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Conserving small and fragmented populations of large mammals: Non-invasive genetic sampling in an isolated population of Asian elephants in Nepal

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ABSTRACT

The Terai is one of the world's most spectacular landscapes, encompassing parts of Nepal and northern India. This area used to harbour large and continuous populations of charismatic species like elephants, tigers and rhinoceros. However, recent habitat fragmentation reduced these populations into small, partially or completely isolated remnants. The largest of these fragments in Nepal is the Bardia National Park. Here, the elephant population was functionally extinct in the early 1970s and -80s, but was rescued by a considerable number of immigrants in 1994. In order to assess population size, sex ratio, age structure, and levels of genetic variation, we carried out non-invasive genetic sampling, using elephant dung as the source of DNA. A capture-mark-recapture estimate of population size suggested that there were 57 individuals in the study area, which agrees well with field observations. Notably, a strongly male-biased sex ratio was evident among sub-adult individuals. This observation suggests the presence of sub-adult immigrants in the population, which was supported by formal migrant detection analysis. Genetic variation was quite high and the evidence for male immigrants suggests that there are good prospects for maintenance of genetic diversity. A decade ago a large-scale project was initiated in the Terai region to link remaining populations of large mammals through dispersal corridors. The program is basically founded on the assumption that habitat fragments are isolated with little or no migration between them. Our results indicate that this may not be the case, at least not for the Asian elephant in western Nepal, which therefore reduces the alleged extinction risk from genetic erosion and stochastic demographic events.

Introduction

Asia's wild elephant populations (*Elephas maximus*) have declined dramatically over the last century in the face of poaching and habitat destruction. The species is now close to extinction in many areas where it was previously common (Kemf & Santiapillai 2000; Sukumar 1989, 2003). No definite figure exists on the global population size, but a qualified estimate from 1995 ranged from 34 500 to 51 000 animals (Hedges et al. 2005). In comparison, there are approximately ten times as many elephants in Africa (*Loxodonta africanus*; Blanc et al. 2007; Eggert et al. 2003). Over the last decade, several populations of the Asian elephant have dwindled further, and current population numbers may have fallen well below 1995 estimates (Blake & Hedges 2004). Since 1986, the species has been listed as endangered in the IUCN Red List of Threatened Species (IUCN 2011), and is included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; UNEP-WCMC 2010).

Due to rapid human population growth and associated habitat loss, a particularly dramatic decline has occurred in the north and northwest of the Indian sub-continent, in the region commonly referred to as the Terai. Covering almost 50,000 km^2, the Terai encompasses parts of Nepal and northern India, reaching from the tall alluvial grasslands along the large tributaries of the Ganges River to the sal (*Shorea robusta*) forests on the southern slopes along the foothills of the Himalayas. This area used to harbour a large and continuous elephant population, numbering thousands of individuals. Today, there are only about 900–1500 elephants left in the entire Terai (Sukumar 2006), distributed mainly among two wildlife sanctuaries and three national parks in India and one national park and one wildlife reserve in Nepal.

In the Nepalese part of the Terai there were probably more than 1000 elephants in the mid 20th century (Smith & Mishra 1992). However, a malaria eradication program in the 1950s followed by a human resettlement program led to heavy loss of continuous

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forestland, which reduced suitable habitat to small, partially or completely isolated fragments, leading to a drastic reduction in population size (Shrestha 1979). The largest of these is the Bardia National Park. In the 1970s and 1980s, elephants in Bardia were on the brink of extinction, consisting of 10–15 seasonal visitors in the monsoon (Bolton 1976; Dinerstein 1979). However, in 1994 numbers increased abruptly due to immigration, probably from India (Velde 1997). The current all-year population is now estimated at approximately 80 animals, of which 30 occupy the Babai valley northeast of our study area (see Fig. 1; Pradhan 2007). In contrast to most other remaining habitat fragments in the Terai, narrow natural corridors – albeit degraded – still connect Bardia National Park with semi-isolated elephant populations on both sides of the border.

In 2001, an innovative and ambitious, large-scale project – the Terai Arc Landscape (TAL) program – was initiated as a joint venture between India and Nepal. Its overall goal is to preserve the remaining populations of wild elephants, tigers (*Panthera tigris*) and greater one-horned rhinoceros (*Rhinoceros unicornis*) in Nepal and northern India with habitat protection and dispersal corridors as important conservation tools (WWF 2003). The Terai region is densely populated, and any conservation action should be broadly supported by both ecological and genetic data. However, there is no knowledge of levels of genetic variability for any large mammal

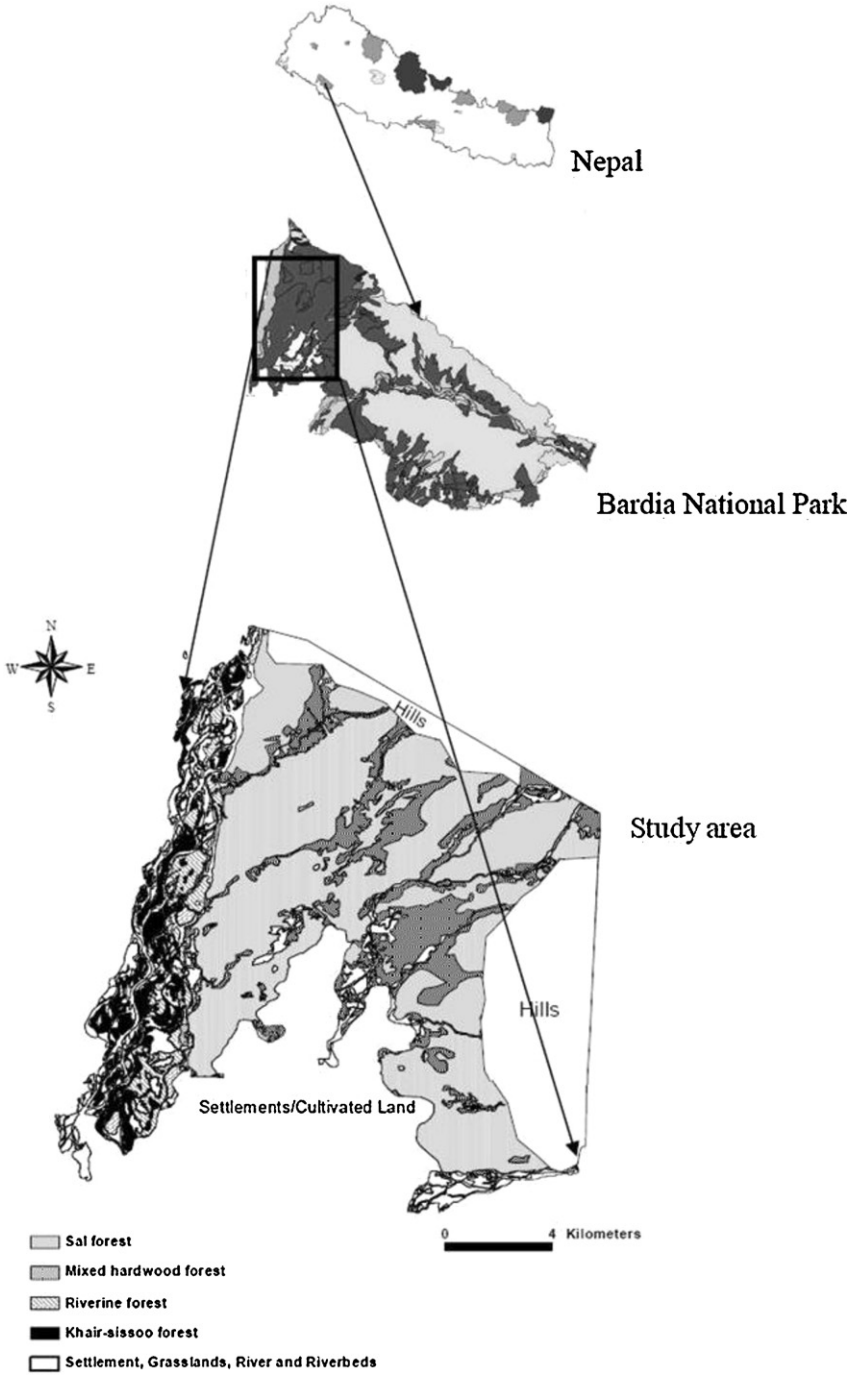

Fig. 1. The study area and its geographical location in Nepal.