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Connectivity of the Asiatic wild ass population in the Mongolian Gobi

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ABSTRACT

Long-distance migrations of wildlife have been identified as important biological phenomena, but their conservation remains a major challenge. The Mongolian Gobi is one of the last refuges for the Asiatic wild ass (*Equus hemionus*) and other threatened migratory mammals. Using historic and current distribution ranges, population genetics, and telemetry data we assessed the connectivity of the wild ass population in the context of natural and anthropogenic landscape features and the existing network of protected areas. In the Mongolian Gobi mean biomass production is highly correlated with human and livestock density and seems to predict wild ass occurrence at the upper level. The current wild ass distribution range largely falls into areas below the 250 gC/m^2/year productivity isoline, suggesting that under the present land use more productive areas have become unavailable for wild asses. Population genetics results identified two subpopulations and delineated a genetic boundary between the Dzungarian and Transaltai Gobi for which the most likely explanation are the mountain ranges separating the two areas. Home ranges and locations of 19 radiomarked wild asses support the assumed restricting effects of more productive habitats and mountain ranges and additionally point towards a barrier effect of fences. Furthermore, telemetry data shows that in the Dzungarian and Transaltai Gobi individual wild ass rarely ventured outside of the protected areas, whereas in the southeast Gobi asses only spend a small fraction of their time within the protected area network. Conserving the continuity of the wild ass population will need a landscape level approach, also including multi-use landscapes outside of protected areas, particularly in the southeast Gobi. In the southwest Gobi, allowing for openings in the border fence to China and managing the border area as an ecological corridor would connect three large protected areas together covering over 70,000 km^2 of wild ass habitat.

1. Introduction

Habitat loss and fragmentation have been identified as key threats to biodiversity conservation worldwide. Busy transportation routes and fences are significant mortality factors (Harrington and Conover, 2006; Lovari et al., 2007), impede movement of wildlife by creating access barriers to important resources (Frair et al., 2008), stop or slow population expansion (Kramer-Schadt et al., 2004), or subdivide once-continuous populations into more or less isolated subpopulations (Lankester et al., 1991). Large-bodied, far-ranging mammals like large carnivores and large herbivores are particularly sensitive to fragmentation because they need access to large tracts of continuous habitat. Seasonal changes in habitat conditions can force large herbivore populations to migrate between distinct seasonal ranges (Wolanski et al., 1999; Ferguson and Elkie, 2004), whereas unpredictable changes in habitat conditions can force them to resume nomadic movements (Mueller et al., 2008). The fragmentation of habitat into small and often non-contiguous patches decreases their capacity to escape locally poor habitat conditions and may result in dramatic population declines (Berger, 2004; Bolger et al., 2007). Furthermore, small and fragmented subpopulations become vulnerable to chance events like demographic, genetic, and environmental stochasticity (van Noordwijk, 1994; Frankham, 2005). The smaller the subpopulation and the more unpredictable the habitat, the higher the risk of local extinctions becomes.

Landscape genetics has become a powerful tool for addressing population fragmentation on the landscape level (Holderegger and Wagner, 2008). Several studies have revealed

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clear associations between habitat fragmentation and the genetic structure of wide-ranging, long-lived, and large-bodied mammal species (McRae et al., 2005), and identified barriers (Riley et al., 2006) as well as corridors (Dixon et al., 2006). A recent approach applied landscape genetics to optimize dispersal and corridor models (Epps et al., 2007); however, the application of genetic tools for conservation is still largely method and theory driven, rather than focused on real data sets with relevance to conservation problems (Vernesi et al., 2008).

Although long-distance migrations and nomadic movements over extensive areas have been identified as important biological phenomena (Convention on Migratory Species (CMS), 2002), their conservation remains a major challenge of the 21st century (Berger, 2004; Thirgood et al., 2004; Bolger et al., 2007; Wilcove and Wikelski, 2008). The steppes, desert steppes, and deserts of Central Asia are still home to several globally threatened migratory or nomadic large herbivores (Berger, 2004; Bolger et al., 2007). However, a growing human population, changes in land management, exploitation of natural resources, and the development of infrastructure place increasing pressure on these species and their habitats (Reading et al., 1998; Milner-Gulland et al., 2003; Ito et al., 2005; Clark et al., 2006; Qui, 2007; Wingard and Zahler, 2006). Among these species is the Asiatic wild ass, *Equus hemionus*.

The Mongolian Gobi and adjacent areas in northern China provide the last refuge for the Asiatic wild ass and other threatened wildlife (Clark et al., 2006; Yang, 2007). Anecdotal evidence suggests that the Asiatic wild ass may have lost as much as 70% of its range since the 19th century because of direct persecution and competition with humans and their livestock over water and pasture use (Zevegmid and Dawaa, 1973; Reading et al., 2001). Reliable historic population numbers for wild asses are unavailable (Reading et al., 2001) and recent estimates are either plagued by a high variance of the estimate (Reading et al., 2001; B. Lkhagvasuren and S. Strindberg, unpubl. data) or a lack of statistical rigor in the analysis (Lhagvasuren 2007; Yang, 2007). Most likely the Mongolian population still numbers in the magnitude of 10–20,000 animals (B. Lkhagvasuren and S. Strindberg, unpubl. Data; Kaczensky, unpubl. Data), while adjacent China likely houses another few thousand animals (Yang, 2007; Yang, unpubl. data).

The Asiatic wild ass has been fully protected in Mongolia since the 1950s (Clark et al., 2006), and large portions of its habitat are under formal protection. Nevertheless, little is known about the degree of connectivity and whether or not the current protected area system is adequate to safeguard the wild ass population of the Gobi.

People consider wild asses to compete with their livestock for pasture and water. As a consequence wild asses are actively chased away or illegally killed by people (Kaczensky et al., 2006; Wingard and Zahler, 2006) and the mere presence of people and their livestock at water points can limit or block access for Asiatic wild asses (Denzau and Denzau, 1999; Kaczensky et al., 2006). In recent years, Mongolia has been anticipating the development of a commercialized agricultural sector that could easily cause greater intrusion of human activities into the Gobi areas (World Bank, 2003). Development of other sectors of the Mongolian economy, especially mining and road construction (World Bank, 2006), could further affect the environmental security and habitat needs of the Asiatic wild ass and associated wildlife in the Gobi (Kaczensky et al., 2006).

An evaluation of the connectivity of the still abundant Asiatic wild ass population would yield important information about the integrity of the Gobi ecosystem and identify possible movement barriers. Such barriers are likely to also affect other species that presently have a more restricted distribution range, such as the wild Bactrian camel (*Camelus ferus bactrianus*), the saiga (*Saiga tatarica*), or the re-introduced Przewalski's horse (*Equus ferus przewalskii*, Clark et al., 2006). Using telemetry, population genetics, and distribution range data, we assessed the connectivity of the wild ass population in the context of natural and anthropogenic landscape features.

2. Study area

The Gobi areas cover roughly 300,000 km^2 of desert steppe and desert areas in southern Mongolia (Fig. 1). The climate is strongly continental with long cold winters (January mean, −15 °C to −20 °C) and short hot summers (July mean, 20–25 °C). Average annual precipitation ranges from 50 mm in the Transaltai Gobi, to 100 mm in the Dzungarian Gobi, and up to 200 mm in parts of the southeastern Gobi (von Wehrden and Wesche, 2007). Because the area also shows high levels of inter-annual variation in precipitation, the majority of the Gobi is believed to follow non-equilibrium dynamics (von Wehrden et al., submitted for publication) and thus to have a low risk for degradation caused by grazing.

Elevations range from 550 to 3750 m. The Dzungarian Gobi is located in a natural basin flanked by the southern tip of the Altai Mountain range to the north and east and a mountain range along the border to China in the south. The Transaltai Gobi is flanked by the Edrene mountain range in the north but also encompasses a medium-sized mountain range in the south–central part. The

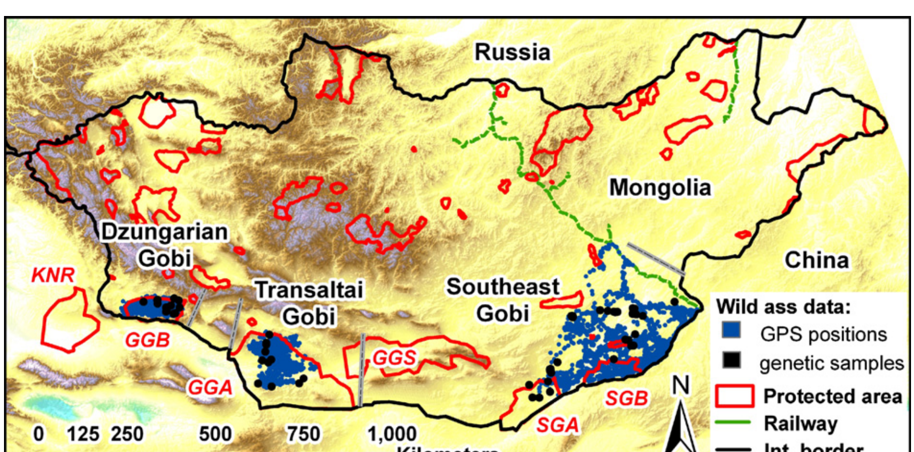

Fig. 1. GPS locations and ranges of 18 Asiatic wild asses in the Dzungarian, Transaltai, and southeast Gobi of Mongolia 2002–2008. Grey lines delineate the three geobiographical areas of the Mongolian Gobi. KNR = Kalimalai Nature Reserve, GGA = Great Gobi A strictly protected area, GGB = Great Gobi B strictly protected area, GGS = Gobi Gurvan Saikhan National Park, SGA = Small Gobi A strictly protected area, SGB = Small Gobi B strictly protected area.