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Review paper

Mammalian communities as indicators of disturbance across Indonesian Borneo

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ABSTRACT

Using camera traps at eight grids across Indonesian Borneo we show how mammalian species assemblages can provide reliable information about how disturbance affects a forest. This enables us to use the large mammal community structure at each site to assess the impacts of human disturbance and habitat variables. Occupancy ranged from 0.01–0.77 with pig-tailed macaques, muntjac, orang-utans, sun bears, bearded pigs and common porcupines consistently having an occupancy of >0.5. These large mammals were generally making use of the whole forest surveyed and avoided the forest edge in only a few grids. A General Linear Model with general contrasts and survey effort as a covariate was performed to assess the impact of different variables. Logging and hunting were positively associated with low species number ($F = 6.3$, $p = 0.012$ and $F = 5.4$, $p = 0.003$ respectively). Logging and hunting contributed to a low % of carnivorous species ($F = 1.5$, $p = 0.021$ and $F = 4.8$, $p = 0.041$ respectively) and a higher % of IUCN Endangered and Vulnerable species ($F = 5.9$, $p = 0.044$ and $F = 5.0$, $p = 0.044$ respectively). The presence of burnt areas within the study grids was positively associated with reduced species numbers ($F = 5.3$, $p = 0.018$) and reducted % of carnivorous species ($F = 6.8$, $p = 0.023$) but not the % of IUCN Endangered and Vulnerable species. This is likely a result of burnt areas reducing the area of suitable habitat for many mammals. The proximity of the grids to roads, villages, rivers and presence of logging camps have been proposed as suitable parameters to indicate disturbance. In our study none of these parameters significantly affected the total species numbers, % of carnivores, and % of IUCN concern (Endangered and Vulnerable), nor did the protected status of the forest. We have identified 4 species as specific indicators whose presence or absence can help determine the type and/or extent of forest disturbance and/or be a proxy indicator for the presence of other species. Leopard cat (*Prionailurus bengalensis*) and pig-tailed macaques (*Macaca nemestrina,* generalists); sambar deer (*Rusa unicolour,* large, wide-ranging herbivores) and clouded leopards (*Neofelis diardi*) as a proxy for at least 2 of the smaller felid species.

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Contents

1. Introduction

Logging continues at a rapid rate in many tropical forests and has mixed effects on forest animal diversity (van Niewstadt et al., 2001; Wells et al., 2004; Meijaard et al., 2005; Wilcove et al., 2013). The effects of logging also change over time. Species composition in logged forests approaches that of unlogged forests just a few decades after logging has ceased (Danielsen and Heegaard, 1994; Slik and Verburg, 2002; Brodie et al., 2014). Selectively logged forests are becoming an increasingly dominant component of many tropical landscapes and yet, the conservation value of selectively logged tropical forests is less understood (Burivalova et al., 2014) than those of more dramatic land cover changes, such as deforestation driven by agriculture or tree-plantation developments (Estrada and CoatesEstrada, 1996; Meittinen et al., 2012).

Hunting occurs over even larger areas in the tropics than logging, and often, though not always, accompanies logging (Waltert et al., 2002; Brodie et al., 2014). It is also important to determine whether impacts of logging and hunting are correlated across species. Certain taxa, particularly large herbivores, may be vulnerable to extirpation due to both logging and hunting (leading to a positive correlation between the impacts of logging and hunting) or susceptible to either hunting or logging but not the other (no correlation) (Ripple et al., 2015).

Sundaland, encompassing the Malay Peninsula, as well as the islands of Borneo, Java, and Sumatra, contains one of the richest concentrations of biodiversity on earth, and preserving it is a priority for global biodiversity conservation (Myers et al., 2000). The island of Borneo covers less than 0.2% of the earth's land surface (743,330 km^2), yet is home to 4% of the world's plant species and 5% of birds and mammals (MacKinnon et al., 1996b) including up to 15,000 species of flowering plants (as many as the whole African continent), 3000 species of trees, 222 species of mammals and 420 species of resident birds (MacKinnon et al., 1996b). It is also home to 13 non-human primate species, eight of which are endemic (Groves, 2001; Brandon-Jones et al., 2004).

Borneo's biodiversity is under threat from increasing anthropogenic disturbances such as mining and logging, land conversion for monocultures such as oil palm plantations and forest fires (Aldhous, 2004; Fuller et al., 2004). In addition, indirect destruction is caused by the infrastructure created to access mines/plantations etc. such as roads and settlements and pollution from agricultural and extractive industry as well as artisanal mining. The impact of hunting animals for meat and/or as a response to human-wildlife conflict is poorly documented and understood (e.g. Voss et al., 2001; Matthews, 2006; Peres and Palacios, 2007; Ancrenaz et al., 2013; Ancrenaz et al., 2015; Brodie et al., 2014; Gaveau et al., 2014). Hunting of wildlife is perceived to be widespread across Kalimantan (e.g. Meijaard, 2001; Struebig et al., 2007; Harrison et al., 2011; Cheyne et al., 2013. We used questionnaires to complement the camera trap surveys and provide insight into attitudes to conservation and wildlife and potential impact of hunting (direct or indirect) on Sunda clouded leopards (*Neofelis diardi*) and other species. We sought to gain a better understanding of villagers' dependency on natural resources, impact on biodiversity and the identification of environmental changes as perceived by locals who might indicate possible threats to nature and communities. We present a single approach method using camera traps at grids with very varied management, protected status, habitat, accessibility and levels of human disturbance. We recognise that no single method is likely to be ideal for all purposes, or even suitable for use in all forests Harrison et al., 2012a). Instead, we chose the best and most consistent method, camera trapping, to (1) make use of all the data, (2) remove the reliance on one or two elusive species (Dufrêne and Legendre, 1997; Carignan and Villard, 2001) and (3) provide reference/baseline data.