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Protected area management priorities crucial for the future of Bornean elephants

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ABSTRACT

Tropical protected area management strategies have traditionally been heavily skewed towards high carbon, primary forests. This focus can result in areas, such as heavily logged forests, being viewed as low quality and thus offered up for conversion. We assessed the importance of intact to heavily logged forests for the Bornean elephant in the Malaysian state of Sabah. By modelling distributions of elephants throughout Sabah based on GPS telemetry tracking of 29 individuals and airborne three-dimensional forest mapping, we present the most wide-scale analysis of forest use by Bornean elephants to date. Forests of 13 m in stature were found to be of highest suitability for elephants, especially when these areas were flat and low lying. Forest statures of this order are consistent with degraded landscapes, often viewed as suitable for oil palm conversion. Less than a quarter of fully-protected intact forests in Sabah were of suitable stature for elephants, whereas disturbed commercial forest reserves were found to be highly suitable. We suggest that the importance of degraded landscapes for the future of elephants is currently underestimated, and thus, the need for the preservation of such habitats is not seen as a priority. The loss of these landscapes to large-scale agriculture could prove detrimental to the longevity of the species in Borneo.

1. Introduction

Land use change has had, and is predicted to have, the broadest negative effects on global biodiversity (Foley et al., 2005; Sala et al., 2000). Areas currently experiencing high rates of land-use change are tropical biomes, with this trend increasing (Hansen et al., 2013). Land use conversions occur for a variety of reasons including timber production, conversion to agriculture, mining, human settlements and many more (Brandt et al., 2016; DeFries et al., 2004; Laurance et al., 2014; Meyer and Turner, 1992). Furthermore, activity such as selective logging has the potential to degrade remaining habitat, which is often subsequently viewed as of lower conservation priority (Edwards et al., 2014). Rather, logged forests may represent a major, currently undervalued, tool for biodiversity conservation, with much of the original biodiversity often being maintained (Berry et al., 2010; Bicknell et al., 2015; Edwards et al., 2014; Prosser et al., 2016).

In Southeast Asian forests, selective logging has historically targeted valuable dipterocarps, which contributed ~80% of timber exports from the region between 2006 and 2007 (ITTO, 2008). Across studies, logged forests appear to maintain ~90% of original biodiversity, when compared to that of primary forest (Berry et al., 2010; Brodie et al., 2015; Meijaard et al., 2005). Retention forestry, whereby a proportion of original vegetation is left unlogged, has been shown to further reduce negative impacts on biodiversity (Fedrowitz et al., 2014; Gustafsson et al., 2012). Although myriad studies have examined the effects of logging on fauna (Prosser et al., 2016), many suffer from inconsistencies in design (Laufer et al., 2013). Furthermore, many meta-studies foster broad generalizations about selectively logged forests that may lead to misleading conclusions, particularly with regard to differing logging intensities (Burivalova et al., 2014). The effects of logging on large mammals present further challenges, with many species elusive and habitats inaccessible.

The Bornean elephant (*Elephas maximus borneensis*), as sub-species of the Asian elephant (*E. maximus*) and the largest mammal in Borneo,

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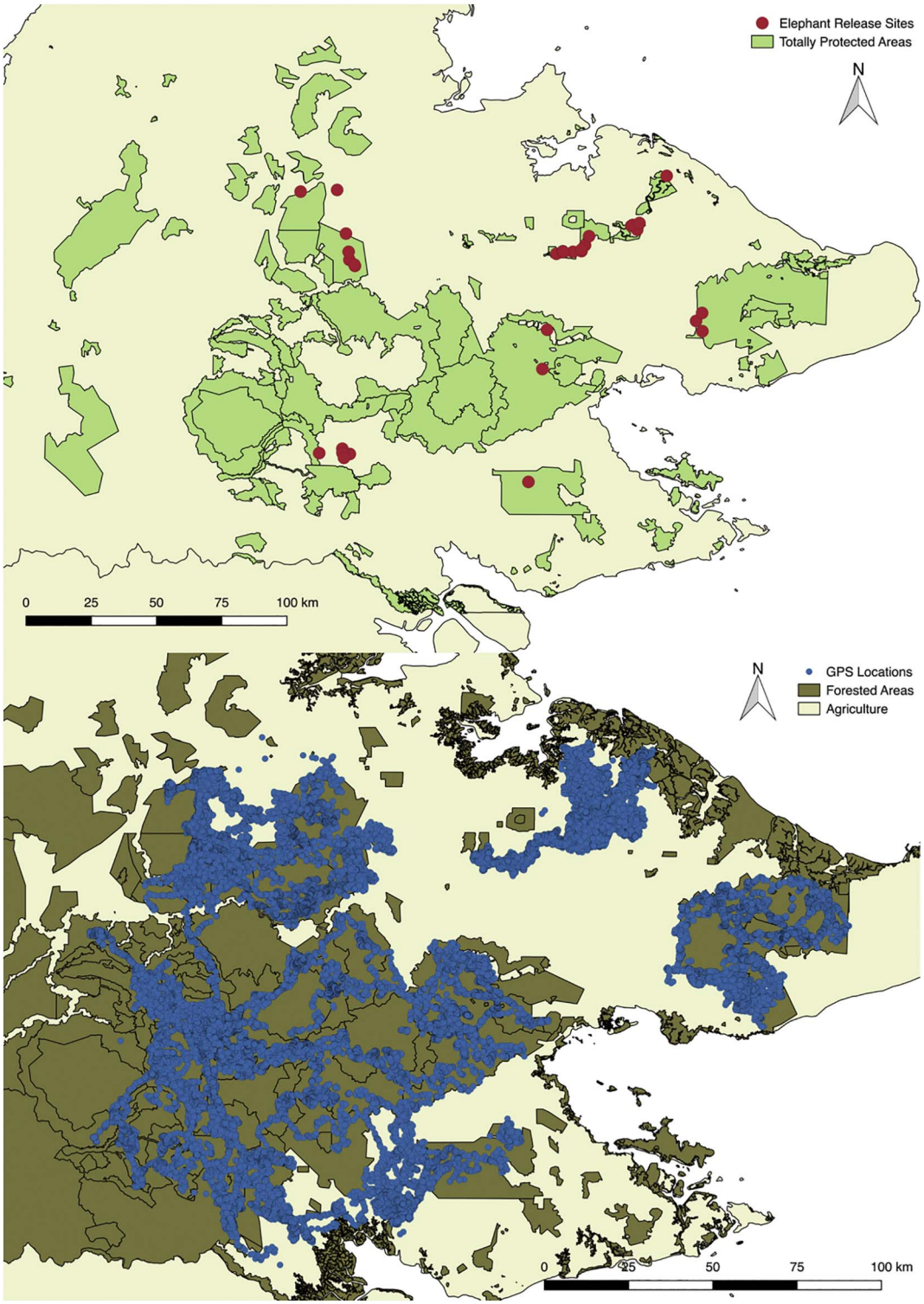

Fig. 1. a. Release locations of GPS collared elephants throughout Sabah. b. Location data for the metapopulation of GPS-tagged individual elephants indicating the spread of data.

is now thought to be indigenous to the island, with genetic evidence dispelling a widely held notion that the sub-species was introduced by humans (Fernando et al., 2003; Sharma et al., 2018). Asian elephants are broadly listed as endangered on the IUCN Red List (IUCN Red List, 2008), with Bornean elephants numbering just ~2040 individuals (Alfred et al., 2010). A large proportion of existing ecological research on Asian elephants has focused on populations in mainland Asia (Koirala et al., 2016; Kumar et al., 2010; Jathanna et al., 2015; Liu et al., 2016; Sukumar, 1990; Steinheim et al., 2005; Wadey et al., 2018). Mainland Asian elephants are found in a variety of habitats, ranging from savanna, where their presence is negatively associated with increasing rainfall and normalized difference vegetation index (NDVI) (Jathanna et al., 2015), to rainforest habitats, where riparian vegetation plays a key role in water and food availability (Kumar et al., 2010). Bornean elephants, conversely, being restricted to Northern Borneo, are found in largely lowland rainforest habitats (Alfred et al., 2012).

Conservation planning in tropical forests has historically focused on