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The effects of extreme forest fragmentation on the bird community of Singapore Island

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Abstract

Singapore Island suffered one of the highest known deforestation rates in the tropics from the mid-to-late 19th century when over 95% of its native lowland forest was cleared. We compared the current bird community structure and composition among three habitat types, i.e., old (>50 years, 7–935 ha) and young ($\leqslant$ 50 years, 29–49 ha) naturally regenerating secondary forests and abandoned wooded plantations (27–102 ha) dominated by exotic species. Forest patch area had the strongest influence on the current species richness. The overall bird richness was not greater in most mature forest patches, but 20 species were only found in the old secondary forests and five of these were found in <50% of these patches. The rapid decrease in the number of forest species in plantations was offset by an increase in the number of open habitat species. Comparisons with current bird communities in nearby mainland forest sites (Peninsular Malaysia) suggest that the forest avifauna of Singapore is depauperate. The preservation of larger mature and maturing forests is therefore required for conserving the extant forest avifauna in Singapore. Connecting isolated patches can also be envisioned to facilitate movements of forest birds that have low densities and restricted distribution.

Keywords: Tropical forest; Habitat degradation; Conservation; Avifauna; Island; Southeast Asia

1. Introduction

Tropical rainforests are unique sources of biodiversity and most of them are disappearing at an alarming rate (Achard et al., 2002). Lowland tropical forests in particular (below 1000 m) are being lost or degraded by logging, hunting, cultivation or urbanisation (Laurance, 1999). Extinctions within the tropical belt primarily as a result of the inability of biotic communities to withstand these environmental changes have been reported (Leck, 1979; Karr, 1982; Brash, 1987; Diamond et al., 1987; Newmark, 1991; Castelletta et al., 2000). Studies on the impact of deforestation and related disturbances on the tropical wildlife are needed to determine the conservation value of remaining disturbed and isolated forests. Such studies are few from Southeast Asia where deforestation has been rapid and extensive (Laurance, 1999; Achard et al., 2002).

We studied the landbird fauna of Singapore because it provides one of the most extreme cases of tropical deforestation in the world, with a moderate level of insularisation (Turner et al., 1997). It is a relatively small island (585 km^2), at the tip of the Malay Peninsula and it was originally covered with dense rainforest. On the island, heavy deforestation started shortly after 1819, pristine forests were cut, then cultivated or left to regenerate when not used for urbanisation and construction of water reservoirs (Fig. 1; Corlett, 1992). Only a tiny fraction of the natural forest (0.04%) remained unexploited and this was reduced to small disturbed fragments now scattered in a highly urbanised matrix. Thus, the local forest bird community, already affected by its insular situation, suffered the cumulative effects of habitat reduction, fragmentation and degradation. The

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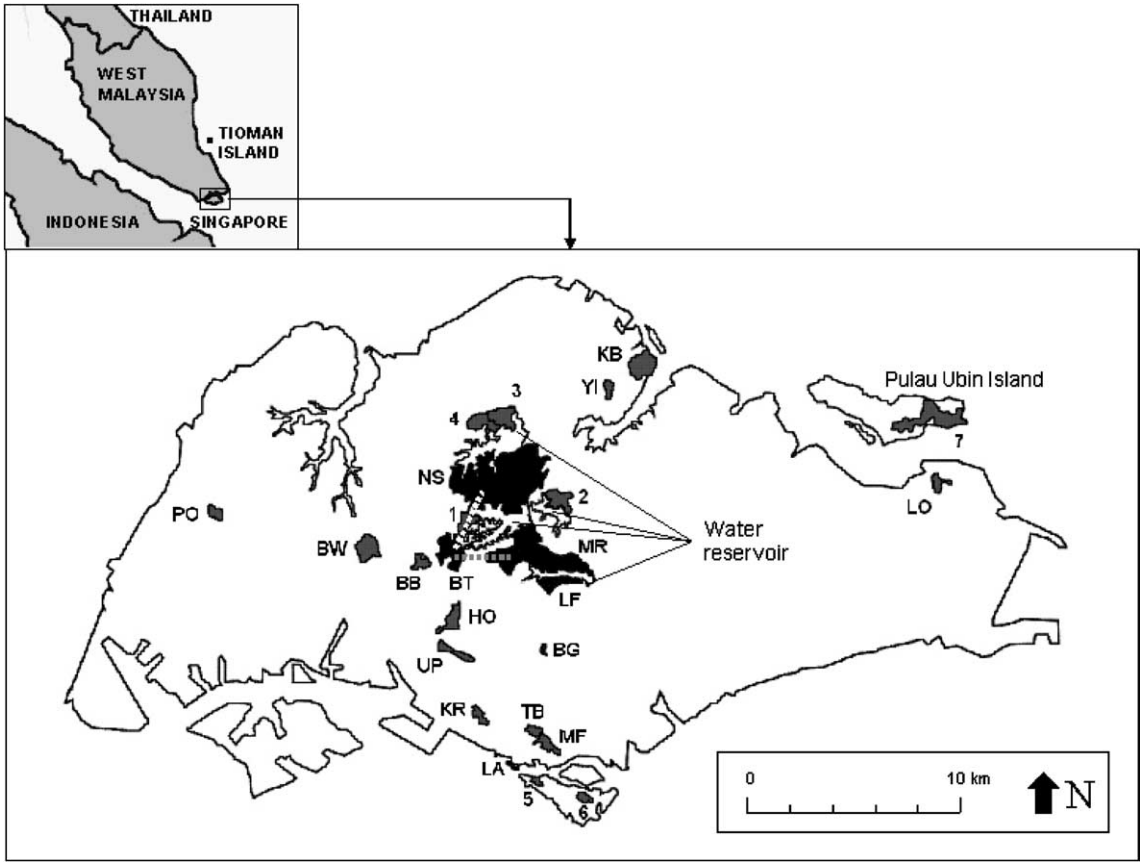

Fig. 1. A regional map of Southeast Asia with Singapore's location. Enlarged view of Singapore showing the location of the study patches (initials, see Table 1). Patches only used for isolation measurements are indicated by a number with 1 = Chesnut Peninsula Forest, 2 = Lower Pierce Forest, 3 = Upper Seletar Peninsula Forest, 4 = Seletar Forest, 5 = Mount Imbiah Park, 6 = Mount Serapong Wood, 7 = Ubin Island East Wood. Dotted lines indicate where patches could be connected.

deforestation and concomitant large-scale fragmentation of the forest has had detrimental effects on the forest bird community in Singapore as >90% of the forest avifauna has been lost (Castelletta et al., 2000).

The aim of this study was to assess the conservation value of existing remnant and regenerating forests for the forest avifauna of Singapore. We determined the effects of variables such as patch size, forest type, isolation and vegetation characteristics on the bird community. Such variables have been previously found to affect the forest bird diversity (e.g., Pearson, 1975; Opdam et al., 1985; Rotenberry, 1985; Bierregaard et al., 1992; Schmiegelow et al., 1997).

We also make two comparisons with neighbouring Peninsular Malaysia. First, to determine the conservation importance of different Singaporean patches, we compared their bird richness with that in larger and less disturbed forests of nearby Peninsular Malaysia. Second, we compared bird community similarity of our forested patches with regenerating Malaysian forests to determine whether degraded forests have similar bird richness. Important conservation implications of our case study include identifying priority habitats and sites for conservation in Singapore, and management directions needed to stop any further impoverishment of the island's forest bird richness. Our results also have conservation relevance for degrading forested landscapes within Southeast Asia.

2. Study area

Singapore is a tropical Southeast Asian island that lies between 1°09′N–1°29′N and 103°38′E–104°06′E. It has a maximum diameter of 23 km (N–S)–42 km (E–W) and is only separated from southern Peninsular Malaysia by the 1.4 km Straits of Johor. Most of the country is lowland reaching a maximum elevation of 163 m at the Bukit Timah Nature Reserve. The close proximity of Singapore to the equator accounts for a typical equatorial climate characterised by high mean annual temperatures (30 °C) and high average daily humidity of 90% (Corlett, 1992; Jeyarajasingam and Pearson, 1999). The mean annual rainfall is over 2000 mm and exceeds 100 mm even in the driest months. The main wet season