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Notes and comments

Edge effect of busy high traffic roads on the nest site selection of birds inside the city area: Guild response

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ABSTRACT

The rapid development of road infrastructure is inevitable with increasing world human population and rise in the number of vehicles on the roads is going to be an increasing threat to native habitat of many wildlife populations around the world. The present work examines the edge effect of high traffic roads on nest site selection of birds in Udaipur city, Rajasthan (India). A total of 112 nesting site of 14 bird species (among six guilds), was recorded during the study. All six guilds (i.e., carnivore, omnivore, granivore, nectivore, frugivore and insectivore) were sharing similar kind of habitat with fine scale differences ($P < 0.0001$). The PCA revealed that trees with suitable GBH, canopy and height were supporting birds' nesting diversity, but the buildings were supporting the highest number of nesting. Different guilds showed different preference to different variables. Spatial heterogeneity, less predation, optimal feeding ground and higher number of advertising and display boards of shops at roadside buildings might be crucial factors for birds' nesting in this highly disturbed area.

1. Introduction

The rapid development of road infrastructure and rise in number of vehicles on the roads is going to be an increasing threat to native habitat of many wildlife populations around the world (McGregor et al., 2008; Polak et al., 2013; Chen and Koprowski, 2016a). In the case of birds, the literature has shown that occurrence, abundance and species richness of birds is reduced near to roads. This reduction is larger near high-traffic roads than low-traffic roads (Summers et al., 2011). Roads as physical encroachment gives rise to disturbance and barrier effects that contribute to habitat fragmentation, disturb and pollute the physical, chemical and biological environment (Laurance et al., 2004; Chen and Koprowski, 2016b). Indirect effects include noise and artificial light influence avian biorhythms regarding to development, singing patterns, breeding, molting and migration (De Molenaar et al., 2006; Morelli et al., 2014). The traffic activity associated with roads may affect habitat use by breeding birds and nesting predators (Pescador and Peris, 2007; Parris and Schneider, 2008). Collision with road traffic causes death of many birds, mostly native, and growing constantly over the years (Erritzoe et al., 2003). Most of the studies (Iglesias-Merchán and Diaz-Balteiro, 2016; D'Amico et al., 2016) argued or assumed that the disturbance by traffic noise is main cause of breeding birds' responses to traffic roads, while Summers et al. (2011) highlighted road mortality for decreasing bird species richness/abundance proximity to roads than traffic noise. Deicing agents, petroleum-based organic compounds, sediments and other substances regularly run off on roads during construction, main-

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tenance, and use (Kociolek et al., 2011; Karlson et al., 2014). Road salt also attracts birds and its ingestion can lead to death (Findlay and Kelly, 2011). Dust on roads changes vegetation composition (Farmer, 1993; Spellerberg, 1998), which can also affect birds. Pollution appears to have fewer effects than other road related effects (Kociolek et al., 2011). Although the ubiquity of road contaminants, toxic effect of roads appears to be rare, even in areas with high traffic volumes (D'Amico et al., 2016).

Some studies (Whitford, 1985; Byrkjedal et al., 2012; Kmetova et al., 2012; Morelli, 2013; Morelli et al., 2014) also recorded positive effects of roads and related structures on bird species and communities. Roads or highways are provide foraging habitat due to an increase of food availability associated with roadkills (Dean and Milton, 2003), reduce the predation pressure due to minor presence of natural predators and also provide warm surface or microenvironment that help birds to conserve metabolic energy (Whitford, 1985). Roadside vegetation, open space and artificial lights provide foraging habitat due to increasing food availability (Byrkjedal et al., 2012). Powerlines, barbed wires, signboards and other human structures associated to roadsides often used as song-posts by birds (Morelli et al., 2014) and also offer perch sites for hunting activities especially for insectivorous species and raptors (Ceresa et al., 2012; Kmetova et al., 2012; Morelli, 2013). Trees near roads, bridges and pylons offer safe nesting places due to a higher habitat complexity in city areas (Leveau and Leveau, 2005).

As the world human population increases, expansion of road network associated with urban areas is inevitable. The associated ecological footprint is already too large and continuously growing (Morelli et al., 2014). Various urban ecological studies (Fernandez-juricic, 2000; Brook et al., 2003; Peris and Pescador, 2004; Yang et al., 2015) underline the importance of identifying different urban structures and habitats which are supporting several bird species and different responses for different bird species. Many times even the same bird species and guild display different responses to urbanization (Lim and Sodhi, 2004). Moreover, Jaeger et al. (2005) highlighted that each species has a capacity, called "road avoiding behaviour", to reduce the negative effects of roads that make individuals enable to use road and roadside as optimal habitats. Therefore, a more appropriate and accurate knowledge and understanding the relationships among birds and roads should be useful for conservation-focused road infrastructure planning.

Erritzoe et al. (2003) found a greater abundance of birds and species richness on roadsides than adjacent fields. Studies on edge effects of various habitats provide contradictory results. Elevated nest predation rates have been recorded in some landscape edges (Burkey, 1993; Paton, 1994; Pescador and Peris, 2007), while in others no edge effect is evident (Esler and Grand, 1993; Nour et al., 1993).

Nest-site selection is closely associated to fitness owing to the effect on offspring production (Martm and Roper, 1988). Individuals nesting near suboptimal habitat may have depressed reproductive success compared to others in the population. Beside many negative effects of road and increasing human infrastructure, various bird species often use and nesting in roadside edge habitat (Morelli, 2013). In the present investigation, we studied nest site selection of birds in this highly disturb microclimate in the city area and our objectives were (1) to identify nested bird species and prefer nest sites, (2) response of the bird guild to nest site selection and (3) identify the important habitat variables influence nest site selection.

2. Study site and methods

Research was carried out in Udaipur city (28.58°N, 73.68°E), Rajasthan, India (Fig. 1). According to 2011 population census, conducted by the Indian Government, current population density is 262 humans per square kilometer and city land area is around 40 km^2. Urban space includes mosaic of different habitat types, such as public parks, forest fragments, agriculture fields, institutional green spaces, protected area (i.e., Sajjangarh Wildlife Sanctuary), constructed areas and lakes system (Mehra et al., 2014). The city is encircled by Aravallis Mountain range, elevation range from 558 to 767 m msl, and Ahar river flows diagonally from north-west to south-west in city (Koli et al., 2011). The climate is tropical and mean monthly temperature range from 20 °C in January to 34 °C in May. The area is characterized by three distinct seasons; summer (March–June), Monsoon (July–October) and Winter (November–February), while mean annual precipitation is 654.3 mm.

Six roads vary in length (Fig. 1) with high traffic (where >45 pedestrians and >170 vehicles pass per hour) were selected amid city to understand the road side nest site selection of birds. Pedestrian surveys were conducted during morning session to record nesting sites in May and June 2016. During the survey, we found many uncompleted and non-active nests, but for study purpose, only active nests were recorded which indicated by the presence of at least one bird or nestlings tending the nest. The width of the strip either road side varies from 5 to 20 m according to visibility and building locations. Ali and Ripley (2007) was followed for scientific names and feeding guild of recorded bird species.

Wherever an active nest was found, following parameters were recorded without disturbing nest and nesting bird; bird species, GPS location of nesting sites, nest site height (NSH), if nest found on a tree then nest tree species, nest height (m, NH), nest site type (NS, i.e., buildings, tree, pipe hole, electric pole, bridge cavity, on ground and mobile tower), distance to road (m, DTR), distance to building (m, DTB), distance to water resources (m, DTW; water resource available for bird' use i.e., drinking, bathing), distance to bin center (m, DTBin; a site of garbage generally for household waste), distance to food center (m, DTF; a site where food vendor prepares food and sell) and disturbance level (DL) at site. The nesting tree attributes were recorded include tree height (m), GBH (girth at breast height, m), and canopy cover (m^2, CA). Nest heights and nest site heights were measured using clinometer, while GBH was measured at 1.8 m height above the ground using measuring tape. Disturbance level at nest site was recorded according to Soh et al. (2002) by recording the number of passing pedestrians, number of passing vehicles and parked vehicles within 30 m of nesting site during morning' peak time from 07.30 to