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Source: Journal of Vertebrate Biology, 70(2)

Published By: Institute of Vertebrate Biology, Czech Academy of Sciences

URL: https://doi.org/10.25225/jvb.21027

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Journal of Vertebrate Biology

Open Access

J. Vertebr. Biol. 2021, 70(2): 21027 DOI: 10.25225/jvb.21027

SHORT NOTE

Birds in power-line corridors: effects of vegetation mowing on avian diversity and abundance

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Received 2 April 2021; Accepted 7 May 2021; Published online 11 June 2021

Abstract. Human activities have tremendous impact on the environment but the extent of this influence on animals is frequently unknown. Here we focus on a ubiquitous man-made landscape element, power line corridors in forested areas where vegetation is regularly mowed, and its effects on avian species richness and abundance. We surveyed bird communities at 35 sites in southern Czech Republic and found power line corridors hosted on average three more bird species and eight more individuals than transects in the surrounding forests. The lesser whitethroat (*Sylvia curruca*) and the tree sparrow (*Passer montanus*) were the most frequently detected species under power lines, suggesting the importance of these habitats for open-habitat specialists. Overall, we found positive effects of this human-altered landscape element on avian communities but future studies could focus on communities of other animals in this habitat with an emphasis on the presence of endangered species.

Key words: anthropocene, disturbance, ornithology, transmission network

Human activities alter landscapes and the environment on a global scale (Lambin & Meyfroidt 2011, Harden et al. 2014), frequently with negative consequences for animals (Antrop 1998, Hoekstra et al. 2004, Cushman 2006, Newbold et al. 2015). However, some human activities can also result in increases in local animal diversity (Oltjen & Beckett 1996, Knuijt 2020) mainly due to creation of new habitats. Man-made landscape features are common, widely affect animal behaviour and distribution of animals (Slabbekoorn & den Boer-Visser 2006, Palomino & Carrascal 2007), and thus warrant research interest.

Electricity is essential for humans and the need for its distribution creates large-scale electricity transmission networks worldwide (Armaroli & Balzani 2011). Overhead power line networks cross the landscape and alter its character as vegetation is trimmed short under the power lines to minimize electricity losses, especially in forested regions. Despite landscape fragmentation, these regularly mowed habitats with spontaneous vegetation succession could increase habitat heterogeneity and the local number of species. Moreover, these sites could host open-habitat specialists that are among the most rapidly declining species of European birds (Donald et al. 2001). Importantly, power line corridors and power line pylons were already found to elevate diversity and abundance of flowers (Eldegard et al. 2015) and butterflies (Berg et al. 2013), host high numbers of small

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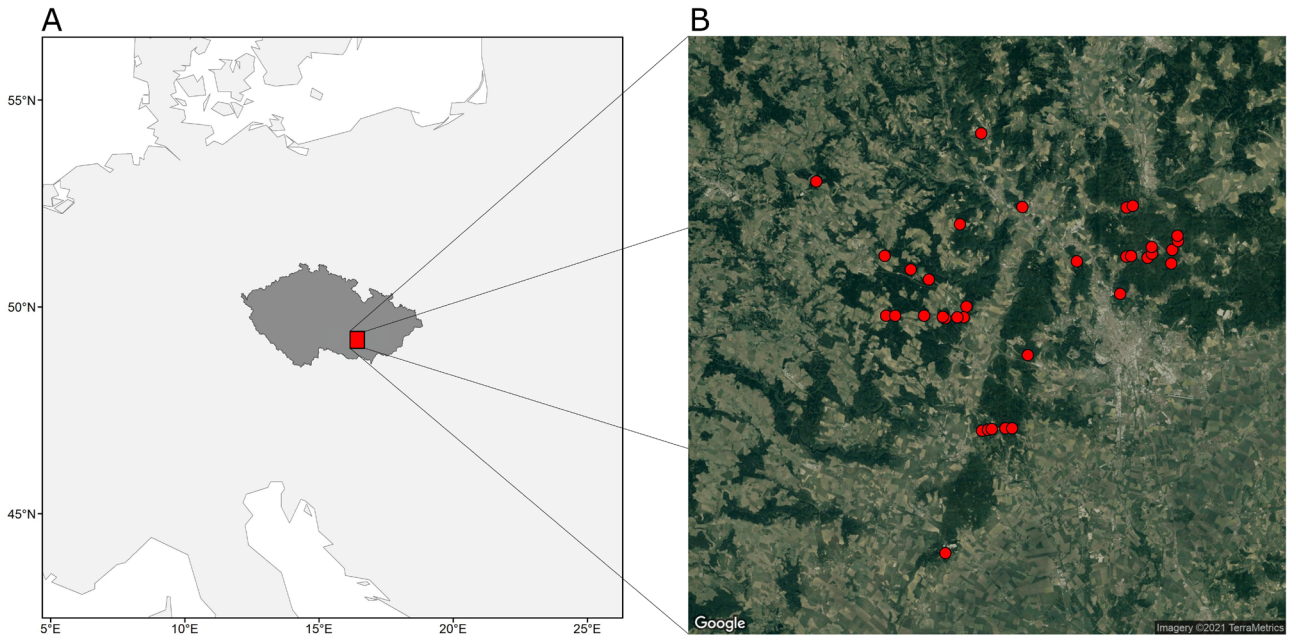


Fig. 1. (A) Study region (red) within the Czech Republic (dark grey) and (B) location of sampling sites (dots).

mammals (Šálek et al. 2020) and birds in open farmland landscapes (Tryjanowski et al. 2014), and provide nesting opportunities for large bird species (Tryjanowski et al. 2004, Bai et al. 2009). However, only limited information is known about the effects of power line corridors in forested areas on local avian diversity and abundance.

During the breeding season (April-June) in 2018-2020, we recorded all individual birds in corridors under power lines and in the surrounding forests at 35 sites in the southern Czech Republic (Fig. 1). We selected pairs of line transects ("power line" and "control"; mean length = 520 m; SD = 60; n = 70) at each of the sampling sites in distance of 143 m (mean; SD = 29) from each other to prevent double counting of the same individuals (Table S1). We visited each site (35 pairs of line transect) twice in the breeding season (first visit: 14 April-13 May; second visit: 19 May-16 June; mean difference: 42 days, SD = 11), to account for temporal changes in species detectability (Lack 1950, Wyndham 1986), in early hours (mean = 6:02 a.m., SD = 21 min) and recorded all individual birds seen or heard.

We additionally recorded the degree of development of vegetation in the power line corridor at each sampling site. For this purpose, we classified the vegetation cover into one of five categories: 1) freshly mowed vegetation, bare ground or sparse grass cover, 2) dense grass cover with sparse ruderal plant species (e.g. common

Table 1. Summaries of models examined in the study. Species represents number of species detected and abundance the sum of individuals of all species, type represents the transects in power line corridors or control transects in forested surrounding areas (controls are contrasted), and level represents vegetation development level. Non-intercept estimates are not back-transformed.

Model	σ^2_{year}	σ^2_{site}	σ^2_{visit}	$R^2_{marg.}$	$R^2_{cond.}$	parameter	estimate	lower 95% CI	upper 95% CI	*P*
species ~ type	0.004	0.002	0.001	0.22	0.26	intercept	10.28	8.81	11.95	< 0.001
						control	–0.36	0.48	0.25	< 0.001
abundance ~ type	< 0.001	0.053	0.015	0.29	0.55	intercept	18.46	14.47	23.67	0.004
						control	–0.56	–0.67	–0.44	< 0.001
species ~ level	< 0.001	< 0.001	< 0.001	0.23	0.02	intercept	11.67	9.64	14.05	< 0.001
						level	–0.04	–0.10	0.02	0.202
abundance ~ level	0.002	0.035	0.017	< 0.01	0.41	intercept	19.47	14.24	26.76	< 0.001
						level	–0.02	–0.09	–0.06	0.665

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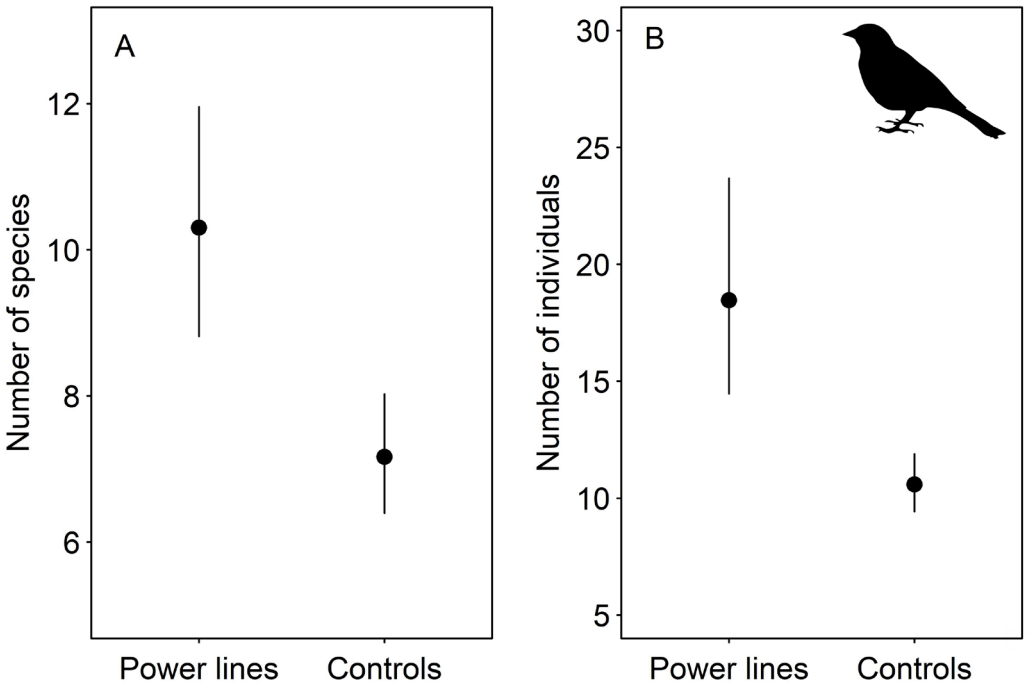


Fig. 2. Average number of species (A) and individuals (B) in transects in power line corridors and control transects in surrounding forested areas. Whiskers represent 95% confidence intervals.

nettle *Urtica dioica* or cleavers *Galium aparine*), 3) sparse shrub (frequently bramble *Rubus* sp.) with individual trees < 1 m in height, 4) dense shrub (frequently blackthorn *Prunus spinosa*) and individual small trees (< 2 m), and 5) small trees (mainly silver birch *Betula pendula*, black locust *Robinia pseudoacacia*, aspen *Populus* sp.).

To compare species richness (number of species) and abundances (sum of individuals of all species) between power line and control transects, we employed linear and generalised linear mixed effects models (R package *lme4*; Bates et al. 2015). We calculated the average number of species detected in power line and control transects using the R function *glmer* with a Poisson distribution of residuals. Similarly, we employed the *lmer* function to obtain an average number of individuals (log transformed) detected in transects. We accounted for data non-independence by including year, site and visit as random intercepts. We applied the same model structures to test the impact of growth level on species diversity and bird abundance. In all models, residuals were homoscedastic and we back transformed model estimates in the results to ease interpretation. We calculated confidence intervals of parameter estimates using *confint.merMod* function, marginal and conditional r-squares according to Nakagawa & Schielzeth (2013) using the *r.squaredGLMM* function from *MuMIn* R package (Bartoń 2018), and *P* values using the *lmerTest* R package (Kuznetsova et al. 2017).

Finally, we calculated the frequency of detections of individual species only in the power line transects, separately for visits but with years combined. This estimate represents a proportion of visits when the species were detected only in the power line corridor but were absent in the control transect.

In total, we detected 2,192 individuals of 38 species at 35 sampling sites. The power line corridors hosted on average 10.3 species, while the control transect in the surrounding forest only hosted an average of 7.2 species (Fig. 2; Table 1). The number of individuals detected was similarly higher on average in power line corridors with 18.5 individuals contrasting with 10.6 individuals in the control transects (Fig. 2, Table 1). Vegetation development level did not affect either number of species (estimate = 0.96) or number of individuals (estimate = 0.98; Table 1).

Species most frequently recorded exclusively in the power line corridor at the sampling sites were lesser whitethroat (*Sylvia curruca*), Eurasian tree sparrow (*Passer montanus*), great tit (*Parus major*)

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Table 2. Proportion of sampling sites (%) where a species was recorded in a powerline transect but was absent from the control transect (first visit = 35; second visit = 35). The ten most frequently recorded species during the first visit are presented. Full list of species is in Table S2.

Species	First visit	Second visit
lesser whitethroat *Sylvia curruca*	48.6	48.6
Eurasian tree sparrow *Passer montanus*	45.7	40.0
great tit *Parus major*	40.0	31.4
great spotted woodpecker *Dendrocopos major*	40.0	45.7
blue tit *Cyanistes caeruleus*	37.1	20.0
common wood pigeon *Columba palumbus*	34.3	22.9
European robin *Erithacus rubecula*	31.4	25.7
yellowhammer *Emberiza citrinella*	28.6	28.6
song thrush *Turdus philomelos*	25.7	48.6
common pheasant *Phasianus colchicus*	22.9	14.3

and great spotted woodpecker (*Dendrocopos major*). These species were recorded on average in 42.5% of visits (n = 70) only in the power line transect (Table 2).

Electricity transmission networks alter landscapes, modify habitats but the impacts of these changes on wildlife are known mostly for farmland. Uncropped habitats at pylon bases elevate species richness of plants and small mammals in crop fields (Kurek et al. 2016, Šálek et al. 2020), pylon constructions provide nesting opportunities (Tryjanowski et al. 2004, Bai et al. 2009, Moreira et al. 2018), and power lines host more bird species than surrounding open farmland habitats (Tryjanowski et al. 2014). In our study, we compared avian species richness and abundance in power line corridors and surrounding forested habitats. We found power line corridors hosted more individual birds and species than surrounding forest and we frequently detected open-habitat species in power line corridors. Our results indicate the importance of these anthropogenic habitats for avian communities, but also raise questions for future research.

Higher numbers of individual birds and species detected in power line corridors could reflect high habitat heterogeneity at these sites. The vegetation in these habitats is mowed regularly and creates patches of bare ground and heterogenous soil moisture patterns (Berg et al. 2013). Consequently, the plant communities are rich, frequently occupied by thermophilic and shade-intolerant plant species (Eldegard et al. 2015), which could provide more nesting opportunities, greater species richness and abundance of seeds, insects or high numbers of small mammals and birds. In croplands, pylon construction bases were found to host rich plant communities with more small mammals (Kurek et al. 2016, Šálek et al. 2020) than surrounding fields. The previous findings thus indirectly support our explanation of higher food availability for birds in power line corridors, though there are no studies directly focusing on food availability (e.g. seed or insect abundance) in power line corridors to date.

Lesser whitethroat, Eurasian tree sparrow, great tit and great spotted woodpecker were the most frequently detected species in power line corridors (Table S2). Both lesser whitethroat and Eurasian tree sparrow are species that breed in open habitats with shrub vegetation (Cramp 1992). Habitats below power lines thus appear to serve as a suitable breeding habitat for these species. In contrast, great tit and great spotted woodpecker are forest species and their high abundance in open habitats below power lines was therefore unexpected. However, dead trees occur frequently at the edge of power line clearings (our observation). Trees at the edge of power corridor clearings are likely stressed by direct exposure to sun or mowing activities and have thus higher mortality (McIntire et al. 2016). Dead trees host species rich insect communities (Hövemeyer & Schauermann 2003, Jonsell et al. 2005, Davies et al. 2008), offer nesting habitats for woodpeckers and consequently their cavities are used by other cavity-nesting species such as the great tit (Cramp 1992, Martin & Eadie 1999). To conclude, power line corridors and their management probably affect the surrounding tree vegetation via changes

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in light availability, temperature, and soil moisture and this can result in higher density of dead trees with positive implications for other organisms (Müller & Bütler 2010).

Power line corridors significantly differed in vegetation structure from adjacent forested transects. Visibility was much greater in the power line corridors and could result in higher estimates of species numbers and abundances. However, we argue that the impacts of such habitat differences should be negligible on the species numbers recorded, though we also suggest future studies should incorporate distance sampling to account for differences in detectability between habitats with different structure (Bibby et al. 2000). Future studies might also consider sampling bird communities along long transects to increase the probability of recording rare and endangered species, and to show the potential importance of these man-made habitats for these scarcer species (Donald et al. 2001).

We showed that regularly mowed power line corridors in forested areas can elevate the number of bird species and individuals. Our work thus complements previous findings for positive impacts of uncropped habitats around pylons (Tryjanowski et al. 2014, Kurek et al. 2015, 2016, Šálek et al. 2020), beside the widely known negative impacts of transmission systems for bird mortality caused by collisions and electrocution (Loss et al. 2014). We suggest future studies should focus on insect communities and insect biomass in these habitats compared to surrounding forests and to further develop the optimal period of vegetation growth and mowing periods maximising the positive outcomes for biodiversity in these habitats.

Acknowledgements

This work was supported by the Czech Science Foundation (grant no. 20-00648S). We thank Martin Paclík, Martin Šálek, Carl Smith and an anonymous reviewer for their critical comments. Data used in the manuscript are freely available from the Zenodo data repository (http://doi.org/10.5281/zenodo.4769872). Author contributions: V. Brlík conceived the idea. J. Hrouda collected the data. J. Hrouda and V. Brlík analysed the data and wrote the manuscript.

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Supplementary online material

Table S1. List of sampling sites, geographic coordinates, mean transect length and vegetation development in power line corridors.

Table S2. Full list of proportions of sampling sites where species were recorded in power line transect but were absent from control transects. Species are sorted in descending order according to their frequency during the first visit (first visit = 35, second visit = 35).

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