Chapter 8

Biogeographic and Anthropogenic Effects on Asian Elephants in Tropical Forests of Sumatra, Indonesia

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ABSTRACT

DISTANCE protocols and MIKE Survey Standards were used in the field to determine Critically Endangered (CR) (A2c) Sumatran elephant (Elephas maximus sumatranus) occupancy, density and abundance in Gunung Leuser National Park (GLNP). Forest and habitat type, age, character, and integrity were the most significant factors affecting elephant occupancy. Principal forage types relative to elephant activity were palms and lianas, which dominated significantly in undisturbed primary forest. DISTANCE model density $D=0.167$ elephants/km$^{-2}$ (95% CI: 0.106–0.262), best-fitting occupancy $\Psi=0.6321$ (SE±0.0010) and detection probability $p=0.6225$ (SE±0.0001) estimates combined yielded $N=407$ elephants (95% CI: 258–638) in GLNP. The most parsimonious occupancy model estimated $N=392.82$ elephants (SE:±30.65; 95% CI: 332.78–452.95) in GLNP. Forest restoration, ecosystem protections, and conservation plans for Asian elephants, biodiversity, and forests are suggested in this study.

INTRODUCTION

Asian elephant (Elephas maximus) populations have declined and fragmented significantly during the second half of the 21st century (Olivier 1978; Sukumar 1989; Choudhury et al. 2008; IUCN 2019) and are most endangered of the remaining extant Proboscidea (Shoshani & Tassy 2005). E. maximus is listed as Endangered (EN) (A2c) with a declining population trend on the IUCN Red List (Choudhury et al. 2008; IUCN 2019). It is also protected as an Appendix I species with CITES (2019). The Sumatran subspecies, E. m. sumatranus, is listed as Critically Endangered (CR) (A2c) with a declining population trend across its range along with a continuing decline in area, extent, and quality of habitat (Gopala et
Mitochondrial DNA variation patterns indicate that *E. m. sumatranus* is monophyletic (Fleischer et al. 2001) and, consequently, this subspecies has been defined as “evolutionarily significant” (Choudhury et al. 2008; IUCN 2019). Given its status and the increasing rates of critical habitat loss, degradation, and fragmentation along with increased poaching and retribution killings, *E. m. sumatranus* has been given “particularly high priority” for its conservation in the wild (Choudhury et al. 2008; Gopala et al. 2011; IUCN 2019).

Tropical and subtropical dry and moist broadleaf lowland forests are critical habitats for *E. m. sumatranus* and, therefore, are of “major importance” (Gopala et al. 2011; IUCN 2019). Consequently, the biogeographically diverse Gunung Leuser National Park (GLNP) and Leuser Ecosystem (LE) in the provinces of North Sumatra and Aceh, Indonesia (Figure 1) are two of the most important refuges of these ecosystem types remaining for this subspecies. Sumatran elephants coevolved with primary lowland tropical and subtropical moist and dry forests and they are principally adapted to, and reliant on, resources from these ecosystem types. Grasslands and scrub are important for *E. maximus* in other regions (Choudhury et al. 2008), but such habitats supply lesser degrees of elephant forage in Sumatra. Tropical and subtropical dry and moist broadleaf lowland forests provide the highest forage diversity and quality for *E. m. sumatranus* (Gopala et al. 2011; IUCN 2019), including palms and lianas, which are important items in the *E. m. sumatranus* diet (Oliver 1978; Sukumar 1990, 2000; Steinheim et al. 2005).

Indonesia’s tropical forest cover is the third largest in the world. Primary lowland forests are most biodiverse in Sumatra and provide critical habitat for *E. m. sumatranus*. However, 85% of elephant habitat in Sumatra lies outside of protected areas (Gopala et al. 2011) and has experienced some of the highest rates of deforestation in the world (Uryu et al. 2010; Margono et al. 2012; 2014). During 2001-2017, Indonesia lost 24.4 Mha of tree cover with 89% resulting in permanent deforestation (WRI 2019). The Leuser Ecosystem, including portions of GLNP, lost approximately 167,000 ha during this period (WRI 2019; D. M. Augeri pers. obs.) (Figure 1). During 1990–2010, primary forest declined by 40% across Sumatra while overall forest cover was reduced by 36% (Margono et al. 2012, 2014). Timber harvests on the island have been at least four times higher than sustainable levels (Brown et al. 2005), subsequently reducing these forests by 2/3rd to 4/5th of their original extent (Whitten et al. 2000; Kinnaird et al. 2003; Hedges et al. 2005). As a result, more than 69% of *E. m. sumatranus* habitat was lost between 1985-2011 (Gopala et al. 2011; IUCN 2019).

Most forest cover in Sumatra outside of protected areas is fragmented into blocks smaller than 250 km² (Figure 1) (Gopala et. al. 2011; IUCN 2019). Such fragments are too small and restricted for viable elephant populations to survive over the long-term (Gopala et. al. 2011; IUCN 2019). This type of isolation and insularization increase the most significant impacts of habitat loss and fragmentation (Lovejoy et al. 1986; Laurance & Bierregaard 1997; Bierregaard et al. 2001; Wilson 2016), particularly for large wide-ranging species like Asian elephants (Choudhury et al. 2008; Gopala et. al. 2011). These and other anthropogenic disturbances (i.e., poaching and retribution killings) continue at increasing rates in Sumatra and the elephant population is “severely fragmented” (Gopala et al. 2011; IUCN 2019).

Population estimates of *E. maximus* vary greatly. Rigorous sampling-based surveys are minimal and previous population figures are still considered educated guesses. The latter includes the widely cited estimates of a) 41,410–52,345 worldwide with as many as 2,400–3,400 elephants in Indonesia (Choudhury et al. 2008; IUCN 2019) and b) the most recent estimates of 45,697-48,534 with ca. 1,784 elephants in Indonesia (AERSM Final Report 2017). Such estimates lack sufficient data and should be considered cautiously (Blake & Hedges 2004; Hedges 2006; Choudhury et al. 2008; Gopala et al. 2011; IUCN 2019). Prior to the present study, rigorous data and population estimates did not exist for