Does railway noise affect forest birds during the winter?

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Abstract

The construction of new railway routes and the modernisation of existing ones usually have an adverse effect on the natural environment in the vicinity of such transport corridors. Negative effects of the construction of the railway line can be observed even at a considerable distance. The high frequency of wildlife-train-collisions (*wtc*) can lead to the death of many animals. Many groups of animals, including birds, are exposed to noise, which modifies their densities in the neighbourhood of railway lines. The relevant literature reports both positive and negative effects of railway lines on birds. The present study addressed the question of how noise generated by trains affects woodland birds during winter. Birds were counted at 45 observation/listening points located along three rows running parallel to the railway line (15 points in each row) at different distances from the tracks (30 m, 280 m and 530 m). Each point was described in detail with the aid of a suite of environmental parameters. Three hundred and forty-eight birds from 20 species were recorded during the study. The level of noise decreased with distance from the tracks. The numbers and species diversity of birds were both higher close to the railway line than deep in the forest. The richer structure of the forest edge was an attractive habitat for birds. Birds belonging to different feeding and social guilds were distributed evenly right across the study plot. Passing trains and the noise they generated did not cause a drop in bird density by the tracks. The results of this study may be useful during the planning of new railway routes and the modernisation of existing ones in the context of applying measures to minimise the negative effects of a railway line on the environment through which it passes.

Keywords Edge effect · Disturbing factors · Woodland · Railroad tracks

Introduction

The expansion of road and rail infrastructure is exerting increasing pressure on habitats close to transport corridors, a process that is expected to continue for the foreseeable future. The main problems caused by such expansion include the occupation and destruction of new land, the fragmentation of natural habitats, as well as noise, light and chemical pollution (McCollin 1998). One direct effect of road and rail traffic is the mortality of wild animals on roads and tracks (Erritzoe et al. 2003; Borda de Agua et al. 2017), while noise generated by road and rail traffic is a very important indirect factor affecting the fauna (Brumm

and Slabbekoorn 2005; Reijnen and Foppen 2006; Halfwerk et al. 2011). Anthropogenic noise differs fundamentally from natural sources of noise produced, for example, by running water, wave action at sea or wind (Wood and Yezerinac 2006). In contrast, noise generated by road and rail traffic has evident and diverse effects on the distribution of fauna, including birds, in the vicinity of roads and railway lines, as evidenced by the fairly extensive subject literature (Reijnen and Foppen 1994, 2006; Polak et al. 2013). Most authors investigating the effect of noise from roads carrying heavy traffic consider that it causes bird densities in their vicinity to drop. Studies carried out during the breeding season and autumn migration period have demonstrated unequivocally that noise adversely affects birds occupying habitats near roads (McClure et al. 2013; Wiącek et al. 2015a, b). The results obtained from a similar study carried out in winter were slightly different: in early winter, traffic noise had no effect on the distribution of birds near the road, but as spring approached and the days became longer, the birds began to avoid sites affected by noise pollution (Wiącek and

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Polak 2015). This altered response to noise is probably due to seasonal neurophysiological changes in the perception of sound signals (Lucas et al. 2002, 2007). Recent research on the effect of railway noise on birds has yielded a different picture. A survey carried out during the breeding season along a railway line passing through woodland showed that noise is not a factor preventing birds from nesting near the tracks (Wiącek et al. 2015b). Quite the opposite, in fact: the rich woodland edge habitats provide excellent conditions for many bird species. The habitat factors associated with the edge effect encourage far more birds to nest near the tracks, even though noise levels there are higher than in the depths of the forest (Barbaro et al. 2012, 2014; Batáry et al. 2014). As a moving train is a rapidly travelling, point source of noise, it affects birds only briefly, without eliciting any significant negative effects (Wiącek et al. 2015b). Preliminary observations made on the same study plot during the autumn migration period corroborate the results from the breeding season. One should bear in mind, however, that sound propagation in woodland is different from that in open habitats like meadows, and birds living in the latter are affected by noise from trains (Waterman et al. 2002). This leads to a decline in the densities of birds living near railway lines, in the same way as near very busy roads. The least understood period in the life cycle of birds is the wintering period. The winter weather in central and eastern Europe is a severe test for the birds because of the low temperatures, falls of snow and frequent changes in intensity of these factors (Gołowski and Kasprzykowski 2010). That is why the activities of birds during winter take quite different forms from those typical of spring and summer, when they are building nests and looking after their young. In winter, birds have two basic objectives: to find food and avoid predators (Wiącek and Polak 2015). To achieve them, birds behave in different ways. One is to form mono- or multipiece flocks, a behaviour that makes the search for food more effective and reduces the risk of attack from a predator (Krebs and Davies 1987). Many eyes and ears will quickly detect the presence of a predator or food, offering the flock greater chances of escape or survival than for solitary individuals (Freeberg and Lucas 2002). Therefore, the main problem in this context may be that extraneous noise from road vehicles or trains will drown out warning signals emitted by birds that have detected a predator. Indeed, such noise itself is often perceived as a threat and elicits flocking behaviour, just as the presence of a predator (Owens et al. 2012). The calls of birds living in flocks have different meanings. They may indicate the status of an individual in the flock, identify a stranger in the group, inform the members of the flock about a food resource or sound warnings about predators (Nowicki 1989; Soard and Ritchison 2009). These signals enable birds to communicate within a group and between neighbouring flocks without the need for visual contact; hearing suffices

(Slabbekoorn and Halfwerk 2009; Mockford and Marshall 2009). But any interference with these signals by road or rail noise can lead to energy being wasted in the search for food and increase the risk of being spotted by a predator, and thus to the death of one or more birds. Hence, if these important signals are masked by extraneous noise, the probability of the birds' survival is diminished, especially in winter (Oden 2013). Experience gained from the results of other research indicates that habitat factors are crucial as regards the distribution of birds along tarred roads or railway lines. A rich habitat structure with abundant food resources, despite a high level of noise and the risk of collision with vehicles at the edge of the transport corridor, is an attractive place for many bird species. A woodland margin, well insulated, rich in different species of trees and shrubs, provides a host of ecological niches, eagerly sought by birds as well as other animals (Helle and Muona 1985; Batáry et al. 2014). The plentiful resources of food, despite the noise and the presence of humans, mean that birds and other animals do not shun such areas. Moreover, the heavy traffic scares away predators, which is another safety factor, notwithstanding the danger from collisions with vehicles (Pescador and Peris 2007).

The main aim of our research was to investigate whether the railway line affected the distribution of birds during winter. We predicted that the intensity of railway noise could negatively impact on the avian abundance and species richness. Noise can also affect the preferences of different species of birds to be in the vicinity of tracks or to avoid this neighbourhood. During three winter months, woodland birds from different ecological guilds were investigated due to their distribution to the railway. The null hypothesis assumed that the influence of train noise on the distribution of birds in the study area would be neutral. The alternative hypothesis assumed that the railway would exert a negative influence and that we should therefore expect a decrease in abundance and species richness in close proximity to the railway. Another scenario is that the birds due to the edge effect can prefer the vicinity of the tracks and the numbers of birds and their species richness in the immediate vicinity of the tracks will be higher as had been the case during the breeding season and autumn migration in our earlier study (Wiącek et al. 2015a, b).

Study area and methods

The study was carried out in the Puławy Forest District (N51°50'02", E21°91'94") in eastern Poland. The prevailing habitat in the study plot was coniferous forest with dominant Scots pine (*Pinus sylvestris*) and an admixture of silver birch (*Betula pendula*). The birds were surveyed along the double-track Warsaw–Lublin–Dorohusk railway

line near the village of Gołęb. The intensity of traffic was 144 trains—111 passengers and 33 freight—in 24 h. The line runs through the forest in a 50 m wide corridor. The study plot was situated to the north of the tracks. The density of woodland birds was determined using the point-count method (Bibby et al. 1992). The study was done at 45 observation/listening points located along three rows running parallel to the railway (Fig. 1). All the points were established using GPS receivers before the start of counting. The first row of 15 points (henceforth referred to as points A) lay 30 m from the railway, the next row of 15 points (points B) was situated 280 m from the railway, and the last row of 15 points (points C) ran at a distance of 530 m from the tracks. All the points were 250 m apart from one another. Counting at each point lasted for 5 min. All the birds within a radius of 100 m were recorded, excluding birds flying over the study plot. Three counts were done at each point—on 15 December 2015, 16 January 2016 and 16 February 2016. All the counts were carried out from 07:30 to 10:30 h. The limiting factor in this type of study was the fact that the observers themselves sometimes had difficulty in hearing the birds above the noise of trains, so some will have gone unrecorded

(Rheindt 2003; Summers et al. 2011). Nevertheless, we were aware of these limitations and tried to minimise them. Our task was made a little easier because the traffic along the railway was not continuous, and we were able to record the birds' vocal activity in the quieter gaps.

The counts at all the points on one day were done by three experienced observers (JW, MF and MP), who walked parallel to one other, each along a different row of points (A, B, C). Before the counts were started, the study plot was selected very carefully in order to reduce to an absolute minimum the effect of environmental parameters on bird clustering. The plot was located in the depths of a large, dense forest complex (Fig. 1). The noise of trains and structure of the vegetation at every listening point was assessed with the aid of a suite of environmental parameters (see Table 1).

Sound levels during the counts were measured directly to determine the model of noise propagation across the study area. The level of railway noise was measured at each point during every count in December, January and February using a digital sound level meter CHY 650 (IEC 651-1979 Type 2, ANSI S1.4-1983 Type 2, JIS C 1502). The noise level at the centre of each point was measured for 5 min and

Fig. 1 Study area with the 45 listening/observations points during the winter period near a railway Lublin–Warsaw

Table 1 The habitat variables obtained at the observation/listening points

Variable	Meaning
Canopy cover (%)	% canopy cover in eleven categories: 0–0%; 10–1–10%; 20–11–20%; 30–21–30%; 40–31–40%; 50–51–60%, 60–61–70%, 70–71–80%, 80–81–90%, 90–91–99%, 100–100% within circle (radius 30 m)
Tree height (m)	Mean height of 5 trees growing within circle (radius 30 m) and measured by the altimeter
Number of deciduous trees	Number of deciduous trees of the nearest 30 trees that were > 20 cm diameter at breast height
Number of dead trees	Number of dead trees that were > 20 cm diameter at breast height within circle (radius 50 m)
Density of shrubs	Number of shrubs growing within 30 m radius circle
Shrub cover (%)	% shrub cover in eleven categories: 0–0%; 10–1–10%; 20–11–20%; 30–21–30%; 40–31–40%; 50–51–60%, 60–61–70%, 70–71–80%, 80–81–90%, 90–91–99%, 100–100% within circle (radius 30 m)
Herb cover (%)	% herb cover in eleven categories: 0–0%; 10–1–10%; 20–11–20%; 30–21–30%; 40–31–40%; 50–51–60%, 60–61–70%, 70–71–80%, 80–81–90%, 90–91–99%, 100–100% within circle (radius 30 m)
Herb height (cm)	Mean height of herb vegetation at 5 places chosen randomly within circle (radius 30 m)

the highest level recorded. Railway noise was measured on weekdays in good weather (no rain or high winds).

The division into feeding and social guilds was based on Tomiałojć et al. (1984), Cramp and Perrins (1977–1994) and Wiącek and Polak (2015). Owing to the small sample size, raptors were not included in the ecological guild analyses. Parametric tests were applied following checks that distributions were normal (Kolmogorov–Smirnov test; $P > 0.05$). A bilateral critical region was assumed in these tests, and results were deemed significant if the probability of committing an error of the first kind was equal to or less than 0.05. Redundancy analysis (RDA) was used to analyse the relationship between the numbers of particular bird species and distance from the railway—this parameter acted as the environmental variable. A Monte Carlo test with 500 permutations was used to determine the significance of the canonical axes. Only species with abundances ≥ 10 individuals were included in the RDA. The propagation of noise over the study area was assessed using ANOVA and the differences in species richness and numbers in specified categories of observation points determined. In the models, we included the noise level, species richness and abundance as dependent variables while the independent variable was the distance from the railway. The measure of species richness was taken to be the sum of all species come across during the three counts, and the number of birds was the maximum number of all individuals discovered during all three counts. The differences in abundance and species richness were tested in the relation to the distance from the railway using ANOVA.

Multiple regression analysis was conducted to test the impact of the eight environmental parameters on the abundance and number of species. Therefore, multivariate analysis of variance (MANOVA) was performed to test for variation in avian feeding guilds at the points located at different distances from the railway. The means are given together with their standard deviations $\pm$ SD. The computations were performed using STATISTICA 12.0

(Statsoft Inc. 2014) and Canoco 4.0 software (ter Braak and Smilauer 1998).

Results

Environmental parameters

The noise intensity at the A points was 71.6 ± 21.3 dB (range 33.5–93.1 dB, $n = 45$), at the B points was 50.7 ± 12.1 dB (range 32.5–81.5 dB, $n = 45$) and at the C points was 51.1 ± 9.8 dB (range 34.2–66.6 dB, $n = 45$)—Fig. 2. The mean noise intensity during the counts was 60.2 ± 16.4 dB (range 34.2–93.1 dB; $n = 45$) in December, 53.5 ± 19.5 dB (32.5–90 dB; $n = 45$) in January and 60.4 ± 17.1 dB (36.1–91.8; $n = 45$) in February, and there were no

Fig. 2 Intensity of the railway traffic noise at the listening/observation points in different distances from the railway in December, January and February

differences between months ($F_{2,132}=2.20$; $P=0.11$). There were significant differences in noise propagation between the point categories during the counts in December (ANOVA; $F_{2,42}=5.52$; $P<0.01$), January ($F_{2,42}=18.73$; $P<0.001$) and February ($F_{2,42}=12.56$; $P<0.001$).

Analysis of the environmental parameters showed that the area in which the birds were counted was homogeneous with respect to habitat (Table 2). Three of the eight habitat parameters differentiated the study area. The number of deciduous trees and herb cover decreased with distance from

the railway and only canopy cover increased with distance from the railway.

Number of individuals

The three counts yielded a total of 348 birds belonging to 20 species (Table 3). The most numerous species was great tit (*Parus major*)—16.6% of the birds counted in the study area. Other dominants ($\geq 5\%$) were mistle thrush (*Turdus viscivorus*), great spotted woodpecker (*Dendrocopos major*), coal tit (*Periparus ater*), crested tit (*Lophophanes cristatus*), goldcrest (*Regulus regulus*), siskin (*Spinus spinus*) and raven (*Corvus corax*). The numbers of the most common birds (> 10 inds.) differed widely in relation to distance from the railway (Monte Carlo test of the significance of the first axis; F ratio = 3.244; $P=0.006$; Monte Carlo test of the significance of all axes; F ratio = 2.173; $P=0.006$; Fig. 3.). The following species were more abundant near the railway: goldcrest, great tit, great spotted woodpecker, siskin and raven. Numbers of the following species increased with distance from the railway: mistle thrush, Eurasian jay (*Garrulus glandarius*) and willow tit (*Poecile montana*).

There were significant differences between the mean bird abundances (all individuals/point) in the different rows in December (3.2 ± 2.7 ; range 0–8; $n=45$; ANOVA: $F_{2,42}=14.91$, $P=0.001$), but in January (1.8 ± 2.3 ; range

Table 2 Habitat variables at the point-count locations in relation to distance from the railway (points A—30 m, points B—280 m, points C—530 m). Data are presented as median values. Differences between points were tested using the Kruskal–Wallis test

Variable	Points A	Points B	Points C	$H_{2,45}$	P
Canopy cover	5	7	7	12.550	<0.05
Tree height (m)	13	14.5	13.9	3.133	ns
Number of deciduous trees	2	0	0	10.189	<0.05
Number of dead trees	4	3	2	1.875	ns
Shrub cover	3	3	3	2.726	ns
Density of shrubs	115	40	120	2.726	ns
Herb cover	3	1	1	7.130	<0.05
Herb height (cm)	32.6	23.2	20	4.879	ns

Table 3 Species composition of the woodland bird community in relation to distance from a railway line (points A—30 m, points B—280 m, points C—530 m) in eastern Poland. The birds are classified according to foraging guilds: G—Granivorous–insectivorous; I—Insectivorous; R—raptorial and social guilds: F—flocking species, S—solitary species

Species	Foraging/social guilds	Total number	Number of individuals		
			A points (n = 15)	B points (n = 15)	C points (n = 15)
<i>Parus major</i>	I/F	58	24	7	27
<i>Turdus viscivorus</i>	G/S	44	13	3	28
<i>Dendrocopos major</i>	G/S	42	21	13	8
<i>Periparus ater</i>	I/F	40	16	7	17
<i>Lophophanes cristatus</i>	I/F	38	13	7	18
<i>Regulus regulus</i>	I/F	36	25	5	6
<i>Corvus corax</i>	–/S	18	8	5	5
<i>Spinus spinus</i>	G/F	18	15	3	0
<i>Poecile montana</i>	I/F	11	1	4	6
<i>Garrulus glandarius</i>	–/S	11	2	3	6
<i>Aegithalos caudatus</i>	/F	11	0	11	0
<i>Pyrrhula pyrrhula</i>	G/F	6	1	5	0
<i>Dryocopus martius</i>	I/S	4	1	3	0
<i>Turdus merula</i>	I/S	3	3	0	0
<i>Dendrocopos minor</i>	/S	3	0	3	0
<i>Chloris chloris</i>	/F	1	1	0	0
<i>Troglodytes troglodytes</i>	I/S	1	0	0	1
<i>C. coccythraustes</i>	G/F	1	0	0	1
<i>Certhia familiaris</i>	I/F	1	1	0	0
<i>Buteo buteo</i>	R/S	1	0	1	0
Total		348	145	80	123

Fig. 3 Ordination diagram of redundancy analysis for most common bird species registered during the study in relation to distance from the railway

0–13; $n=45$; ANOVA $F_{2,42}=2.68$, $P=0.08$) and February (2.7 ± 2.6 ; range 0–15; $n=45$; ANOVA; $F_{2,42}=0.35$; $P=0.7$) the differences were not significant. The numbers of birds were significantly higher near the railway. The mean number of birds at points A was 10.9 ± 4.0 (range 4–21; $n=15$) and was higher than the numbers at points B (6.5 ± 4.2 ; 1–16; $n=15$) and C (6.0 ± 4.9 ; 0–16; $n=15$). There were significant differences between the numbers of individuals in the different rows (ANOVA $F_{2,42}=5.55$, $P=0.007$; Fig. 4).

Multiple regression analysis indicated that only two of the eight environmental parameters (in all cases $P=0.067$) influenced abundance (all individuals/point), i.e. the number of deciduous trees ($B=-0.43$; $SE=0.19$; $P<0.05$) and gaps in the tree stands ($B=0.32$; $SE=0.16$; $P<0.05$).

Fig. 4 Number of individuals at different distances from the tracks (30, 280, 530 m)

Fig. 5 Number of bird species at different distances from the tracks (30, 280, 530 m)

Number of species

The number of species per point was the highest near the railway (ANOVA $F_{2,42}=5.19$, $P=0.009$; Fig. 5). The mean number of species at points A, lying closest to the railway, was 5.7 ± 1.6 (range 3–9, $n=15$) and differed significantly from the number at points B (3.5 ± 1.8 ; range 1–6; $n=15$). In row C, the number of species was 3.6 ± 2.1 (range 0–7; $n=15$). There were no significant differences between the mean number of species per counting point in December (2.2 ± 1.7 ; range 0–5; $n=45$), January (1.4 ± 1.3 ; range 0–4; $n=45$) or February (1.8 ± 1.4 ; range 0–5; $n=45$; ANOVA; $F_{2,36}=1.05$; $P=0.36$). None of the environmental factors (multiple regression; in all cases $P=0.66$) had any influence on species richness.

Ecological guilds

More insectivorous and granivorous species were observed near the railway line, but the differences between rows (A, B, C) were not significant (MANOVA; $F_{4,25}=1.51$, $P=0.19$). The situation was similar in the social guilds (flocking and solitary), but the differences between the rows (A, B, C) were not significant (MANOVA; $F_{4,25}=2.20$; $P=0.07$). The proportions of insectivorous and granivorous birds from one count to the next were similar, i.e. they did not differ significantly (MANOVA; $F_{4,25}=0.62$, $P=0.65$). The same applied to birds forming flocks and to solitary ones (MANOVA; $F_{4,25}=0.34$; $P=0.85$).

Discussion

The results of studies along tarred roads and railway lines show that noise, together with other factors like vehicle lights, pollution and the presence of humans, strongly modifies the distribution of fauna, including birds, in such areas (Reijnen and Foppen 2006; Wiącek et al. 2015b; Lucas et al. 2017). Noise from very busy roads has been shown to cause considerable drops in bird numbers and diversity in their vicinity (Reijnen and Foppen 1994, 2006; Reijnen et al. 1995; Palomino and Carrascal 2007; Polak et al. 2013; Wiącek et al. 2015a). In contrast, our results relating to railway lines have demonstrated that the noise from trains does not adversely affect the density of woodland birds. Quite the reverse, in fact: the numbers of birds and their species richness in the immediate vicinity of the tracks are higher than in the depths of the woodland. The winter microhabitat conditions in the forest edge can modify the availability of seeds and eggs, pupae and larvae of insects living on the edge of forest. Therefore, some avian species feeding on such food prefer the neighbourhood of tracks. Some species as raven, great tit, great spotted woodpecker preferred ecotone habitat similar as during breeding season (Wiącek et al. 2015a, b). Other species as Eurasian jay and willow tit were distributed more evenly or avoided the neighbourhood of the railway similar as during the winter period near asphalt road (Wiącek and Polak 2015).

Wholly contrasting results regarding the distribution of birds in open meadow habitats adjacent to railway lines were obtained in the Netherlands, however (Waterman et al. 2002): the main cause of such a reaction on the part of birds was noise. These observations were corroborated by experiments with a “phantom road”, performed in the USA by McClure et al. (2013). Using loudspeakers deployed along a woodland transect to broadcast the noises of a busy road, those experiments demonstrated that this factor was the main reason for the fall in bird densities near linear sources of noise. But not all studies of how railway lines affect birds demonstrated decreasing numbers and species diversity in their vicinity. Research carried out along a railway line in Tibet (Li et al. 2010) and in woodlands in eastern Poland (Wiącek et al. 2015b) showed that the noise generated by trains did not have a negative effect on birds, and that close by the tracks the density of birds was greater than deep in the forest. This is because birds perceive a fast-moving train as a point source of noise. The birds get accustomed to such disturbances, and the relative infrequency of such events does not impede their vocal communication (Wiącek et al. 2015b). Moreover, the edge effect plays an important part in this context, as it creates favourable habitat conditions for birds along the woodland margin (Barbaro et al. 2012; Batáry et al. 2014). The results of the present study endorse

this view. Another study that we carried out in winter along a very busy road showed that, despite the high level of noise, the habitat factors along the edge of the woodland were sufficient to meet the birds’ needs (Wiącek and Polak 2015). Many authors indicate that habitat parameters can significantly modify the distribution of birds in the vicinity of transport corridors (Šálek et al. 2010; Halfwerk et al. 2011; Wiącek et al. 2015a, b). However, the results of our observations indicate that habitat factors did not affect the bird abundance and species richness on the study plot during the winter period.

The wintering period in the context of the effect of road/rail noise on birds is as yet poorly understood. Weather-wise, winter is a period of hardship for birds (Goławski and Kasprzykowski 2010). In contrast to the breeding period, when the priority is reproduction and care of the young, the fundamental problem in winter is finding food and avoiding the attention of predators. The results we obtained during our winter research along a railway line showed that insectivorous and granivorous birds were distributed fairly evenly at different distances from the tracks: this behaviour was consistent in every month of the study. During winter in eastern Poland, the forest floor is usually covered to varying depths with snow, which hinders birds in their search for food, just as is the case in open country like farmland (Goławski and Kasprzykowski 2010). Moreover, the snow layer cancels out any differences in the availability of food on the ground; only along the woodland edges, where levels of insolation are high, as a result of which the snow melts faster, is food more accessible. While this benefits primarily the granivores, the insectivores can also find enough to satisfy their needs. In the upper storeys of a homogeneous woodland habitat the availability of seeds as well as insect larvae is usually even. One result of this situation is also the lack of differences between the distributions of flocking species and those that spend the winter solitarily. These results differ significantly from those obtained during the breeding period from the same study plot, where insectivores preferred the neighbourhood of the railway tracks (Wiącek et al. 2015b). The burgeoning vegetation along a woodland edge at such sites gives rise to a greater variety of microhabitats that are attractive to insects and their predators (Barbaro et al. 2014).

This study is the first to address the effect of train noise on birds living in close proximity a busy railway line during winter. Living conditions for some bird species in the vicinity of tracks are more favourable than in the depths of the forest (Wiącek et al. 2015a, b). The greater species richness of plants on the edge of the forest is a rich food base for herbivores (Helle 1983; Barbaro et al. 2012; Batáry et al. 2014). The species richness of plants attracts insects and this is beneficial for insectivorous species (Helle and Muona 1985; Huhta et al. 1999). This situation is obvious

in spring and summer during the breeding season, but in winter there is still a part of seeds and wintering insect larvae on the plants. In addition, the lower intensity of train traffic compared to asphalt roads is also beneficial for birds seeking food (Wiącek et al. 2015a, b). Probably, for this reason, the edge of the forest is attractive for birds during the winter as well as during the breeding season. That is why the results appear to be important in the context of optimising bird conservation efforts along environmental corridors created by railway lines. Favourable conditions for birds in the vicinity of railway tracks do not require expensive noise protection measures, such as screens. These protections are very expensive and do not give the expected results. Our results could be useful during the financial planning stage of new railway routes and the modernisation of existing ones. Therefore they may also have a considerable influence on the application or non-application of measures aimed at minimising the effect of railway traffic and the noise it generates on woodland birds. Our study showed that character of transport corridor in central Poland shape the winter site preferences in woodland birds. The area of the forest edge was an attractive habitat for individuals. The obtained results indicated that noise does not adversely affect birds wintering in the vicinity of railway lines. The use of noise barriers is not necessary, however, we should treat these results with caution, as these are the first and preliminary study on this issue. The next stage of our research will be the assessment of changes in the impact of noise on forest birds during autumn migration. Comprehensive assessment of the impact of noise on forest birds in different phenological periods will allow to draw final conclusions. Our current knowledge allows to state that greater threat to birds may be collisions with trains or railway infrastructure as catenaries or cables electric rail traction than a decrease in the density of birds in the vicinity of the road due to noise (Morelli et al. 2014).

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