Journal for Nature Conservation 40 (2017) 113–119

Contents lists available at ScienceDirect

Journal for Nature Conservation

journal homepage: www.elsevier.com/locate/jnc

The conservation value of unlogged and logged forests for native mammals on the East Coast of Peninsular Malaysia

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ARTICLE INFO

Keywords:
Biodiversity
Forest reserve
Logging
Mammals
Species composition

ABSTRACT

Tropical forests across the world provide important habitats for a diverse number of conservation priority species, yet are under threat from a range of anthropogenic impacts including logging. This study aims to quantify mammalian biodiversity in unlogged and logged forests in the adjoining Tembat and Petuang Forest Reserves, Terengganu, on the East Coast of Peninsular Malaysia. Data was collected over a series of surveys using direct and indirect observation methods from 2008 to 2014. A total of 30 medium and large sized mammals species were identified, with 27 of those species found in unlogged forests and 22 species in logged forests. Carnivores encompassed 11 species from 67 observations representing 15% of the total number of observations. The family Felidae had the highest number of species (six species), followed by Hylobatidae, Cercopithecidae and Suidae with three species each. A total of 17 species contributed to more than 90% of the mammal community in the unlogged and logged forests, while six species were uncommon and only observed once during the entire survey. Species abundance in the unlogged forest was significantly greater than the logged forests, but the difference was not significant for species richness. This study provides critical baseline information on the impact of unlogged and logged forests and the identification of threatened species warrant the establishment of conservation measures such as anti-poaching patrol and ranger stations in the study area.

1. Introduction

Tropical rainforests are complex ecosystems that provide shelter and food sources to a vast number of fauna species, supporting more than 80% of terrestrial living organisms (World Bank, 2008), many of which are priorities for conservation (IUCN, 2006; Sodhi, Lian, Brook, & Ng, 2004). Forests also play important roles in the mitigation of the effects of climate change (Walton et al., 2015) primarily through the reduction of CO_2 in the atmosphere (Schlamadinger & Marland, 1996). However, around 13 million hectares of forests continue to be lost globally every year (FAO, 2010a) and about 200 km^2 each day (IUCN, 2015).

Tropical rainforests are threatened by multiple anthropogenic factors including logging, expansion of agricultural land, introduction of invasive species, wildfires, hunting, mining activities and dam construction (De Thoisy, Renoux, & Julliot, 2005; Brook, Sodhi, & Bradshaw, 2008; Olupot, Barigyira, & Chapman, 2009). Deforestation due to human population expansion and economic activities is the primary threat to tropical forest sustainability (Phillips, 1997; DeFries Rudel, Uriarte, & Hansen, 2010; Southworth, Nagendra, & Cassidy, 2012). Globally the rate of forest conversion to other uses or lost through natural causes has decreased from 16 million hectares per year in the 1990s to 13 million hectares a year in the last decade. Nevertheless, the FAO still considers the rate of forest loss alarmingly high (FAO, 2010a). Logging activity for forest production, even when conducted selectively (Martin, Newton, Pfeifer, Khoo, & Bullock, 2015; Burivalova, Sekercioglu, & Koh, 2014; Edwards & Laurance, 2013) and forest conversion into agriculture are the main factors responsible for forest loss and in turn biodiversity loss (Green, Cornell, & Balmford, 2005; Gaveau, Wandono, & Setiabudi, 2007; Fitzherbert et al., 2008). Furthermore, tropical species appear more susceptible to disturbance, thus leading to high levels of extinction in tropical regions (Vamosi & Vamosi, 2008).

The focus of this study is on Malaysia, a high biodiversity region in Southeast Asia (Myers, Mittermeier, Mittermeier, Da Fonseca, & Kent, 2000; Sodhi et al., 2004), found within the Sundaland hotspot, one of

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http://dx.doi.org/10.1016/j.jnc.2017.10.005
Received 16 June 2017; Received in revised form 6 October 2017; Accepted 24 October 2017

25 global biodiversity hotspots identified by Myers et al. (2000). Like other tropical countries Malaysian forest and biodiversity are also under threat, however, the average annual forest loss from 2005 to 2010 was estimated to be modest, at approximately 0.42% (FAO, 2010a) and this loss is largely attributable to planned land-use changes in line with national development policies. Approximately 45% of Peninsular Malaysia's landscapes are forested land with the production forest covering 116,070 km^2 and protection forest are 46,400 km^2 (FAO, 2010b). Logging of the dominant dipterocarp forests in Peninsular Malaysia is conducted through a Selective Management System (SMS) since 1978 (Appanah & Weiland, 1993); a form of selective felling with diameter limits (Appanah & Weinland, 1993). The harvesting cycle under the SMS is 30 years (Okuda et al., 2003).

Protecting large areas of suitable habitat for mammals is required to avoid further species loss (Francis, 2008) in Peninsular Malaysia (western part of the country), which hosts some 229 species of mammals (Davison & Zubaid, 2007). Of particular concern are threats to medium and large size mammals, which play important ecological roles in tropical ecosystems, especially for seed dispersal (Campos-Arceiz, Traeholt, Jaffar, Santamaria, & Corlett, 2012; O'Farrill, Galetti, & Campos-Arceiz, 2013; Sato, 2014). Even though mammals are one of the most thoroughly studied taxa (Rowe, 1988), attempts at quantifying and conserving mammalian biodiversity are hindered by insufficient data (Jones & Safi, 2011). In Peninsular Malaysia, most protected areas comprise unlogged forests, however, little is known about mammalian biodiversity in forest reserves where logging is being undertaken.

The objective of this study was to quantify and compare mammalian biodiversity in unlogged and logged Malaysian tropical forests. A series of mammal surveys were conducted between 2008 and 2014 in logged and unlogged forest in Reserves in Terengganu. Firstly, we assessed diversity for a number of taxonomic ranks (order, family and species) of medium and large sized mammals in unlogged and logged forests. We then compared species richness and abundance based on feeding guilds. Lastly, we compared survey observations made using animal signs versus direct visual observations. We conclude by discussing the differences in diversity recorded in unlogged versus logged forest, then examine the rare species recorded and finally the implications of our research for the conservation and future research directions for the assessment of medium and large sized mammals in tropical forests in Malaysia.

2. Methods

2.1. Study area

This study was conducted in two adjoining forest reserves, the Tembat Forest Reserve (TFR) and Petuang Forest Reserve (PFR), in Hulu Terengganu, on the east coast of Peninsular Malaysia (Fig. 1). Together these reserves encompass an area of approximately 1722 km^2 and are part of Greater Taman Negara. They are connected to Taman Negara Terengganu (national park) in the south-west, and the Kenyir Lake in the south-east. TFR and PFR include wildlife linkages which contribute to the Central Forest Spine Project, a national wildlife corridor scheme. These linkages are composed of unlogged forests which connect Taman Negara National Parks and the TFR to adjoining forest complexes in Peninsular Malaysia.

The Malaysian government has approved a second dam project within TFR and PFR, which covers 572 km^2, including a 62 km^2 inundation area and 520 km^2 water catchment area. A total of 186 km^2 has been clear felled since 2014 to make way for this project. The areas surrounding the tributaries of the Terengganu river, the Pelagung River and Puah River, were logged in the early 2000s. While other areas in the PFR are protected from logging as they are classified as forests for soil protection due to steep slopes of more than 40° and/or altitudes of more than 1000 m. The forest in the study site are categorised as lowland dipterocarp forest to hill dipterocarp forest, with altitudes that range between 150 m and 420 m.

2.2. Animal sampling

Wildlife surveys were conducted in the study region by the Department of Wildlife and National Parks (DWNP). A total of 28 predetermined transects, 14 in unlogged and 14 in logged forests were surveyed annually from 2008 to 2014. The transect lengths were 15 kilometres and were spaced at 2–5 kilometre intervals apart to avoid intersecting. The survey rate was approximately 2.50–3.75 kilometres per day or 0.42–0.625 kilometres per hour, depending on the topography and forest conditions. In the case of rain, the survey was stopped temporarily until the weather was more favourable for surveying.

The survey teams were deployed at one end of each of the transect simultaneously on the same day, which were accessed mostly via logging roads. Team members were mainly experienced DWNP rangers with at least five years field experience and had been trained to identify mammal species based on animal tracks (Fig. 2). Each team was given four days to complete the transect. Once the survey started, each team followed animal paths, old trails, footpaths and old logging roads while maintaining the general direction of the transect. The survey teams started as early as 8:30 amto increase opportunities to encounter wildlife and stopped for a breaks every 45 min for approximately 15 min until the team reached the desired camp location at approximately 4.30 pm.

The observation methods used during the survey were direct and indirect observations. Direct observations were based on visual identification. However, due to the difficulty of observing animals for long periods of time observers needed to have considerable expertise and only confirmed identifications were recorded. All species identification followed Francis (2008). Indirect observation methods during these surveys were based on the identification and interpretation of field signs. The field signs observed during these surveys include vocalisation, footprints, scrapes and scratches, feeding signs, identification of faeces, carcases and wallows.

2.3. Data analysis

We used similarity percentage (SIMPER) one-way analysis in PRIMER 7 to identify which species contributed most to the differences in species composition in both forest types (i.e. logged and unlogged) (Clarke & Warwick, 2001). We made an assumption that all observations in each transect were independent of each other (i.e. the same individual was not observed twice).

For comparison and correlation between samples the data analyses were carried out in GenStat Release 12.1 software (12nd Edition). A two-sample Poisson Test was used to test the difference between species abundance and richness. We also made a comparison of the number of individuals from different feeding guilds in samples by using the two-sample Poisson Test. Finally, we used the two-sample Poisson Test to assess the importance of observation modes (i.e. direct versus indirect).

3. Results

3.1. Species composition

A total of 449 animal observations were recorded from 2008 to 2014. In total, 30 mammal species were recorded representing 27 genera, 15 families and seven orders of medium and large sized mammals (Table 1). A total of one, seven, and ten species recorded were listed by IUCN (2016) as critically endangered, endangered, and vulnerable respectively (Table 1). Carnivores were observed 67 times or 15% of the total observations, consisting of 11 species from five families, namely, Ursidae, Felidae, Mustelidae, Viverridae and Canidae. Among these families, Ursidae, which was represented by the Malayan