

# Ecology, occurrence and distribution of wild felids in Sarawak, Malaysian Borneo

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**Abstract** Sarawak is the largest state in the megadiverse country of Malaysia. Its rich biodiversity is threatened by land-use change and hunting, with mammalian carnivores particularly affected. Data on the ecology, occurrence and distribution of small carnivores are crucial to inform their effective conservation, but no large-scale assessments have previously been conducted in Sarawak. Here we examine the status of the five species of felids in Sarawak based on data from camera-trap studies over 17 years (May 2003–February 2021) across 31 study areas, including protected areas of various sizes, production forests and forest matrix within oil palm plantations. Felids were detected at 39% of 845 camera stations. The marbled cat *Pardofelis marmorata* and Sunda clouded leopard *Neofelis diardi* had higher probabilities of occurrence in protected than unprotected areas, and vice versa for the leopard cat *Prionailurus bengalensis* and bay cat *Catopuma badia*. The marbled and bay cats were mostly diurnal, and the leopard cat was predominantly nocturnal; activity patterns did not substantively differ between protected and unprotected sites. The probabilities of occurrence of marbled and bay cats increased with greater distance from roads. The leopard cat and flat-headed cat *Prionailurus planiceps* were more likely, and the clouded leopard less likely, to occur near rivers. Flat-headed cats preferred peat swamp forest, bay cats lowland forest, and marbled cats and clouded leopards occurred in both lowland and montane forest. Felids may tolerate higher elevations to avoid anthropogenic disturbance; therefore, it is critical to preserve lowland and mid-elevation habitats that provide refugia from climate change and the destruction of lowland habitat.

**Keywords** Felids, fragmentation, habitat loss, land-use change, logging, occurrence, oil palm, protected area

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## Introduction

Located in a global biodiversity hotspot, Sarawak, the largest state in Malaysia, has high species diversity and endemism, but this biodiversity is threatened by intense anthropogenic impacts (Ling & Julia, 2012; Hon & Shibata, 2013; Mathai et al., 2016) such as rapid land-use change (Wilcove & Koh, 2010). The expansion of oil palm plantations and logging operations, for example, has reduced natural habitats for many species of conservation concern (Mathai et al., 2010, 2016; Gerber et al., 2012; Hon & Shibata, 2013; Runting et al., 2015; Caruso et al., 2016). The average deforestation rate in Borneo is c. 0.25 million ha annually (Gaveau et al., 2019) and Sarawak lost c. 80% of its primary forest during 1973–2015 (Gaveau et al., 2016). In addition, the development of roads has increased access into previously remote areas, facilitating hunting and other extractive activities. Although hunters in Borneo do not usually target felids, they may take them opportunistically (Kerley et al., 2003; Brodie et al., 2015b; Mohd-Azlan et al., 2017), and larger felid species may be affected by hunting-induced prey depletion. Hunting poses a greater long-term threat than logging to 91% of Bornean primates and ungulates because hunters continue to operate even in overexploited areas (Brodie et al., 2015b). The decline of carnivores can have cascading effects on ecosystems, as they can be important for regulating prey populations or dispersing plant seeds (Mathai et al., 2010; but see Brodie & Giordano, 2013).

Felids are often regarded as charismatic flagship species that can be used to highlight the conservation value of an area. However, little is known about the distribution and ecology of many felids in Sarawak. This scarcity of information on the ecological needs of felids poses a challenge for conservation planning in the state. Five wild felid species occur in Sarawak: the relatively large Sunda clouded leopard *Neofelis diardi* (11–25 kg), the medium-sized Bornean bay cat *Catopuma badia* (also referred to as *Pardofelis badia*; 3–5 kg) and marbled cat *Pardofelis marmorata* (2.5–5 kg),

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