The Gobi Khulan

A Flagship Species for Mobility

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Abstract: *Khulan*, the Asiatic wild ass, have been eradicated from most of their former range. The Mongolian Gobi currently holds more than 80% of the global population and constitutes more than 70% of the global breeding range and therefore is the most important stronghold of the species. In the Mongolian Gobi, individual khulan roam over thousands of square kilometers annually and their movements are among the largest reported for terrestrial mammals globally. The high mobility of khulan plays a critical role for the ecosystem functioning of the Mongolian Gobi, including large-scale seed dispersal and provision of water holes for other wildlife. Khulan also have non-consumptive aesthetic and naturalistic values for local residents and harbor the potential for wildlife tourism and subsistence hunting.

The species is currently listed as *Near Threatened* in the International Union for Conservation of Nature Red List, but remains under close scrutiny because multiple developments which negatively impact the size, quality and functional connectivity of the Gobi–Eastern Steppe ecosystem are happening simultaneously and at an unprecedented speed in an ecosystem which so far has remained at a near natural stage. These developments are the: 1) dramatic increase in livestock numbers and a change in the traditional herding practice, 2) rapid development of the resource extraction sector, and 3) expansion and upgrading of the transport infrastructure to meet the needs of the mining sector and allow Mongolia to connect to international markets.

The paper explores how these threats may affect khulan in the future and why khulan are an ideal flagship species for mobility and landscape connectivity.

Keywords: Asiatic wild ass, Equus hemionus, khulan, flagship species, Mongolian Gobi, mobility, nomadic movements, functional landscape connectivity

Introduction

Large herds of ungulates moving huge distances across the vast open steppes and desert plains of Mongolia rank among the wildlife wonders of the world and represent a defining part of the country's wild heritage. Long-distance movement has always been a necessity for wild ungulates (Rosen Michel and Röttger 2014) such as the Asiatic wild ass (*khulan*, *Equus hemionus*) Mongolian gazelles (*Procapra gutturosa*), goitered gazelles (*Gazelle subgutturosa*), saiga (*Saiga tatarica mongolica*), and wild camels (*Camelus ferus*), as well as for people (Wright 2016) and their livestock as a way of coping with a harsh (Rao et al. 2015) and unpredictable environment (Vandandorj et al. 2015). So far Mongolia has offered seemingly unlimited and unconstrained space for both wildlife and people to move in, but change is coming. Although Mongolia has one of the lowest human population densities in the world, recent years have seen a surge in socio-economic and infrastructure developments. While many of these changes have been central to raising the standard of living of Mongolians, they also hold the potential to severely impact the future of wildlife (Batsaikhan et al. 2014) and nomadic pastoralists (Byambaa and de Vries 2019) if they are not carefully planned and mitigated. In this article we argue that the exceptional mobility of khulan makes it an ideal umbrella species for largely intact and functionally connected dryland ecosystems, and that khulan conservation will benefit many other threatened dryland species as well as local people.

The Global Importance of the Mongolian Gobi for Khulan Conservation

Khulan are one of seven species of the wild horse family (*Equidae*). They once roamed the Eurasian steppes and deserts, but nowadays have become confined to less than 3% of their former range. The Mongolian Gobi now constitutes the most important refuge of the species, holding more than 80% of the global population and constituting more than 70% of the global breeding range (Kaczensky et al. 2015) (Fig. 1). The most recent population estimates suggest that around 64,000

khulan live in the Mongolian Gobi, with a core of 9,000 khulan in the Dzungarian Gobi (Kaczensky et al, unpublished data from 2015) in the southwest and 52,000 khulan in the South Gobi Region (Buuveibaatar et al., unpublished data from 2019) in the southeast of the country and the remainder in between.[1]

Khulan are listed in the International Union for Conservation of Nature (IUCN) Red List as *Near Threatened* because "the rapid infrastructure development and the associated influx of people in large parts of the species' range could quickly result in the re-emergence of former threats (e.g. increased competition with livestock for water and pasture, high poaching levels). Furthermore, linear infrastructure (e.g. roads, railways) – if not carefully designed and mitigated – are likely to result in high mortalities if wild asses are impeded in their long-distance movements and become cut-off from important resources or refuge areas" (Kaczensky et al. 2015).

Because Mongolia is the last stronghold of the species, the ongoing and planned anthropogenic development in the Gobi will determine the species' global status, which gives the country a global responsibility for the species' conservation (Fig. 1).

Ecosystem Services Provided by Khulan

The high mobility of khulan has important ecosystem-level effects and can connect communities of less mobile species. Khulan help maintain a diverse plant community composition through regional and supra-regional seed dispersal. They are particularly important because, unlike other wide-ranging wild ruminant like gazelles or wild Bactrian camels their digestive system is less effective and seeds tend to remain more intact and find a good germination environment provided by the khulan dung (Peled 2010). In this way khulan can help maintain biodiversity and speed up regeneration.

Moreover, khulan provide water sources for other wildlife. Like domestic horses, khulan need to drink daily, at least during periods when the vegetation is dry or the ambient temperatures are high (Payne et al. 2020). But khulan not only visit surface

1 Population estimates from the Transaltai Gobi and Gobi Gurvan Saikhan National Park are rather outdated and these areas need to be re-evaluated to correctly assess the national status.

water such as springs, rivers, and ponds to drink, but they also dig for water in dry riverbeds where there is subsurface flow. These diggings can be up to half a meter deep and provide other wildlife with access to water which would be otherwise unavailable for them (Kaczensky et al. 2006).

Due to their long crowned (hypsodont) teeth and their digestive system, khulan can feed on coarse or senescent vegetation, thereby stimulating regrowth particularly in steppe regions. In under-grazed steppe systems, their large-scale movements can be expected to create a mosaic of grazed and ungrazed patches, which provide different habitats for a greater variety of steppe species. During winter when deep snow is present, their trampling and feeding craters in the snow create corridors for smaller wildlife and provide easier access to the plant cover for shorter legged-herbivores like gazelles.

Khulan also play an important role in natural food webs, providing prey for large predators like wolves and carcasses for mammalian and avian scavengers such as foxes and vultures. Importantly, the presence of khulan also has aesthetic and naturalistic values (Kellert 1984) for local people. Khulan are beautiful, fast, social and persevering animals which fill people encountering them with awe. During interviews, local herders in the Gobi have often pointed out the beauty of khulan and the general spiritual importance of wildlife or, as a herder stated, "Nature can be beautiful in itself, but it's the wildlife that makes it more beautiful and lively and people can see it and feel happy" (Kaczensky 2007). Furthermore, khulan are a charismatic faunal element that could enhance the tourist value of the Gobi region through carefully designed community-based wildlife tourism.

Hunting khulan is an activity that has been practiced by the nobility and local people alike for centuries throughout the species range (Goldberg 2018). Nowadays, the species is fully protected throughout its global range, but poaching remains a global threat (Wingard and Zahler 2006). Khulan can make use of marginal pastures distant from water and legalizing subsistence hunting could act as an incentive for local herders to share their pasture, leave marginal areas ungrazed, refrain from poaching and even report on poachers. However, legal use

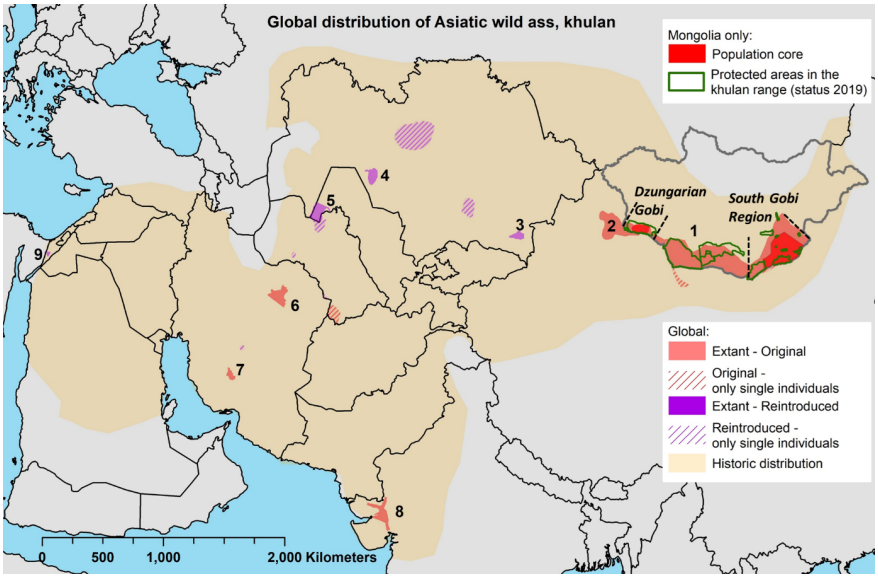

Fig. 1 Historic and present range of the Asiatic wild ass (Equus hemionus), khulan. Populations: 1= Mongolian Gobi; 2=Kalamaili, Xinjiang, China; 3=Altyn Emel, Kazakhstan, 4=Barsa Kelmes, Kazakhstan; 6=Touran, Iran; 7= Bahram-e-Goor, Iran; 8=Little Rann of Kutch, India; 9=Negev, Israel.

would necessitate a sound monitoring system, a change in legislation and a fair and sustainable quota system.

Conflicts between People and Khulan

With space becoming increasingly limited in the Anthropocene, conflicts between khulan and people are inevitable, especially during periods of resource limitations. Throughout their range, khulan are regarded as pasture competitors when perceived "too numerous"; in the Dzungarian Gobi there is special concern over khulan herds depleting winter pastures (Kaczensky et al. 2006) P. Enkhsaihan, N. O. Ganbaatar, Chris Walzer, Identification of herder-wild equid conflicts in the Great Gobi B Strictly Protected Area in SW Mongolia, Exploration into the Biological Resources of Mongolia, Exploration into the Biological Resources of Mongolia, 99-116, 10, 2006 and in the South Gobi Region over khulan competing with livestock during periods of poor pasture conditions (e.g. droughts) (Buuveibataar, personal

communication 2019). Furthermore, khulan are believed to damage the pasture with their hooves by digging out plants and their roots, thereby causing erosion.

Where steppe or deserts are converted to agricultural by ploughing or irrigation, khulan are no longer tolerated. Once khulan enter cereal fields, melon plantations, or orchards they can cause damage through trampling and crop consumption (Esmaeili et al. 2019). To gain access to agricultural plots, khulan can knock down fence posts which are weak or poorly anchored in the ground. In Mongolia, this behavior is only observed along the old and largely derelict fence line along the international border with China on the Mongolian side.

Unprecedented Mobility of the Gobi Khulan

In the Mongolian Gobi, individual khulan roam over of thousands of square kilometers annually (Fig. 2) and their movements are among the largest reported for any terrestrial mammal globally (Tucker et al. 2018; Joly et al. 2019). Khulan in the Mongolian Gobi do not show classical migrations, where they move between distinct seasonal summer and winter ranges, but rather move in a nomadic way[2] – without a predictable pattern – in their search for forage and water (Nandintsetseg et al. 2019). Unlike nomadic herders, khulan do not need to return to a ger (yurt) to rest and they are not bound by grazing rights, but rather follow the dynamics of the pasture at the landscape scale. In the South Gobi Region this results in average annual or bi-annual ranges of 30,000 square kilometers (Kaczensky et al. 2006; Payne et al. 2020).

Mobility as an Adaptive Strategy to Cope with Unpredictable Dryland Dynamics

Khulan need to feed on sufficient amounts of grass, and grassland plants such as forbs, and shrubs to provide them with the necessary nutrients to thrive and reproduce. They also need daily access to drinking water when the vegetation is

2 We use the term "migratory" as the general term for long-distance movements to access resources and "nomadic" as a special which is characterized by long-distance movements which are not regular or follow a repetitive pattern.

dry or the weather is hot (Payne et al. 2020). Furthermore, khulan avoid people and their livestock (Buuveibaatar et al. 2016), need to be wary of natural predators like wolves, and will react to other khulan – mostly traveling in groups of two to five animals, but at times forming large groups which can number hundreds or thousands (Buuveibaatar et al. 2017; Kaczensky et al. 2015).

Pasture productivity and water availability in the Gobi are driven by the amount and distribution of precipitation. Different parts of the Gobi receive on average between 50mm and 200mm of precipitation, primarily in summer during the growing season. In reality, the amount, timing and distribution of rain and snow can vary dramatically within and between years (von Wehrden and Wesche 2007). This unpredictability in the resource base is best coped with by being highly mobile and moving to wherever the best pasture happens to be in a given season or year.

Being mobile makes it possible to buffer the effects of local droughts and distributes grazing away from depleted pastures, thereby reducing the risk of overgrazing. These same drivers have also resulted in the nomadic herding culture throughout the steppe and desert regions of Central Asia and Mongolia. Traditional knowledge has been backed up by a modern "rediscovery" that mobility is key to sustainable range management in arid ecosystems (Kakinuma et al. 2019) as the dire consequences of switching to a "modern" sedentary system have become all too obvious (Li and Huntsinger 2011). The ability to track resources over large areas allows ungulate populations to maintain much higher densities than would be possible if they were to be divided into distinct subpopulations with access only to part of the total range (Fryxell et al. 1988). Migratory wild ungulates around the globe tend to crash when their migration routes are blocked by barriers (Bolger et al. 2008).

The arid environments of Central Asia and Mongolia are also prone to extreme events like droughts, floods, and extreme winters with very cold temperatures, icing events or deep snow (referred to as *dzud* in Mongolia), which result in mass-die offs of wild (Kaczensky et al. 2011) and domestic ungulates (Rao et al. 2015). Climate change scenarios predict that these extreme events will increase in the future and one way to cope with regional extreme events is movement away from

the affected areas. During the *dzud* winter of 2009/2010 temperatures were very low and the eastern part of the Dzungarian Gobi received huge amounts of snow. In the most affected area over 80-100% of all livestock died and so did 73% of the resident Przewalski's horses. The highly mobile khulan on the other hand, seem to have avoided a major die off, by moving to less affected areas in the western part of the Dzungarian Gobi (Kaczensky et al. 2011). The prior knowledge of the wider landscape likely facilitates evasive movements by highly mobile, nomadic ungulates like khulan, whereas sedentary ungulates may be more reluctant to leave their familiar range as they have no knowledge of where to possibly find better conditions.

Recent Challenges for Khulan Conservation

The Mongolian Gobi is the last refuge of khulan, but the region is no longer isolated from global economic forces and multiple developments which negatively impact the size, quality and functional connectivity of the Gobi–Eastern Steppe ecosystem are happening simultaneously and at an unprecedented speed in an ecosystem which has so far remained at a near natural stage (Fig. 3):

1) The dramatic and unrestrained increase in livestock and a change in the traditional herding system, resulting in competition with and displacement of khulan from pastures.

2) The rapid development of the resource extraction sector and the associated influx of people and technical infrastructure, resulting in habitat degradation, destruction, and new sources of disturbance.

3) The rapid expansion and upgrading of the transport infrastructure to meet the needs of mining development and to connect Mongolia to the international markets, resulting in habitat fragmentation.

4) Climate change with increasing temperatures and an expected higher frequency of extreme events like droughts and winter storms, resulting in local or regional die-offs and longer-term changes in water and pasture availability.

5) At the same time, old threats like illegal killing persist.

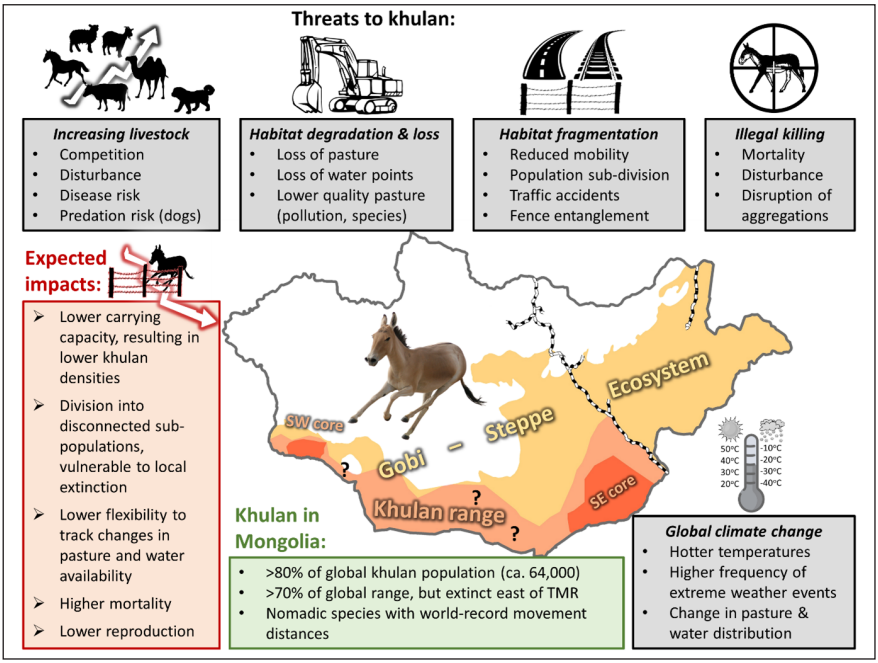

Fig. 2 Challenges for the conservation of khulan in Mongolia. SW core = Dzungarian Gobi; SE core = South Gobi Region; ? = status information needs updates.

Increase in Livestock

The increase in livestock numbers is unprecedented, in 2019 reaching almost 71 million head in Mongolia[3] of which about 10% are found in the Gobi soums in the khulan range. If this trend continues, wildlife will be outcompeted by livestock in all but the most marginal habitats. Species like khulan, which need regular access to water, will be particularly vulnerable as they cannot use pastures more than 15-20 kilometers from water in the Dzungarian Gobi (Nandinsetseg et al 2016) or the South Gobi Region (Payne et al. 2020). In many parts of the former Soviet Union, the rapid decline of khulan was likely driven by no longer having access to water sources due to agricultural conversion, fencing, and the presence of humans and their livestock (Bannikov 1981).

3 See: https://www.en.nso.mn/

Rapid Development of the Resource Extraction Sector

The rapid development of the resource extraction industry – metals, minerals, coal, oil, and gas – results in local habitat destruction by converting pastures into built-up areas, fencing off access, and potentially polluting pastures with chemicals or dust from active operations and tailings storage facilities. Mining also impacts the water regime by tapping into deep aquifers, drilling hundreds of boreholes, and diverting rivers. The potential impacts clash with traditional values and beliefs (Jackson 2018), are highly disputed and are difficult to assess due to the lack of pre-development monitoring and the high natural variability of the ecosystem (JSL Consulting 2017). Since water is the lifeline for wildlife, livestock and people in the Gobi, any change in the water regime will have far-reaching consequences for biodiversity and the local economy.

Linear Infrastructure Development

Resource extraction necessitates transport corridors, many of which are orientated north to south for export to China. New transportation plans also aim for a better connection along the east-west axis aiming to link Mongolia into China's Belt and Road initiative. Several of these corridors cut through the khulan's core range. The structural presence of roads and railways per se does not seem to constitute a major obstacle to khulan movements. Khulan have been observed to cross paved roads and GPS tracking data has confirmed crossings of unfenced paved roads and unfenced railway tracks in Mongolia (Fig. 3, Fig. 4).

However, there is strong evidence that traffic volume determines how likely it is that khulan will cross roads. Monitoring of GPS-collared khulan suggests that crossings of the paved mining road connecting the Oyu Tolgoi copper and gold mine to the Gashuun Sukhait border crossing (with a current traffic volume of 500 vehicles/day) is 53% lower than expected based on GPS track density and shows that those khulan that cross do so primarily at night, when traffic is low (Payne, unpublished data 2016). The OT road is currently not an absolute barrier, but the barrier effect is further enhanced by a parallel mining road from the Tavan Tolgoi coal mine and a railway line under construction, both of which also connect

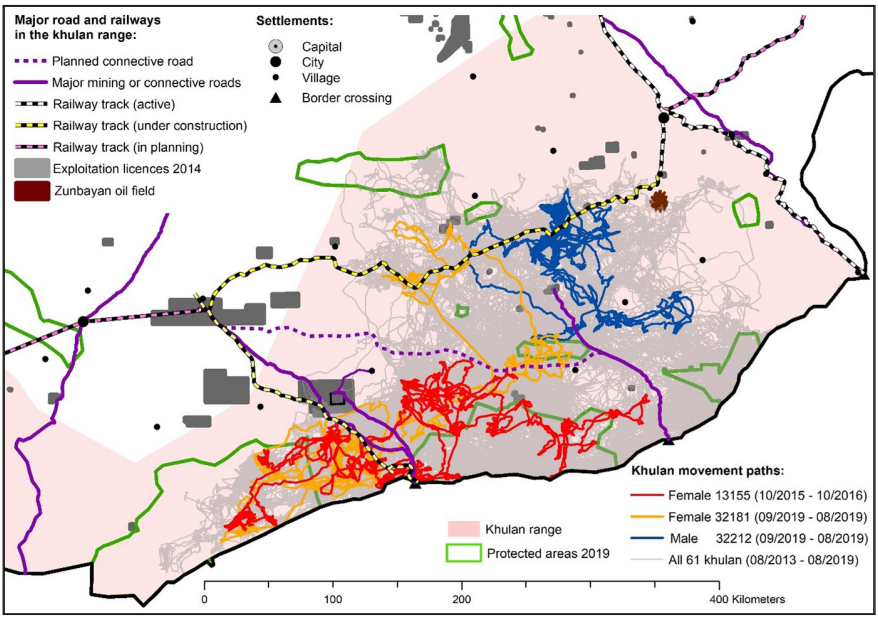

Fig. 3 Movement paths of 61 GPS-collared khulan monitored in the South Gobi Region between 2013 and 2018. Colored movement paths exemplarily show the one-year movements of two female (red & orange lines) and one male khulan (blue lines), covering areas of 14,000 to 32,100 square kilometers (calculated as minimum convex polygons around all GPS locations, but clipped by the international border). Female 13155 was wearing a camera collar and a selection of her pictures can be viewed at: https://arcg.is/1jP4L1.

to the Gashuun Sukhait border crossing (Fig. 3). None of the three transport corridors have crossing structures specifically placed and designed for wildlife. Without proper mitigation structures this infrastructure corridor poses a high risk of fragmenting the once continuous khulan population (Kaczensky et al. 2011b). This is particularly true when traffic volume increases and the railway becomes operational.

Fragmentation of the khulan range has already happened in the past. The construction of the fenced Trans-Mongolian railway resulted in the fragmentation of the Gobi–Eastern Steppe ecosystem into the Gobi and the Eastern Steppe for ungulates (Batsaikhan et al. 2014). Khulan cannot crawl under fences and seem unwilling to jump a fence even as low as 1.5m, hence fences constitute absolute barriers to their movements. About ten years after completion of the railway in

the 1950s, khulan had disappeared from the Eastern Steppe. In the south, the fenced international border with China eventually also became an absolute barrier, especially after upgrading of the fence line on the Chinese side (Linnell et al. 2016) (see also Fig. 3).

How to Maintain Mobility?

Past experience from Mongolia and other parts of the species range shows that, if not carefully planned and mitigated, land-use changes and development can easily lead to habitat loss, degradation, or fragmentation, squeezing khulan into ever smaller and marginal areas, thereby reducing population size and resilience to environmental stochasticity and making them more vulnerable to illegal killing, novel diseases, and climate change (Fig. 3).

Mongolia has hugely committed to conservation by setting aside more than 20% of its land surface as nationally protected areas and is aiming for a coverage of more than 30%. In 2019, The Mongolian parliament designated an additional 22 areas to the national protected area network. Among these approvals was the extension of Great Gobi B Strictly Protected Area in the Dzungarian Gobi. The size of the protected area was increased from 9,000 to 18,000 km^2 and now covers almost the entire khulan range in the south-western Gobi; a huge success for khulan conservation.

However, the majority of khulan live outside Great Gobi Strictly Protected Area (Fig. 1). In the large South Gobi Region, khulan cannot be conserved within protected areas alone, especially because none of the protected areas are even close to the size of the average annual range of 30,000 square kilometers a single khulan covers in this region (Kaczensky et al. 2006; Payne et al. 2020). To maintain khulan and other wide-ranging ungulates at current population levels throughout the Gobi–Steppe Ecosystem, they will need access to the multi-use landscape between protected areas and a high degree of landscape connectivity (Fig. 3), both of which needs to be explicitly taken into account in land-use planning and development following a mitigation hierarchy approach (in short the hierarchy follows

Fig. 4 A khulan making use of one of the first three pilot openings in the fence along the Trans-Mongolian railway. Photo: WCS Mongolia

avoidance, minimization, restoration and offsets in order to reduce development impacts (Arlidge et al 2018)).

Where development is unavoidable, minimizing the impact of linear infrastructure needs to be the default. Wildlife crossings, such as "green bridges" or wildlife underpasses, have been successfully implemented globally to maintain or restore landscape connectivity also in open landscapes (Seidler et al 2018). Experiences from Central Asia species are rare, but there is no reason to assume that these measures will not work in Mongolia, if the dimensions, the frequency (i.e. the number of required crossing structures per length of the linear infrastructure), the type (over versus under passages) and the location of crossings structures are tailored to the needs of the species. The development of the first standards for wildlife crossings along roads and railways in Mongolia in 2015 was an important first step (Mongolian Agency for Standardization and Metrology 2015). For new railways, a no-fencing policy outside of population centers and railway stations needs to be enforced to maintain khulan movements (Fig. 3).

How fence removal can help to re-establish landscape connectivity was recently demonstrated by a pilot project which removed the barbed wire fence along the Tran-Mongolian railway in two locations to create gaps for khulan to cross. The gaps have been monitored with camera traps since May 2019 and in March 2020, one

camera trap documented the first khulan crossing since 1955 (Fig. 4). Hopefully, this success will trigger the re-design of the entire fence and more openings to allow khulan and gazelles to functionally re-connect the Gobi– Steppe Ecosystem.

Conclusion

Mongolia is one of the few countries, where pastoral nomadism is still the default, rather than the exception and where a nomadic lifestyle or at least the idea of a nomadic lifestyle is still deeply ingrained in the nation's identity. But by now the majority of Mongolians live in urban environments and there is a risk of losing the awareness of the importance of mobility for biodiversity conservation and sustainable land-use.

Khulan in the Mongolian Gobi show unprecedented wide-ranging movements and can be used as a flagship species for mobility. An environment that allows khulan to roam requires a high degree of landscape connectivity, which also makes it less prone to local extinctions of plants and animals and more resilient to environmental stochasticity and climate change. Khulan thus also make a good umbrella species for largely intact and connected dryland ecosystems which will benefit many other wide-ranging species and traditional nomadic herding cultures.

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