



## Notes and comments

# Relationship between traffic noise levels and song perch height in a common passerine bird



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## ABSTRACT

The man-made noise is one of the most serious problems that animals living in close contact with humans have to contend with, as it interferes with the transmission of information encoded in acoustic signals sent from emitter to receiver. Birds with their complex songs are particularly vulnerable to anthropogenic noise. This research analyses the selectivity of song posts of the robin *Erithacus rubecula* with respect to a number of habitat parameters and the traffic noise amplitude. The results indicate that the birds take active steps to avoid interference to their vocal communication in the vicinity of busy roads. The males in noisy territories sang from perches located higher above the ground. This is the first report to demonstrate the correlation between song post height and traffic noise levels in a common passerine bird. Very likely, the choice of perches situated higher up in the vegetation improves the robins' auditory perception of neighbouring rivals in an environment polluted by excessive noise levels. The differences in selectivity of song post location between areas with high and low intensities of noise may have serious consequences for the individuals concerned.

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## Introduction

The increasing pressure of human activities on the natural environment is having a whole range of serious adverse effects on living organisms (Benitez-López et al., 2010). One of the most serious threats resulting from the expansion of infrastructure and industry is omnipresent anthropogenic noise, which may significantly modify the behaviour and certain population parameters of animals (Forman and Sperling, 2003). Because birds communicate acoustically, they are especially endangered by such noise (Reijnen et al., 1997). Recent studies have shown that man-made noise is indeed having a significant influence on various bird species, reducing their breeding success, hampering the finding of a suitable mate and forcing them to change the bioacoustic parameters of the sounds they emit while singing during the mating season (Slabbekoorn and Peet, 2003; Halfwerk et al., 2012). The difficulties of vocal communication caused by traffic noise would appear to be one of the main problems affecting the birds inhabiting a noise-polluted area (Fuller et al., 2007). Nevertheless, recent work has shown that some bird species can adjust behaviour to a noisy environment and to offset the negative influence of noise bring into play such plastic responses as the Lombard effect, i.e. increasing the amplitude of the song (Brumm, 2004), raising the frequency spectrum of the song (Slabbekoorn and Peet, 2003; McLaughlin and Kunc, 2013), singing at a time of day when noise levels are lower (Fuller et al., 2007) and intensifying the level of vocalisations (Diaz et al., 2011).

During their transmission from source to receiver, acoustic signals are subject to attenuation and distortion (Wiley and Richards, 1978). All year round acoustic communication depends on the effective emission of sounds, auditory perception

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and the extraction of necessary information contained in the signal (Mathevon and Aubin, 1997; Mathevon et al., 2005). From the acoustic signals the receiver has to extract coded information on the identity, motivation and location of the emitter (Dabelsteen et al., 1993; Holland et al., 1998). To maximise the effectiveness of the sounds they transmit, animals should optimise the locations of the spots from which they emit acoustic signals and where auditory perception takes place (Wiley and Richards, 1978). Height differences in woodland between emitter and receiver can significantly affect communication between them (Holland et al., 1998). Behavioural changes while singing may ensue as a result of feedback from a bird's own internal auditory perception and/or feedback from a female or from males in adjacent breeding territories (Halfwerk et al., 2012). Recent experiments have demonstrated that to improve their auditory perception of sounds emitted by their neighbours, birds change the locations of their song posts by selecting tree branches that are farther away from the ground (Mathevon et al., 2005). One way of improving the detection of acoustic signals in a noise-polluted environment is to sing from a song post placed higher up in the vegetation. It is generally thought that high-lying song posts are advantageous to emitters, especially in long-distance communication (Wiley and Richards, 1978). However, singing from higher perches in forest is assumed to have a predation cost. Recent work has shown that these are the canopy parts more exposed to sparrowhawk *Accipiter nisus* attacks (Krams, 2001). To date, however, no field or experimental tests have been carried out to find out whether birds adjust the high heights of their perches in environments exposed to high noise levels (Møller, 2011).

The model species in this study was the European robin *Erithacus rubecula*, a species that defends its territory year round (Cramp, 1988). The main function of bird song is to attract a female and to defend a territory. The song is emitted in a frequency range from 2 to 9 kHz, and the repertoire varies widely within and between individuals. Woodland birds often choose certain layers of vegetation from which to sing, which are not necessarily preferred for other activities like foraging (Wiley and Richards, 1978). Robins usually choose song posts located fairly low down, usually 1–3 m above the ground, and they often use the same site, even when plenty of alternative ones are available (Cramp, 1988). Recent studies and experiments have shown that anthropogenic noise has an effect on robin song and individuals can adjust behaviour to a noisy environment (Fuller et al., 2007; McLaughlin and Kunc, 2013; Montague et al., 2013; McMullen et al., 2014). In the present work I studied the selectivity of song posts of the robin in different acoustical conditions. If anthropogenic noise affects perch height selection I predict a positive relationship between background noise levels and song perch height, because birds should sing more from higher song posts to improve their ability to hear other birds singing in neighbouring territories (Dabelsteen et al., 1993; Mathevon et al., 2005).

## Methods

The study was carried out from 30th April until 22nd May in 2012 and 2013 in ten forest complexes directly adjacent to different national roads in eastern Poland. The study plots were located near the following villages: Sarny (N 51°34'; E 21°59'), Jaworów (N 51°31'; E 22°2'), Stasin (N 51°12'; E 22°26'), Podkrasne (N 50°50'; E 23°9'), Łopiennik (N 51°1'; E 23°4'), Pikule (N 50°40'; E 22°20'), Zalesie (N 51°22'; E 22°37'), Wandzin (N 51°23'; E 22°38'), Sobieszczany (N 51°2'; E 22°22'), Pułankowice (N 50°57'; E 22°16'). The dominant tree species in these woodlands were scots pine *Pinus sylvestris*, pedunculate oak *Quercus robur* and hornbeam *Carpinus betulus* aged from 56 to 166 years (data from actual forest maps). The intensity of traffic on the road sections investigated was ca. 8000–20 000 vehicles in 24 h. To avoid pseudoreplication, each forest complex was checked just once. The observer walked along a transect (randomly chosen from two transects) parallel to the road and 100 m from it. On detecting a singing bird, the observer approached it to record the significant environmental parameters at that song post. A full set of measurements was obtained for 24 singing robins. The location of each song post was logged on a GPS receiver. The level of traffic noise was measured at a height of 1.5 m above the ground during a period of 5 min using a digital sound meter CHY 650 (IEC 651-1979 Type 2, ANSI S1.4-1983 Type 2, JIS C 1502) with A-frequency-weighting and set to the SLOW option. The maximum amplitude of noise recorded during this period was used in the subsequent analysis. The birds chose nine species of trees. Tree and song post heights were measured with a Silva CM 1015/2025 PA (Silva Sweden AB) clinometer accurate to 50 cm (for song posts located up to 20 m above ground level) and to 25 cm (<20 m). To check the robins' tree height preferences, the heights of 116 other trees (selected at random every 200 m along a transect) were measured at all the localities. The structure of the vegetation at every sampling and control point was assessed by use the same methods. The diameter at breast height (DBH) of trees was measured with a tape accurate to 1 cm. The canopy and bush cover were determined 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). The distance of the bird from the road was taken to be the shortest straight-line distance between the tree used as a song post and the centreline of the roadway, as measured by the GPS receiver. The number of tree species among the 30 nearest trees with DBH > 20 cm was counted. Song-post measurements were made throughout the day from 07:35 to 18:50 h. Observations were carried out on weekdays only in rain-free stable weather conditions, at temperatures from 11 to 28 °C, air humidity from 55% to 80% and wind speeds <4 m/s. The means are given together with their standard deviations ± SD.

## Results

The average distance between the song-post tree and the roadway centreline was 115.5 ± 61.5 m (15–233 m,  $n = 24$ , Table 1). 38% of all tested robins sang in close proximity to the roads (<100 m). The level of traffic noise in the robin

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