i e ń z a j ę c i a skrzynek (tab. 3) był w Poznaniu wyraźnie wyższy (58%) niż w Warszawie (44%), co wiąże się m.in. z odmiennością terenów i zestawu użytych skrzynek. Stopień zajęcia małych i średnich skrzynek, najliczniej użytych w badaniach – 47% (w Warszawie) i 73% (w Poznaniu) – mieścił się w zakresie wyników notowanych na terenach leśnych. Wieloletnie (12 lat) obserwacje na 2 terenach w Poznaniu nie wykazały kierunkowych zmian w zasiedleniu skrzynek, brak takich tendencji wykazują też na ogół dane z piśmiennictwa. Już w drugim roku po zainstalowaniu skrzynek osiągnął typowy dla danego terenu stopień zasiedlenia.

T y p y s k r z y n e k . W badaniach użyto 8 typów skrzynek (tab. 3). Zastosowane w Poznaniu skrzynki małe i

średnie (typy A i B) były wykonane z trocino-betonu, wszystkie inne w obu miastach – z drewnianych desek.

Najwyższy stopień zasiedlenia miały skrzynki małe i średnie (tab. 3). Miały też najbardziej uniwersalne zastosowanie – wykorzystywało je 10 gatunków. Modyfikacje wielkości otworu i głębokości tych skrzynek oraz sposób ich umieszczenia (wysokość, otoczenie drzewami, osłonięcie gałęziami) – stwarzają możliwość ograniczania przewagi konkurencyjniejszego szpaka, mazurka i wróbla w stosunku do sikor i mucholówki żałobnej, co w mieście ma szczególne znaczenie.

Stopień wykorzystania innych rodzajów skrzynek (półtwarde, duże dla sów i kaczek) – był niski (tab. 3). Znaczny stopień zasiedlenia przez krzyżówki miały jedynie skrzynki „psie budy” (typ „Anas”) umieszczane na ziemi na niedostępnych wypach. Niepomyślny wynik zasiedlenia innych typów skrzynek wiązał się prawdopodobnie (w przypadku pelzacza, kawki, kopciuszka, puszczyka) z dostępnością korzystniejszych miejsc lęgowych, niewłaściwym umieszczeniem skrzynek (puszczyk, krzyżówka), zbyt małą głębokością skrzynek typu D (kawka), a także z małą liczebnością występowania gatunków, dla których skrzynki te były przeznaczone.

Skrzynki trocino-betonowe zastosowane w Poznaniu miały, w porównaniu z tradycyjnymi drewnianymi użytymi w Warszawie, wysoki stopień zasiedlenia i korzystne wyniki lęgów.

U m i e s z c z e n i e i r o z m i e s z c z e n i e . Badania wykazały brak wyraźnej preferencji do zajmowania skrzynek z otworem umieszczonym w określonym kierunku oraz (Cieślak 1990) brak uzależnienia w stosunku do przebiegu żył wodnych i siatki geobiologicznej. Stwierdzono też, że umieszczenie

skrzynek na wysokości 1–2 m eliminuje ich zasiedlanie przez mazurka, natomiast nie ma znaczenia dla bogatki. Mazurek unikał też skrzynek osłoniętych gałęziami w koronach drzew, a sikora modra w tak umieszczonych skrzynekach gnieździła się najchętniej.

Na obu terenach badanych w Poznaniu, mających bogaty drzewostan, zagęszczenie małych i średnich skrzynek około 10 na ha okazało się optymalne pod względem ekologicznym i praktycznym. W Warszawie oceniono, że w dużych parkach zagęszczenie około 5 skrzynek na ha stwarza wystarczające możliwości osiedlania ptaków, a w małych parkach – 5–10 skrzynek na ha.

P o m y ś l n o ś ć l ę g ó w .
Wyniki lęgów (wielkość zniesienia, produktywność – juv./gniazdo/rok) 5 gatunków najczęściej zasiedlających skrzynki na badanych terenach (mazurek, szpak, wróbel, bogatka, sikora modra) – nie były gorsze w porównaniu z podawanymi przez piśmiennictwo wynikami lęgów tych gatunków na terenach pozamiejskich w rejonie Warszawy i Poznania oraz z zakresem wartości typowych dla gatunku. Skrzynki w Poznaniu, a także kosze holenderskie badane w Warszawie przez Engela *et al.* (1988), zapewniały wysoki sukces wylęgu krzyżówek (100% i 81%). Jednak końcowy wynik zależał tu od warunków wychowania lęgu poza gniazdem – w Poznaniu do samodzielności dorosła większość piskląt, a w Warszawie – 20–30%. Drapieżnictwo i bezpośrednia ingerencja ludzi nie były przyczyną znacznych strat lęgów w skrzynekach. Skrzynki trocino-betonowe zastosowane w Poznaniu dobrze chroniły lęgi przed dostępem drapieżników.

W p ł y w n a a w i f a u n ę . Zastosowanie skrzynek w parkach z młodym drzewostanem, gdzie awifauna była uboga, w istotny sposób zwiększało różnorodność składu gatunkowego (2–5 nowych gatunków) oraz liczebność awifauny (nawet dwukrotnie). W starych parkach o bogatej awifaunie – skrzynki przyczyniały się głównie do jej wzrostu ilościowego (nawet o 60 par na 10 ha). Przyrost ilościowy po zastosowaniu skrzynek osiągał w Warszawie do 30%, a w Poznaniu – 30 i 50% poprzedniego stanu. Zastosowanie skrzynek w Warszawie osiedliło mucholówkę żalobną w 6 parkach, m.in. w śródmieściu, gdzie dotychczas gatunek ten nie gnieździł się. Wzrost ilościowy dziuplaków spowodowany przez skrzynki nie wywierał widocznego wpływu na pozostałą część awifauny badanych terenów.

M o ż l i w o ś c i w y k o r z y s t a n i a . Skrzynki stwarzają znaczne możliwości wzbogacenia różnorodności awifauny parków miejskich (warunkują gnieźdzenie się kilkunastu gatunków) oraz zwiększania jej stanu ilościowego. Ich zastosowanie na terenach zurbanizowanych wymaga jednak większego, w porównaniu z praktyką przyjętą w leśnictwie, zróżnicowania zestawu typów i bardziej umiejętnego ich użycia. W szczególności celowe jest wprowadzenie modyfikacji skrzynek półotwartych zabezpieczających lęgi przed krukowatymi i kotami oraz podobnych lecz większych dla kosa i kokoszki wodnej. Znaczne możliwości wzbogacenia składu gatunkowego i ekologicznego awifauny stwarza też umiejętne zastosowanie dużych skrzynek dla kawki, kaczek i puszczyka.