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CENTRAL ASIAN MAMMALS MIGRATION AND LINEAR INFRASTRUCTURE ATLAS

(Prepared by the Secretariat)

Summary:

The Atlas was prepared within the frame of the Central Asian Mammals Initiative (Document 26.3.5) by the Wildlife Conservation Society (WCS) in cooperation with the International Academy for Nature Conservation of the German Federal Agency for Nature Conservation (BfN/INA) and with funding from the Governments of Germany and Switzerland.

The data for the Atlas, which provides information on species distribution and linear infrastructure, were compiled by WCS and subsequently reviewed and validated by scientists and experts from the region during and following the “Migration and Infrastructure Mapping Workshop” held from 27 April to 1 May 2017 on the Isle of Vilm, Germany. The Atlas highlights problem areas, where linear infrastructure obstructs the migration of Central Asian mammals and provides a resource to inform decision-makers in the region.



CENTRAL ASIAN MAMMALS MIGRATION AND LINEAR INFRASTRUCTURE ATLAS

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Convention on the Conservation of Migratory Species of Wild Animals (CMS)

Central Asian Mammals Migration and Linear Infrastructure Atlas

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This atlas is intended to be maintained as a “living document” that gets constantly updated as new and more accurate information becomes available.

Foreword

Mapping the Serengeti of the North

While most people will be familiar with the great mammal migrations of Africa with hundreds of thousands of wildebeest, antelope and zebra crossing the savannah and swimming through crocodile-infested rivers every year, some less familiar species such as the Saiga Antelope, the Mongolian Gazelle and the Asiatic Wild Ass undertake similar journeys across the steppes, deserts and mountains of Central Asia. It is quite appropriate that this region is sometimes called the “Serengeti of the North”.

Since 2014, efforts under the Convention on Migratory Species (CMS) through its Central Asian Mammals Initiative (CAMI) have catalyzed actions by countries of the region to protect their migratory wildlife, which includes cats such as the Asiatic Cheetah and reclusive Snow Leopard, as well as antelopes, deer, gazelles, wild horses and yaks.

As well as cold deserts and high mountains, Central Asia contains some of the last intact grasslands on Earth. These grasslands are, however, becoming increasingly degraded and fragmented. The rapid increase of linear infrastructure – fences, roads, railways – is posing serious threats as it blocks the animals’ movements, causing direct mortality and isolating populations. Competition with growing livestock herds for pastures as well as human-wildlife conflicts are increasing. Climate change and other environmental pressures further add to the vulnerability of the wild animals.

The result is that many of the migratory species in the region are threatened with extinction. Because they are also being poached, and their fur, horns, meat or other body parts illegally traded, many of these species are also listed under the Convention on International Trade in Endangered Species (CITES).

Over the last several years, CAMI has focused on ensuring that these animals can move freely over long distances to find the best areas or escape harsh weather. Maintaining and, where necessary, restoring the connectivity of those landscapes is essential for migratory species to be able to move - and to survive.

The CAMI Atlas is a major contribution towards achieving this goal. It provides information about the distribution and movements of migratory species and data on linear infrastructure such as fences, roads and railways, and thereby offers a much needed resource for decision-makers as they plan and implement infrastructure projects.

This Atlas is the result of a collective effort involving many species and infrastructure experts, possible through the financial support provided by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Swiss Federal Office of the Environment. It provides an indispensable tool in the effort to ensure the survival of these unique species of Central Asia.

Amy Fraenkel
Acting Executive Secretary
UNEP/CMS Secretariat

Foreword

Freedom of Movement for Central Asian Mammals!

During the Holocene, species such as Saiga Antelopes, Goitered Gazelles and Bactrian Camels enjoyed the extensive and unseparated width of the Central Asian steppes and deserts for free and undisturbed migrations. For thousands of years their freedom of movement was not in question and appeared to be the most natural thing in the world.

Nowadays, in the shadow of the “Anthropocene”, this freedom of motion - previously taken for granted – has become an issue of grave concern.

Man-made structures such as roads, railroads or corridors for the transport of goods and energy - made for good reasons - intersect the once pristine habitats and create barriers to migration. Fences, which accompany these linear structures, increase and worsen such barriers. Consequently, such structures can endanger the survival of migrating wild animal species.

This CAMI atlas reveals the hot spots of tensions, where anthropogenic linear structures collide in particular with endangered populations of large wide-ranging animals. Making the public aware of such issues is a first step to help the search for and putting in place of better solutions and remedies. Next steps will be the integration of the needs of these animals in the planning phase or even the complete removal of barriers.

I hope that this atlas will be helpful in promoting a better understanding and better policies to implement the best solutions that enable the survival of these species, which are linked to the whole ecosystem and dependent on the ability to move freely in an unfenced environment.

I am grateful to all those, who have contributed making this work possible, in particular the team of CMS and the committed CAMI scientists and experts. Moreover, I dedicate my special acknowledgements to all Central Asian States which will make best use of this information to develop their policies for measures to care for the conservation of the species concerned.

Dr. Christiane Paulus

Director “Nature Conservation and Sustainable Use of Natural Resources”

Ministry for the Environment, Nature Conservation and Nuclear Safety

List of Abbreviations

BMU	Ministry of the Environment, Nature Conservation and Nuclear Safety, Germany
BfN	Federal Agency for Nature Conservation, Germany
CAMI	Central Asian Mammals Initiative
CIESIN	Center for International Earth Science Information Network
CMS	Convention on the Conservation of Migratory Species of Wild Animals
GIS	Geographic Information System
INA	International Academy for Nature Conservation
IUCN	International Union for Conservation of Nature
WCS	Wildlife Conservation Society

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Summary of Key Findings

This report provides a comprehensive overview on how and where different types of linear infrastructure affect large mammals in the wider Central Asian region. Wide-ranging large mammals, such as the ten species covered by the Central Asian Mammals Initiative (CAMI) and considered for this report, depend on open and interconnected landscapes for their well-being and ultimately their survival.

Fences, railroads, roads as well as pipelines and canals can have significant negative impact on those species, fragmenting their habitat, isolating populations, preventing access to essential resources such as forage and water, and causing direct injuries and mortality (see Chapter 3).

The rapid construction and planning of new infrastructure and transportation systems in most of the eight CAMI Range States that were considered for this report will put additional pressure on already threatened and endangered species. This report contains maps of each species' distribution range combined with the different types of linear infrastructure, which clearly show where and what types of conflict exist or can be expected (see Chapter 4).

Fences are the type of infrastructure that is most problematic for all species. The design of the fence often determines whether - and which - species can cross it. Fences, for instance along railroads in

Mongolia, constitute a complete barrier for Asiatic Wild Ass, Saiga Antelopes, Goitered and Mongolian Gazelles as well as Wild Camel. Several fences along national borders prevent essential transboundary movements of a number of species such as Saiga Antelopes, Asiatic Wild Ass, Goitered Gazelles, Argali and Wild Camel.

Railroads such as the Trans-Mongolian Railway or the Trans-Kazakhstan Railway cut through the range areas of Saiga Antelopes, Asiatic Wild Ass and Mongolian Gazelles. Double-track and high-speed trains as well as high and steep embankments increase the likelihood of railroads hindering the animals' movements and act as a complete barrier.

Roads can either act as barrier or cause direct mortality: while movements of Asiatic Cheetah do not seem to be affected by roads, the species is frequently involved in car accidents, causing significant mortalities in Iran. Local and unpaved roads have least negative effect, which however significantly increases with traffic volume, speed or type of traffic.

Pipelines have a negative disruptive effect during their construction phase but are then mostly covered underground and have therefore less significant effects.

Canals potentially act as a complete barrier but few canals are found in the current range of the species and are therefore of less immediate concern. However, those potential negative effects need to be taken into account when new canal systems are being planned.

Recommendations

1. The conflict areas identified and presented in this atlas need to be looked at very carefully. Working groups should be set up in the countries concerned, complemented by international cooperation in the framework of CAMI to i) develop a set of targeted remedial actions, drawing on available guidelines and studies, to ii) coordinate implementation of those actions and to iii) monitor effectiveness.

2. In order to protect large mammals and the integrity of their habitat, it is important to look for alternatives to fence construction: If the construction of new fences in a given species' range cannot be avoided, it is essential to design the fence in such a way that it allows the animals to cross. The option of completely removing existing fences that cut through important habitat and movement corridors needs to be taken into consideration and regarded as a serious alternative.

3. Fences along national borders require special attention due to their importance for national security considerations. The successful adjustment of the border fence along the Kazakh-Uzbek border by the Government of Kazakhstan to make it permeable for Saiga, can be used as a positive example. CMS can play an important role in facilitating dialogue and providing expertise for countries to find an appropriate solution that suits both national security concerns and species needs.

4. This atlas should be used as a resource during all phases of the planning process for new infrastructure. The CMS Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia need to inform the planning and construction process from start to end.

1. Introduction

Central Asia harbours the largest intact grasslands worldwide. Saiga Antelopes, Mongolian Gazelles, Wild Camels and many other wide-ranging animals are still able to roam freely for thousands of kilometres on their annual migrations. Recognizing the importance of those landscapes for migratory species, the Central Asian Mammals Initiative (CAMI) was developed under the UN Environment's Convention on the Conservation of Migratory Species of Wild Animals (CMS). CAMI and its associated Programme of Work (POW) were adopted with Resolution 11.24 by CMS Parties at their Eleventh Meeting of the Conference of the Parties (COP11) in 2014 to strengthen the implementation of CMS in the wider Central Asian region. CMS Parties thereby confirmed the indispensable role large mammals play in preserving these unique ecosystems, which are vital to the wellbeing and livelihoods of both animals and humans that share these landscapes. CAMI covers 15 large mammal species that range across 14 countries, nine of which are Party to CMS.

One of the key threats to the integrity and connectivity of those landscapes is the dramatic increase of linear infrastructure. Central Asia is not only rich in biodiversity, but also rich in oil and gas, metals and coal. With high demand for energy and raw materials in China and other neighbouring countries, these resources are being exploited at an unprecedented pace and scale. Numerous long-distance railways and road networks are being built and planned to provide the infrastructure for large-scale natural resource extraction and economic development, stretching all the way to Siberia and the Caspian Sea.

This level of natural resource extraction and infrastructure development is already leading to widespread destruction and fragmentation of the fragile grasslands and deserts of Central Asia. Large ranging animals are losing access to essential feeding and breeding grounds, many migration routes will become bisected by railways, fences and pipelines. The connectivity of those open landscapes enabling the free movement of many large mammals are at risk of being lost – and with it the species that depend on them.

CMS has been working to address the negative impacts of linear infrastructure and barriers to the movements of migratory species for many years: In 2011 the CMS Scientific Council first discussed a study from WWF Mongolia analyzing the effects of infrastructure on migratory mammals in Mongolia, highlighting the fragmentation of populations and direct mortality of Goitered and Mongolian Gazelles and Asiatic Wild Ass caused by railroads and fences. Since then, several activities have taken place including studies and recommendations for wildlife-friendly fences

focusing on Saiga in Kazakhstan, workshops on mining and infrastructure impacts in Mongolia, as well as the development of guidelines and concrete projects such as to remove harmful fences on the ground.

With the adoption of CAMI and the CMS “Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia” at COP11, this issue gained further attention. However, while a great deal has already happened and awareness and support for this issue has increased slowly, it is still far from being resolved: In 2017 for instance, more than 5,300 Mongolian Gazelles died along the Trans-Mongolian Railway due to harsh weather conditions and the inability to escape and cross the fence.

1.1 Rationale for developing a Migration and Infrastructure Atlas

In order to avoid such situations, it is not only important to have a clear understanding about the impact but also about where the animals actually move and what kind of infrastructure is being constructed or planned in their range in order to be able to react immediately and influence the location and design of the fence to make it less harmful.

This atlas aims to provide such information to enable decision makers and other stakeholders to take the needs of migratory mammals into account when planning any type of infrastructure or adjusting already existing infrastructure.

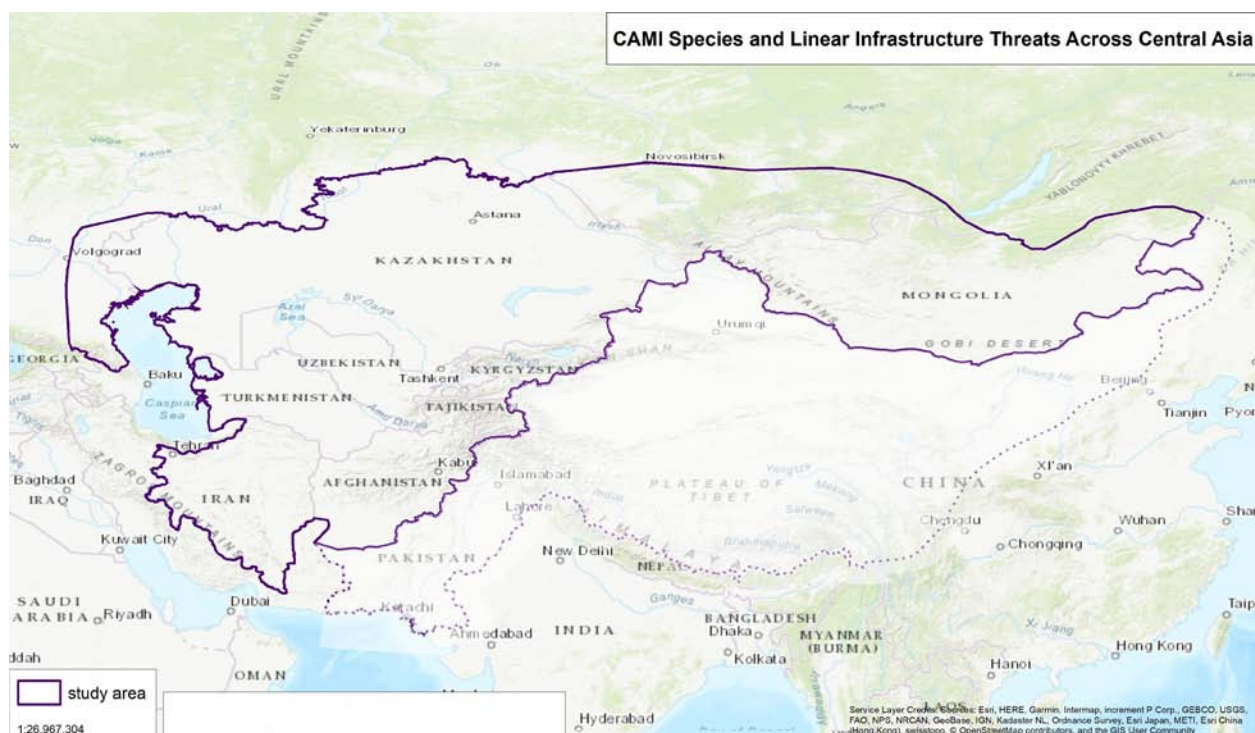
The development of this atlas was recommended at a CAMI priority-setting workshop in 2016 to provide an overview featuring the distribution of the species concerned on one hand and the constructed and planned infrastructure on the other. Its aim is to effectively inform decision makers, development banks and other stakeholders how to apply this knowledge and take the needs of migratory species into account when building and planning any kind of infrastructure.

This atlas provides an analysis to which extent the different species are being impacted by the different types of infrastructure (Chapter 3). It also includes a set of maps for each species for a visual representation of where current and potential future conflicts lie between the mammals of Central Asia and the development of linear infrastructure (Chapter 4).

1.2 Scope of the Atlas

Range: The atlas initially covers the territory of eight Range States of CAMI: Afghanistan, the Islamic Republic of Iran, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan and Uzbekistan. Due to limited data availability as well as capacity and funding limitations, other Range

Map 1. Overview study area



States could not be included. It is the intention to further develop and expand the atlas to cover all countries as soon as additional funding becomes available. Currently, the project area covers eight countries plus a 100-km buffer beyond them, determined through a geographic information system (GIS) analysis.

Species: The migration routes or movement ranges of the following species were mapped for this atlas (the scientific species names applied in the taxonomic reference currently used by CMS, Wilson and Reeder 2005, are indicated in brackets, if different):

Asiatic Cheetah *Acinonyx jubatus venaticus*
Wild Camel *Camelus ferus* (*Camelus bactrianus*)
Bukhara Deer *Cervus hanglu bactrianus* (*Cervus elaphus yarkandensis*)
Asiatic Wild Ass *Equus hemionus*
Chinkara *Gazella bennettii*
Goitered Gazelle *Gazella subgutturosa*
Argali Sheep *Ovis ammon*
Snow Leopard *Panthera uncia* (*Uncia uncia*)
Mongolian Gazelle *Procapra gutturosa*
Saiga Antelope *Saiga tatarica*

1.3. Purpose and Use of the Atlas

The ultimate purpose of this atlas is to provide information to decision-makers and to guide infrastructure planning that provides benefits to people without causing unnecessary harm to migratory species. Infrastructure impacts on species were defined via a

collectively produced Data Dictionary, which specifies the attributes for each type of infrastructure necessary to characterize the degree of threat to each species, and a threat matrix, which ranks the threat posed by each type of infrastructure based on those attributes (see Chapter 3).

In principle, a complete set of fully characterized infrastructure data - such as knowing the exact traffic levels of all roads in Asia - would enable threats to be estimated for all the species. In practice, the attributes of many infrastructure types were not completely filled in by the workshop participants or are simply not known.

As a result, many maps and tables in this atlas have large figures under the 'unknown' heading. While unfortunate in the short term, in the long term we believe that establishing the infrastructure attributes necessary for measuring the threat from infrastructure is an important step forward that could direct data collection and guide the development of an online iterative infrastructure data collection tool to be used by the public as well as provincial- and national-level decision makers.

Beyond the wider mitigation strategies available for the most common effects of infrastructure, this atlas aims to suggest specific remedial strategies for circumstances that are unique to species and infrastructure pairings. The user should note that a paired analysis of species and infrastructure type is only included in this document if there was a conflict detected between a given species'

distribution and a particular infrastructure type.

This atlas is intended to be maintained as a living document that gets constantly updated and readers are invited to contribute current information if they perceive data in the atlas are outdated at some point or new information becomes available.

2. Methodology

The methodological approach for this atlas is based on the IUCN-SSC species conservation planning guidelines (IUCN/SSC. 2008). Some of the globally important projects that have used this process are described in McCarthy et al. (2016), Altrichter et al. (2012), Sanderson et al. (2010), Sanderson et al. (2008), Plumptre (2010), Aveling et al. (2012), Hedges et al. (2008), Garshelis et al. (2007), Durant (2007), and Nowell and Bauer (2006). This workshop-based methodology was adapted for the requirements of developing this atlas and compiling information on species distribution and infrastructure.

The majority of the data for this atlas was collected during a three-day workshop entitled “Atlas of Range-wide Mapping and Priority Setting of CAMI Species (Distribution and Movement Corridors) and Linear Infrastructure Threats across Central Asia” attended by 25 experts on specific species, regions, and/or tools from 27 April to 1 May 2017. Prior to the workshop, the study area of the atlas was identified and determined through a Geographic Information System (GIS) analysis. Experts with knowledge of the distribution and movement patterns of the species under consideration, as well as of linear infrastructure development in the study area, attended the workshop. Those included the CAMI Species Focal Points plus eight colleagues with other relevant experience and expertise. The experts were asked prior to the workshop also to work through their networks to provide the best possible information on both species and the infrastructure.

Simultaneously, data were obtained from other sources. Range data were obtained from the IUCN Red List; infrastructure data were obtained from OpenStreetMap, Esri, CIESIN, and the experts' local knowledge; pipeline data were obtained from a wider variety of sources, including individual company websites, Harvard WorldMap, Wikipedia, and the US Energy Information Administration. In addition, data on planned infrastructure were identified on the Center for Strategic and International Studies' “Reconnecting Central Asia” website.

Prior to the workshop, GIS experts compiled the information into a database along with reference information regarding national boundaries, mountain ranges, major cities, and satellite/aerial photography compilations provided by the Esri (Redlands, CA). Because the number of roads in the combined datasets was so large, a first draft was created of consolidated roads using mostly Esri data as a basis for the workshop, which could be easily added to. All data were then split by species and area to fall into the domains of the three identified workshop editing groups.

The experts in their editing groups worked collectively to review and edit the data. Editing groups were formed by geographical region or species, depending on the stage of the data collection and assessment process. These efforts produced updated range and movement areas maps for the ten species. The group further used expert opinion to weigh the influence on movements associated with the species crossing each of the identified subtypes of linear infrastructure. The questions asked included:

- *To what extent does e.g. a paved road constitute a barrier to e.g. Mongolian Gazelle?*
- *Is it a complete barrier, a partial barrier, or not a barrier?*
- *If that road has significant traffic, some traffic, no traffic, how is movement affected?*

Immediately after the workshop, the data clean-up stage began and continued for six weeks. The maps and tables in this document represent the collaboration and agreement of the 25 workshop participants.

3. Types and Impact of Linear Infrastructure

The various types of linear infrastructure can each have a different impact on the movements and mortality

of the species concerned. The following types of infrastructure were considered for this atlas and their negative effects are summarized below, starting with infrastructure that has the heaviest impact to those that are less harmful.

1. Fences - Fences are clearly the number one threat and a major concern for all CAMI species. For several species fences constitute absolute barriers, which cannot even be mitigated by a change in design. Fences prevent animals from essential movements in search for food and water or to avoid harsh weather. Additional impacts include entanglement, injuries possibly leading to infection and death, and use by poachers and predators as a tool to entrap.
2. Railroads - Challenges presented by railroads are the elevated rail bed often resulting in a steep embankment and the tracks themselves. The barrier effect of a railroad per se is further enhanced if fenced, resulting in the added risk of wildlife getting trapped in the railway corridor.
3. Roads - Paved and unpaved roads are among the most common of infrastructure types; they offer a challenge to wildlife because sporadic traffic presents a high threat of mortality to crossing wildlife, high traffic volumes eventually make it impossible for wildlife to cross. Roads also allow easy access for poachers to formerly difficult-to-reach areas of wildlife habitat. The barrier effect of busy roads per se is further enhanced if fenced, resulting in the added risk of wildlife getting trapped in the road corridor.
4. Canals - A network of irrigation canals exists in many Central Asian countries. The impact of canals on movements of ungulates is not well understood, but they do not seem to have a significant impact or act as a major movement barrier; however, this is mainly due to the fact that there is little overlap with species distribution.
5. Pipelines - Many sections of pipeline are buried throughout the CAMI range and so are mainly disruptive to CAMI species during construction or in specific places where they remain above ground.

Although the effect of different infrastructure types varies somewhat between species and habitats (see chapter 3.1 to 3.3), the following negative impacts on CAMI species and their habitat arise from the fragmenting effects of linear infrastructure:

- i) subdivision of once large and connected populations resulting in smaller subpopulations, which are more vulnerable to demographic stochasticity and reduced genetic variability;
- ii) die-offs or decreased fitness when populations are cut off from key resources or refuge areas in emergency situations;
- iii) reduced movement distances - including the loss of migration movements altogether - resulting in an overall altering of natural processes and ecosystem services;
- iv) direct changes in wildlife behaviour and distribution with potentially cascading effects on populations fitness and long-term persistence;
- v) direct impacts such as injuries and mortality through

entanglement and accidents (e.g. collision with roads or railroads).

3.1 Effects of FENCES on Species

The different species are affected to different degrees by infrastructure – while fences do not stop species such as Asiatic Cheetah and Snow Leopards, they are a complete barrier to Wild Camels and Asiatic Wild Ass (see figures below). The analysis below provides an overview on the extent to which a particular type of infrastructure (focusing on fences, railroads and roads) is a barrier to the movements of the animals. Number codes are used to show how the different species are affected by the different types of fences: 2=high barrier effect, 1=moderate barrier effect, 0=low to no barrier effect; 0.5=unknown barrier effect.

3.1 Effects of FENCES on Species

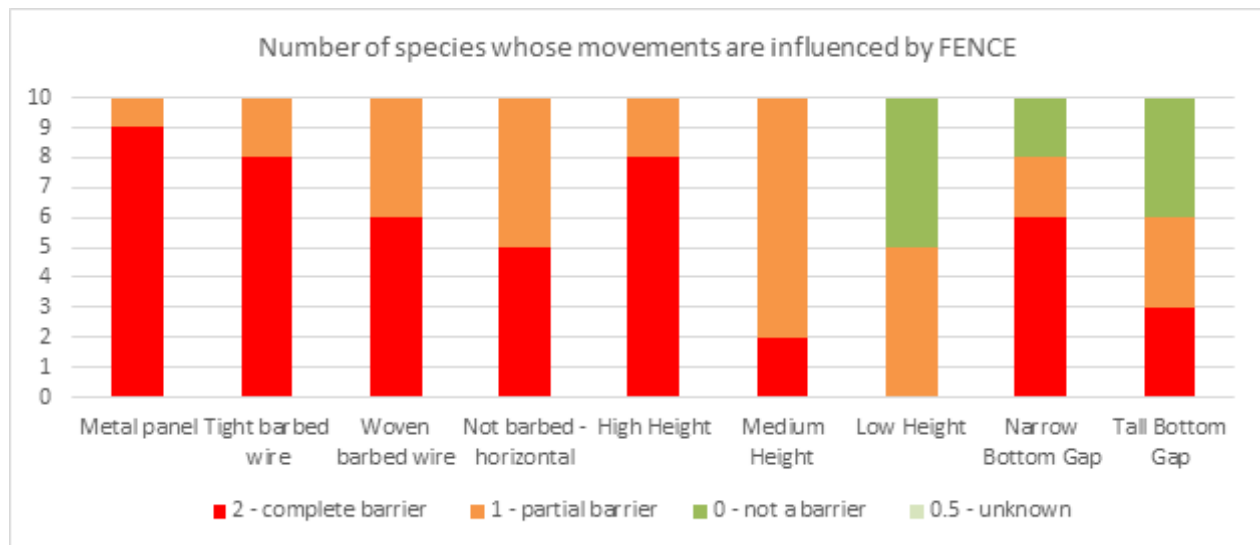


Figure 3.1. Barrier effect of different types of FENCES

This graph shows the barrier effect of each type of fence. Some types of fences are a complete barrier to almost all species such as metal panels (only a partial barrier for Bukhara Deer) and high fences (partial barrier for Snow Leopards). Medium high fences are a partial barrier for most species and the effects of gaps at the bottom of the fence clearly need to be further investigated in order to understand better how this gap needs to be designed in order to allow crossings by

certain species.

It becomes clear that Asiatic Wild Ass, Argali and Wild Camel cannot cross most types of fences and are significantly affected – all fences are either a complete or at least partial barrier. Asiatic Cheetah, Goitered Gazelle and Mongolian Gazelle are also greatly affected with only a few more fence types forming a partial rather than a complete barrier.

Table 3.1. Barrier effect of different types of FENCES shown by species

Species	FENCE								
	Type				Height			Bottom Gap	
	Metal panel	Tight barbed wire	Woven barbed wire	Not barbed - horizontal	High (>2m)	Medium	Low (<1m)	Narrow (<30cm)	Tall (>30cm)
ARGALI SHEEP	2	2	2	2	2	1	1	2	2
ASIATIC CHEETAH	2	2	2	1	2	2	1	0	0
ASIATIC WILD ASS	2	2	2	2	2	2	1	2	2
BUKHARA DEER	1	2	2	1	2	1	0	1	0
CHINKARA	2	1	1	1	2	1	0	0	0
GOITERED GAZELLE	2	2	2	2	2	1	0	2	1
MONGOLIAN GAZELLE	2	1	1	2	2	1	1	2	1
SAIGA ANTELOPE	2	2	1	1	2	1	1	2	1
SNOW LEOPARD	2	2	1	1	1	1	0	1	0
WILD CAMEL	2	2	2	2	2	1	0	2	2

Number of species whose movements are influenced by FENCES									
	Metal panel	Tight barbed wire	Woven barbed wire	Not barbed - horizontal	High Height	Medium Height	Low Height	Narrow Bottom Gap	Tall Bottom Gap
0 - not a barrier	0	0	0	0	0	0	5	2	4
1 - partial barrier	1	2	4	5	2	8	5	2	3
2 - complete barrier	9	8	6	5	8	2	0	6	3
0.5 - unknown	0	0	0	0	0	0	0	0	0

This table shows that fences in all of their different forms are a complete barrier to most of the species. Some ungulates, especially the small gazelles such as the Chinkara can cross a fence if there is a gap at the bottom, through which they can crawl. This is impossible for larger ungulates, including sheep such as the Argali, for which all types of fences except those of low height are a complete barrier.

Overall, this analysis shows that the existence and construction of new fences are a major problem for all species. Some species might be able to cross a certain type of fence while others cannot – this also illustrates the need to where possible completely remove fences in the species range or design them according to the needs of the concerned species. Further research is urgently needed.

3.2 Effects of RAILROADS on Species

Graph 3.2 below shows the barrier effect of each type of railroads. It becomes clear that there is still a lot of uncertainty with regard to the barrier effect of railroads for many species (shown as unknown). Double-track and

high-speed railroads have the largest barrier effect (Saiga and Wild Camel) with low speed and single track having the least impact.

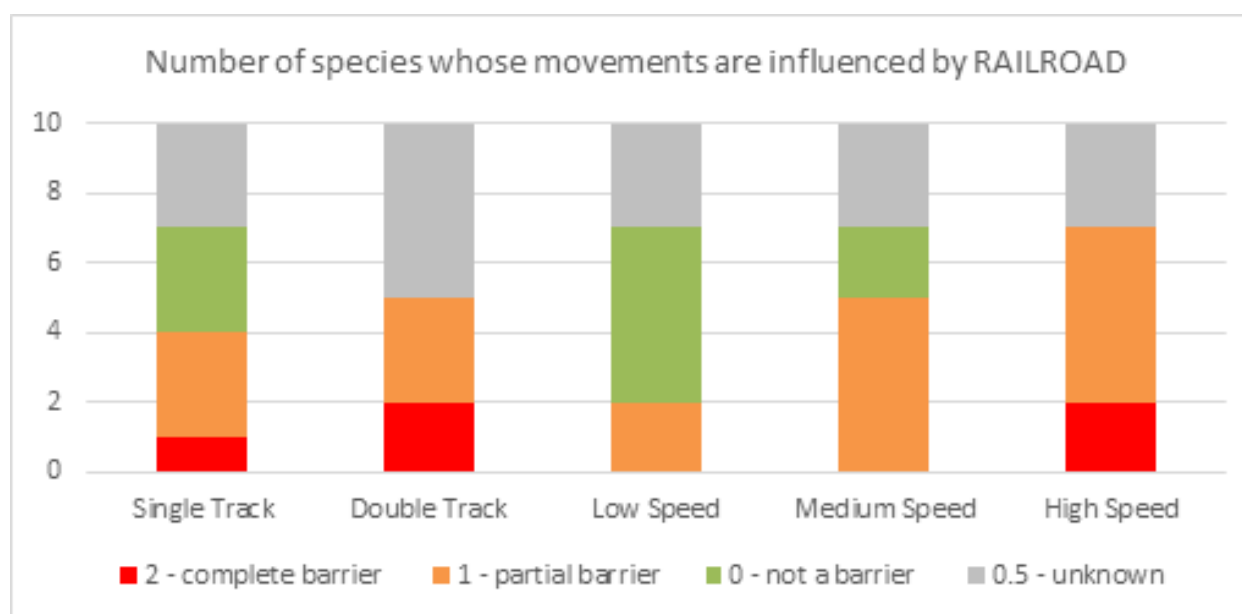


Figure 3.2 Barrier effect of different types of RAILROADS

Saiga and Wild Camel have the biggest problems crossing railroads. For most of the other species railroads are a partial barrier, with speed and width being the

determining factors. It also becomes clear that there is a high degree of “unknown” for many species and further research is therefore needed.

Table 3.2. Barrier effect of different types of RAILROAD shown by species

Species	RAILROAD				
	Track		Speed		
	Single	Double	Low	Medium	High
ARGALI SHEEP	1	1	0	1	1
ASIATIC CHEETAH	0.5	0.5	0.5	0.5	0.5
ASIATIC WILD ASS	0	0.5	0.5	0.5	0.5
BUKHARA DEER	0	1	0	0	1
CHINKARA	0.5	0.5	0.5	0.5	0.5
GOITERED GAZELLE	0.5	0.5	0	0	1
MONGOLIAN GAZELLE	0	0.5	0	1	1
SAIGA ANTELOPE	1	2	1	1	2
SNOW LEOPARD	1	1	0	1	1
WILD CAMEL	2	2	1	1	2

Number of species whose movements are influenced by RAILROAD					
	Single Track	Double Track	Low Speed	Medium Speed	High Speed
0 - not a barrier	0	0	0	0	0
1 - partial barrier	1	2	4	5	2
2 - complete barrier	9	8	6	5	8
0.5 - unknown	0	0	0	0	0

Table 3.2 shows the need for further research to better understand how railroads affect the movements of many species (e.g. Asiatic Cheetah, Asiatic Wild Ass, Chinkara, Goitered and Mongolian Gazelle). Double-tracked railroads are a complete barrier for Saiga and

Wild Camel, while in general railroads – if not fenced – do not seem to have a strong barrier effect for most species, pending further research.

3.3 Effects of ROADS on Species

Figure 3.3 below indicates that unpaved, low traffic and local roads have the least impact on the species. As traffic increases, the barrier effect does too.

Table 3.3 shows that unpaved and local roads are not having a barrier effect for any of the species (except for local roads that can be a partial barrier for Wild Camel).

Wild Camel are clearly having the greatest problems in crossing roads, while none of the road types hinder species such as Chinkara, Asiatic Cheetah (not taking into account the car accidents and resulting mortality) and Snow Leopard completely.

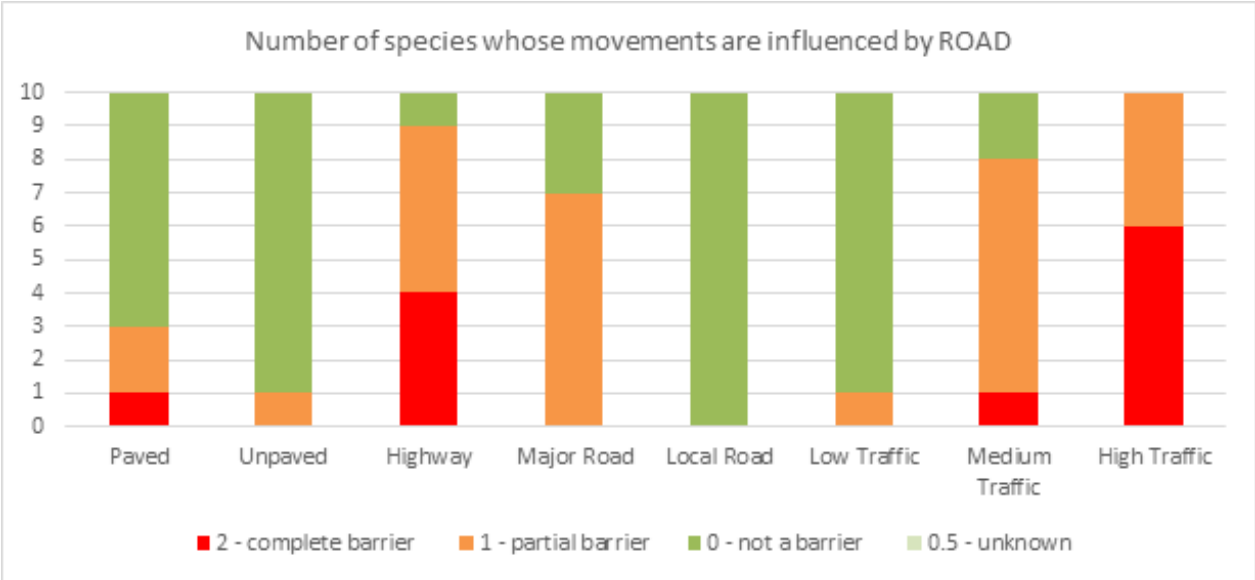


Figure 3.3 Barrier effect of different types of ROADS

Table 3.3 Barrier effect of different types of ROADS shown by species

Species	ROAD							
	Type		Type 1			Traffic		
	Paved	Unpaved	Highway	Major Road	Local Road	Low (<=1 car/hour)	Medium (2-60 cars/hour)	High (>= 1 car/minute)
ARGALI SHEEP	1	0	1	1	0	0	1	2
ASIATIC CHEETAH	0	0	0	0	0	0	1	1
ASIATIC WILD ASS	0	0	1	1	0	0	1	2
BUKHARA DEER	0	0	2	1	0	0	0	1
CHINKARA	0	0	1	0	0	0	1	1
GOITERED GAZELLE	0	0	2	0	0	0	1	2
MONGOLIAN GAZELLE	0	0	1	1	0	0	1	2
SAIGA ANTELOPE	0	0	2	1	0	0	1	2
SNOW LEOPARD	1	0	1	1	0	0	0	1
WILD CAMEL	2	1	2	1	0	1	2	2

Number of species whose movements are influenced by ROADS								
	Paved	Unpaved	Highway	Major Road	Local Road	Low Traffic	Medium Traffic	High Traffic
0 - not a barrier	0	0	0	0	0	0	5	2
1 - partial barrier	1	2	4	5	2	8	5	2
2 - complete barrier	9	8	6	5	8	2	0	6
0.5 - unknown	0	0	0	0	0	0	0	0

It becomes clear that the higher the traffic volume, the bigger the barrier effect. Highways are difficult to cross for most species and a complete barrier for Goitered gazelles and Bukhara deer. While Asiatic

cheetah can cross roads and highways, they frequently die in car accidents and are therefore also greatly affected by roads.

4. Infrastructure Maps by Species

This section includes sub-chapters on each of the different species, with a brief summary of the conservation status of each species and how it is affected by infrastructure. For each species a set of maps show the different types of infrastructure, highlighting where they are located in the species' range and where there is a conflict. The maps are always aligned with the range of the species, thus sometimes only showing a small part of the study area (in case this is the only area where the species occurs), and for species such as Argali or Snow Leopard a much larger expanse encompassing almost the entire study area.

4.1 Asiatic Cheetah

Current Range States: Iran (Islamic Republic of)

Current Global Population: <60 (Farhadinia et al. 2017)

Overview: The Asiatic Cheetah (CMS Appendix I) is a Critically Endangered (IUCN Red List, 1996) subspecies of Cheetah that is only known to live in Iran's arid cen-

tral plateau. Its modern distribution is a small fraction of its historical range that once extended from the Arabian Peninsula across the Middle East, Central Asia and east to India (Farhadinia et al. 2017). The remaining population is estimated to be less than 60, with possibly less than half of the population consisting of mature breeding individuals (Khalatbari et al. 2017).

Infrastructure Threats: The Asiatic Cheetah moves over considerable distances in search of prey species scattered at low densities over large tracts of arid landscape (Farhadinia et al. 2013). The most impactful linear infrastructures identified so far for the Asiatic Cheetah are primary roads. Of 33 documented Cheetah mortalities between 2001 and 2016 due to various causes, at least 14 were killed on roads within or between core areas, making it the major cause of documented mortality for Cheetahs in Iran (Ahmadi et al. 2017). The Asiatic Cheetah is in conflict with the growing network of roads and particularly primary roads transecting its suitable habitat - a threat that markedly increases its risk of extinction (Mohammadi and Kaboli 2016, Farhadinia et al. 2017).

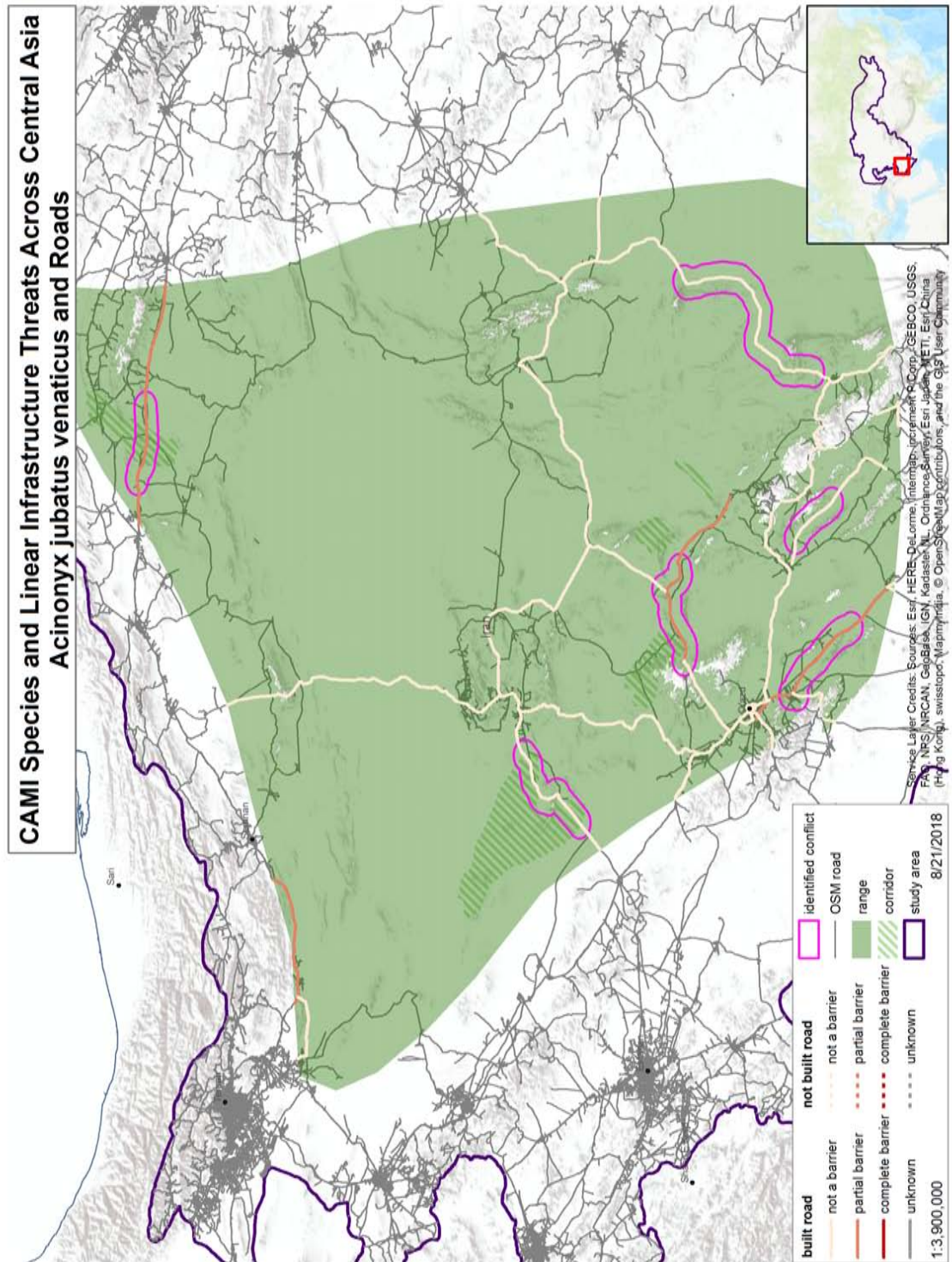
More information:

Asiatic cheetah and CMS

Asiatic cheetah on the IUCN Red List

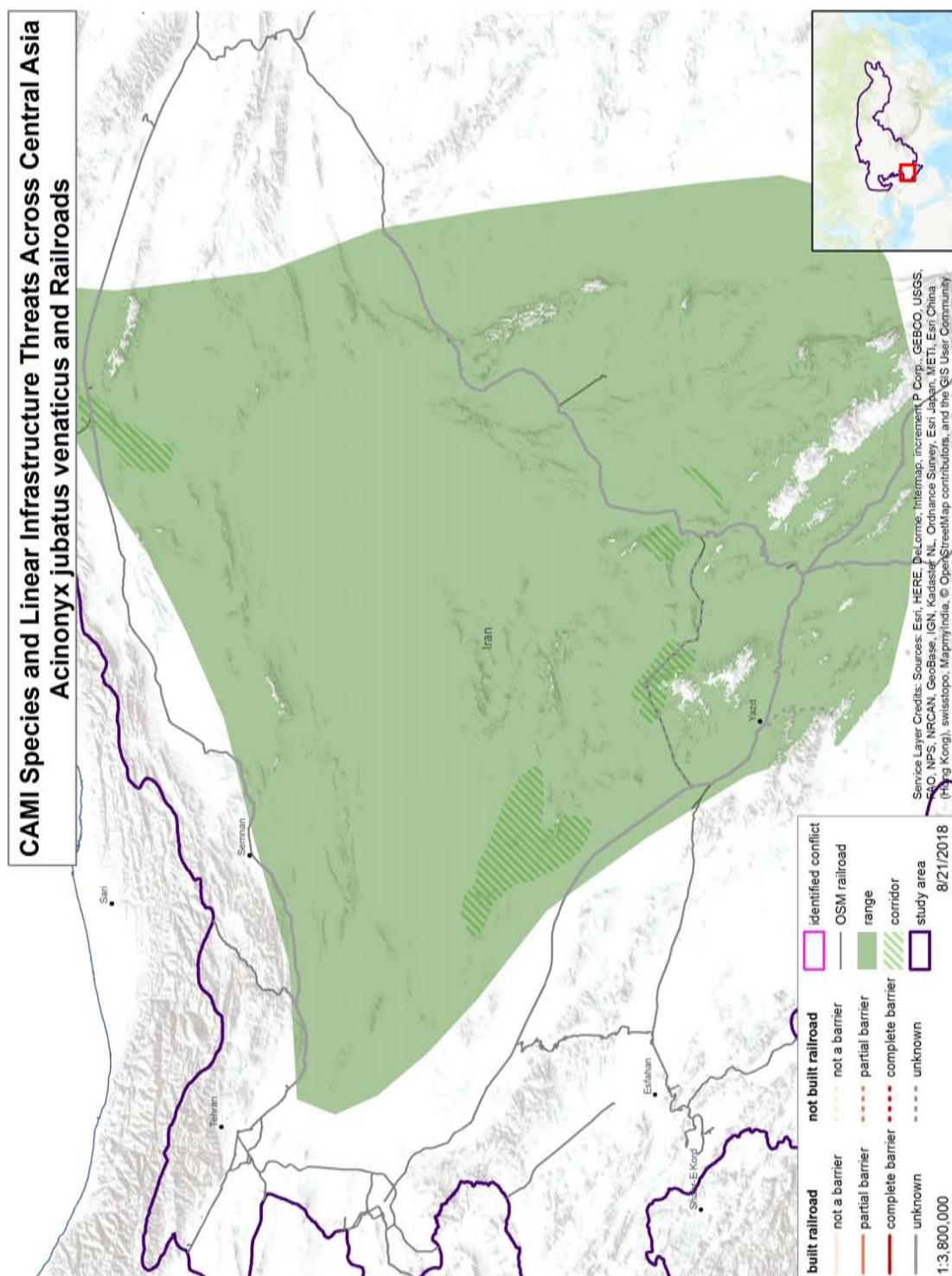


Asiatic Cheetah © Houman Jowkar/CACP

MAP: Asiatic Cheetah (*Acinonyx jubatus venaticus*) || Roads

CAMI Species and Linear Infrastructure Threats Across Central Asia

Acinonyx jubatus venaticus and Railroads



Roads

Conflict Areas

Roads present a major threat, but Highway 44 between Semnan and Mashhad is of particular concern as it transects a key corridor between the core habitats of Touran and Miandasht used by the only known breeding population. Connectivity analyses support the idea that securing this primary road would be critical to reduce risk of collisions with cars (Ahmadi et al. 2017; Moqanaki and Cushman 2016).

Mitigation/Remediation Strategies

- Fence dangerous stretches of roads, and create accompanying wildlife passages, to minimize collisions with cars at documented “hotspots.”
- Install effective, reflective signage close to the road.
- Connect existing underpasses in the case of separated highway lines and monitor for effectiveness.
- Investigate efficacy of speed bumps on low-volume roads.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Built, planned improvements	-
Disrepair	-
Planned, under construction	-
Not a barrier	2,402
Built	2,402
Disrepair	-
Partial barrier	540
Built	540
Built, planned improvements	-
Disrepair	-
Planned/construction	-
Unknown	-
Grand Total	<u>2,942</u>
Expert-highlighted barriers	<u>470</u>
Known roads in range	<u>19,032</u>

Other

Fewer or no conflicts were identified for fences, railroads, canals and pipelines. Railroads and pipelines did appear in the study range and are therefore presented below.

Conflict Areas

The effects of railroads on Cheetah movement are not known. It is suggested that currently this infrastructure is not of major concern because it is usually not fenced.

However, as a result of the growing mining industry within Cheetah habitat, the railroad network is projected to grow accordingly and may cause a suite of conservation threats in the future, such as a fragmentation of Cheetah prey populations.

<u>Calculated Railroad Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Planned, under construction	-
Not a barrier	-
Built	-
Unknown	-
Partial barrier	-
Built	-
Planned/construction	-
Unknown	1,695
Built	1,436
Planned/construction	259
Grand Total	1,695
Expert-highlighted barriers	-
Known railroad in range	1,912

Pipelines

Conflict Areas

Pipelines have not been identified as infrastructure of concern for the Asiatic Cheetah as they most often occur underground in the Asiatic Cheetah's range.

<u>Calculated Pipeline Barriers</u>	<u>km</u>
Not a barrier	208
Built	208
Planned, under construction	-
Unknown	-
Built	-
Planned/construction	-
Grand Total	208
Expert-highlighted barriers	-
Known pipelines in range	208

4.2 Wild Camel

Current Range States: China, Mongolia

Current Global Population: This century, estimates from ground surveys have varied at population estimates of 350-880 Wild Camels in Mongolia (Hare 2000, Guoyang et al. 2002, Magash and Indra 2002, Adiya et al. 2006; 2012). Population surveys of Wild Camels in the early 2000s estimated approximately 730-880 individuals in China (Guoying et al. 2002).

Overview: The Wild Camel (CMS Appendix I) is only found in three locations in northern China (one in the Taklamakan and two in the Lop Nur Desert) and one location in southern Mongolia (Transaltai Gobi; Hare, 2008). The species' distribution in Mongolia is reported to have shrunk by about 70 per cent since the last century, and possibly as early as the 1940s (Adiya et al. 2012, Bannikov 1975). They are categorized as Critically Endangered on the IUCN Red List. Wild Camels are highly mobile and can travel over 75 km in a single day (Kaczensky et al. 2014).

Infrastructure Threats: Several factors are assumed to threaten the Wild Camel's survival, including human disturbance, poaching and competition from, hybridization

with, and disease transmission from, domestic camels (Blumer et al. 2002, Silberman and Burger 2012). Their long-distance movements suggest that Wild Camels can react quickly to local food or water shortages, or to avoid adverse weather conditions and other threats. Other threats to Wild Camel conservation include habitat fragmentation by the Mongolian-Chinese border fence, climate change resulting in drying oases and deteriorating water and forage quality (Clark et al. 2006). Fences, roads and railroads all seem to constitute a complete barrier for Wild Camels. Potential factors affecting Wild Camels on or near the Mongolian-Chinese borders include poaching, mining, and human development (Adiya et al, 2016).

More information:

Wild Camel and CMS

Wild Camel on the IUCN Red List



Wild Camels © Petra Kaczensky

CAMI Species and Linear Infrastructure Threats Across Central Asia
Camelus bactrianus and Fences

Legend:

- built fence**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- not built fence**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- identified conflict**
 - fence
 - range
 - corridor
 - study area

Scale: 1:7,700,000
Date: 8/21/2018

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisslipo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

CAMI Species and Linear Infrastructure Threats Across Central Asia
Camelus bactrianus and Railroads

Legend:

- built railroad**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- not built railroad**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- identified conflict**
 - OSM railroad
 - range
 - corridor
 - study area

Scale: 1:7,700,000
Date: 8/21/2018

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

CAMI Species and Linear Infrastructure Threats Across Central Asia
Camelus bactrianus and Pipelines

Kazakhstan

Mongolia

China

Urumqi

Bayanongor

1:7,700,000

Legend:

- built pipeline**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- not built pipeline**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- identified conflict**
 - pipeline
 - range
 - corridor
 - study area

8/21/2018

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, Geobase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Fences

Conflict Areas

The border fence between Mongolia and China is a complete barrier for Wild Camels, but there is no field survey in this remote area recently.

Mitigation/Remediation Strategies

- remove parts of the border fence to have regular 200-metre gaps every 30 kilometres;
- facilitate greater bilateral cooperation using several mechanisms, including involving security and border agencies;
- increase awareness of cross-boundary issues and improve communication between agency personnel, biologists, and conservationists working on Wild Camel conservation in China and Mongolia;
- organize joint meetings on camel conservation to establish trust and cooperation, and initiate joint research projects;
- conduct a border fence study on Wild Camel habitat in relevant areas;
- establish cooperation between local governmental organization in Gobi-Altai and Bayanhongor province in Mongolia and Xinjiang and Gansu provinces in China, including discussion about transboundary protected-corridor areas for Wild Camels;
- implement conservation-management actions and strategies, including (i) conducting research and consistent, long-term monitoring along international border; (ii) establishing a trans-boundary park between China and Mongolia and protecting movement corridors for Wild Camels.

Calculated Fence Barriers Length in km

Complete barrier	479
Built	479
Partial	-
Unknown	-
Partial barrier	-
Abandoned/disrepair	-
Built	-
Unknown	-
Unknown	46
Built	-
Partial	-
Planned/construction	46
Unknown	-
Grand Total	525
Expert-highlighted barriers	577
Total known roads in range	525

Roads

Conflict Areas

Several roads currently cut through key corridors for Wild Camels and present complete barriers to migration.

Mitigation/Remediation Strategies

- Replace existing roads that bisect migration routes with new roads underground, where feasible;
- Install effective, reflective signage close to the road;
- Consider building overpasses/bridges and monitor for effectiveness.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	417
Built	417
Built, planned improvements	-
Disrepair	-
Planned, under construction	-
Not a barrier	-
Built	-
Disrepair	-
Partial barrier	-
Built	-
Built, planned improvements	-
Disrepair	-
Planned/construction	-
Unknown	-
Grand Total	417
Expert-highlighted barriers	406
Known roads in range	3,929

Railroads

Conflict Areas

One existing railroad in China from Urumqi to Lanzhou presents a complete barrier in the movement corridor for this species. A new expected railroad in China from Huhhot (Inner Mongolia province) to Urumqi will also constitute a complete barrier in the movement corridor of Wild Camels.

Mitigation/Remediation Strategies

- Do not fence this rail line;
- Consider building overpasses/bridges and monitor for effectiveness.

<u>Calculated Railroad Barriers</u>	<u>km</u>
Complete barrier	190
Built	144
Planned, under construction	46
Not a barrier	-
Built	-
Unknown	-
Partial barrier	-
Built	-
Planned/construction	-
Unknown	-
Built	-
Planned/construction	-
Grand Total	190
Expert-highlighted barriers	-
Known railroad in range	975

Pipelines

Note: pipelines are not found to present complete barriers but not all information was available. Further analysis is necessary.

<u>Calculated Pipeline Barriers</u>	<u>km</u>
Not a barrier	-
Built	-
Planned, under construction	-
Unknown	378
Built	162
Planned/construction	216
Grand Total	378
Expert-highlighted barriers	-
Known pipelines in range	378

4.3 Bukhara Deer

Current Range States: Afghanistan, Kazakhstan, Tajikistan, Turkmenistan, Uzbekistan

Current Global Population: ~2,700 in 2015 (O. Pereladova pers. comm in IUCN Red List assessment)

Overview: The Bukhara Deer (CMS Appendix I and II) is a subspecies of the Tarim Red Deer that is native to Central Asian lowlands. Its conservation status has not been assessed separately by the IUCN, but the Tarim Red Deer has the Least Concern status. Not known to be naturally migratory, Bukhara Deer tend to live in riparian forest corridors, occasionally dispersing into adjacent arid shrublands. Seasonal migrations are usually short, in the scale of some tens of kilometres in Kazakhstan (Baskin and Danell 2003). However, possibly as a reaction to habitat loss and degradation (Karlstetter and Mallon 2014), stags searching for mates or local population sizes exceeding habitat carrying capacity, Bukhara Deer have been reported to move across connected or sometimes disconnected stretches of riparian forest in search of more suitable habitats. As the species is capable of swimming across large and turbulent rivers, it moves across water courses that separate Range States (e.g. Moheb et al. 2016).

Infrastructure Threats: Because the Bukhara Deer moves over a range of 6-8 km within small areas (Baskin and Danell 2013) each year, this species is unlikely to be significantly affected by linear infrastructure features as long as they are not developed in its preferred riparian forest habitat.

More information:

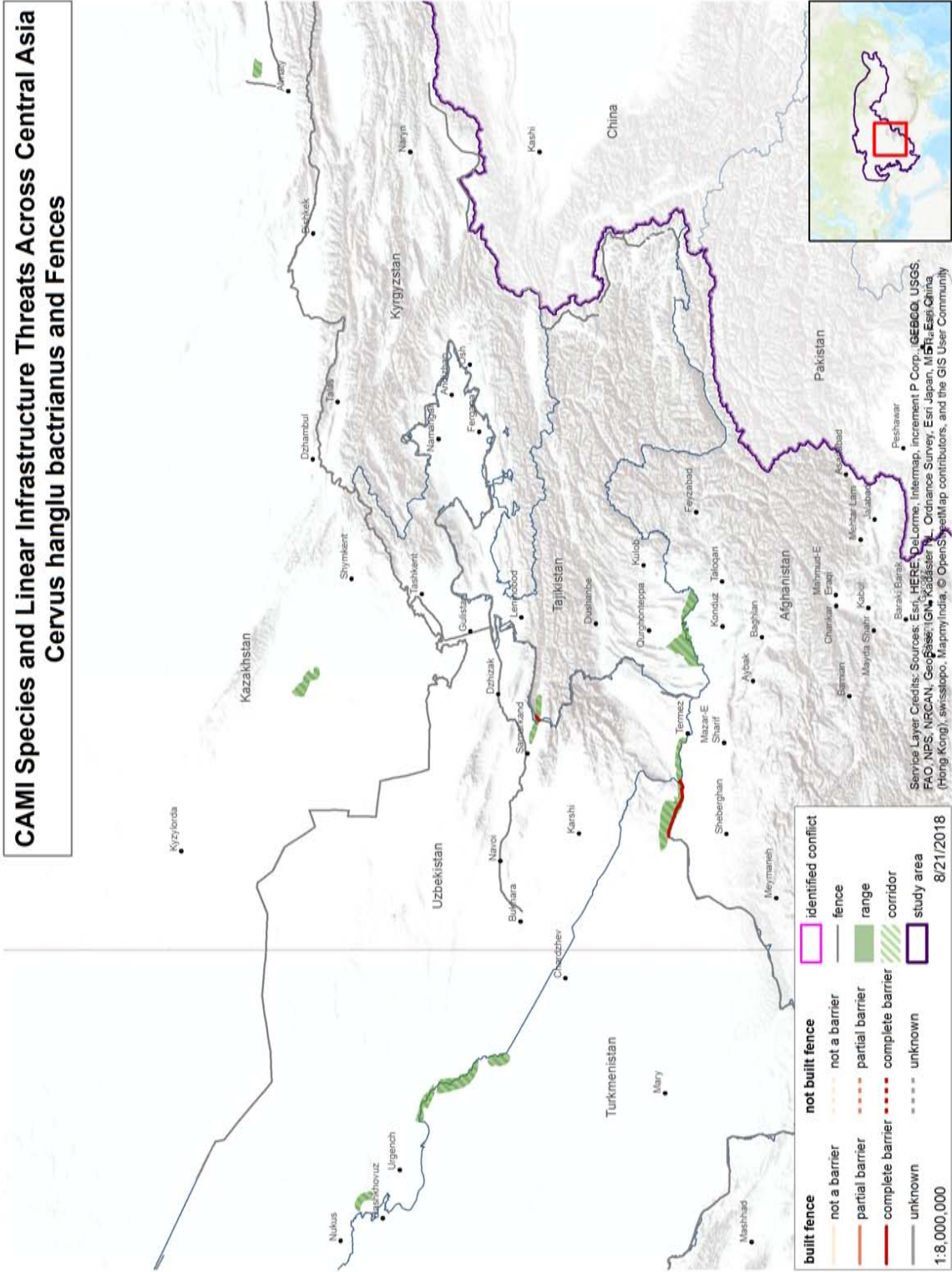
Bukhara Deer and CMS

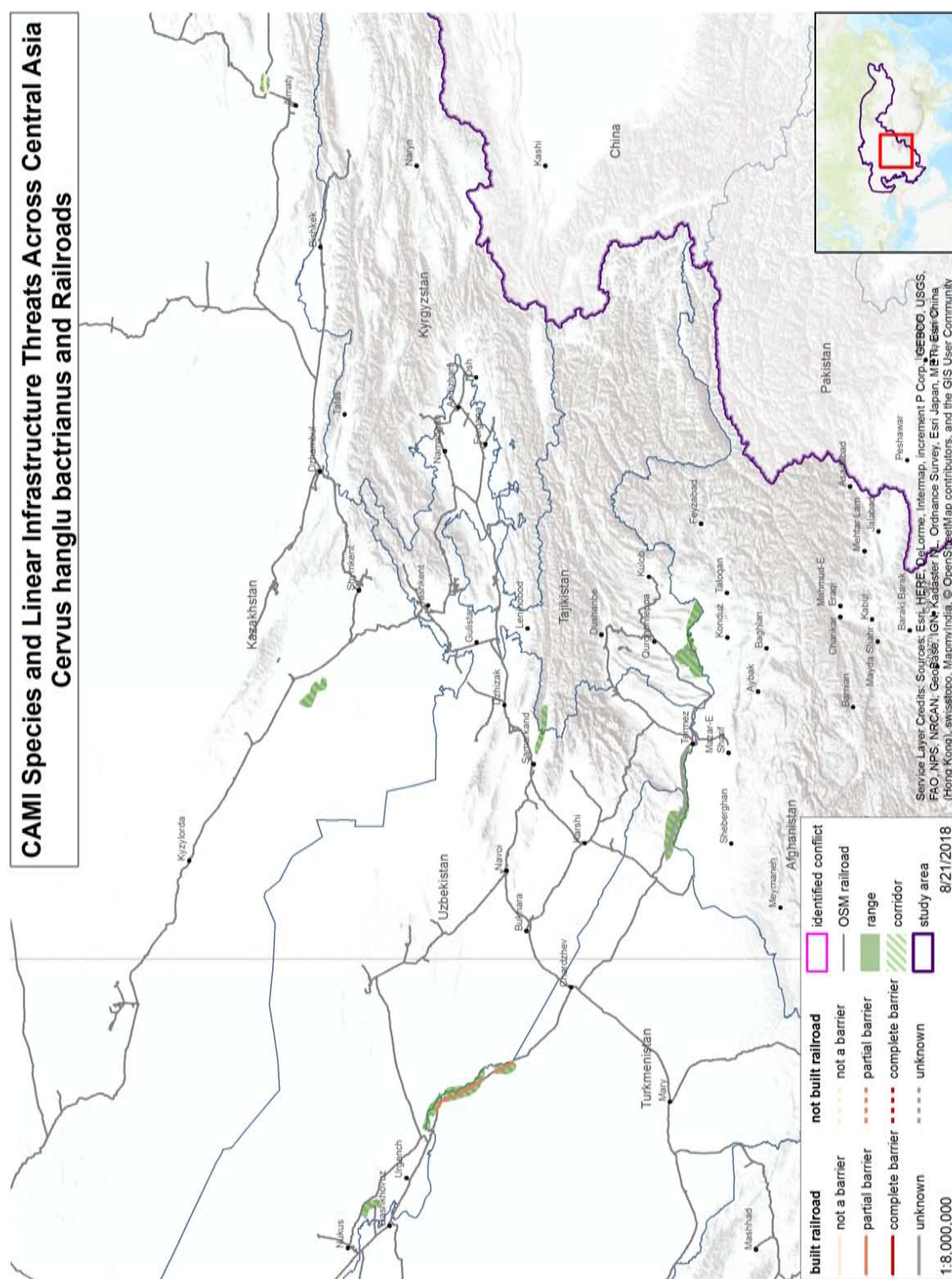
Bukhara Deer on the IUCN Red List



Bukhara Deer © Yelizaveta Protas

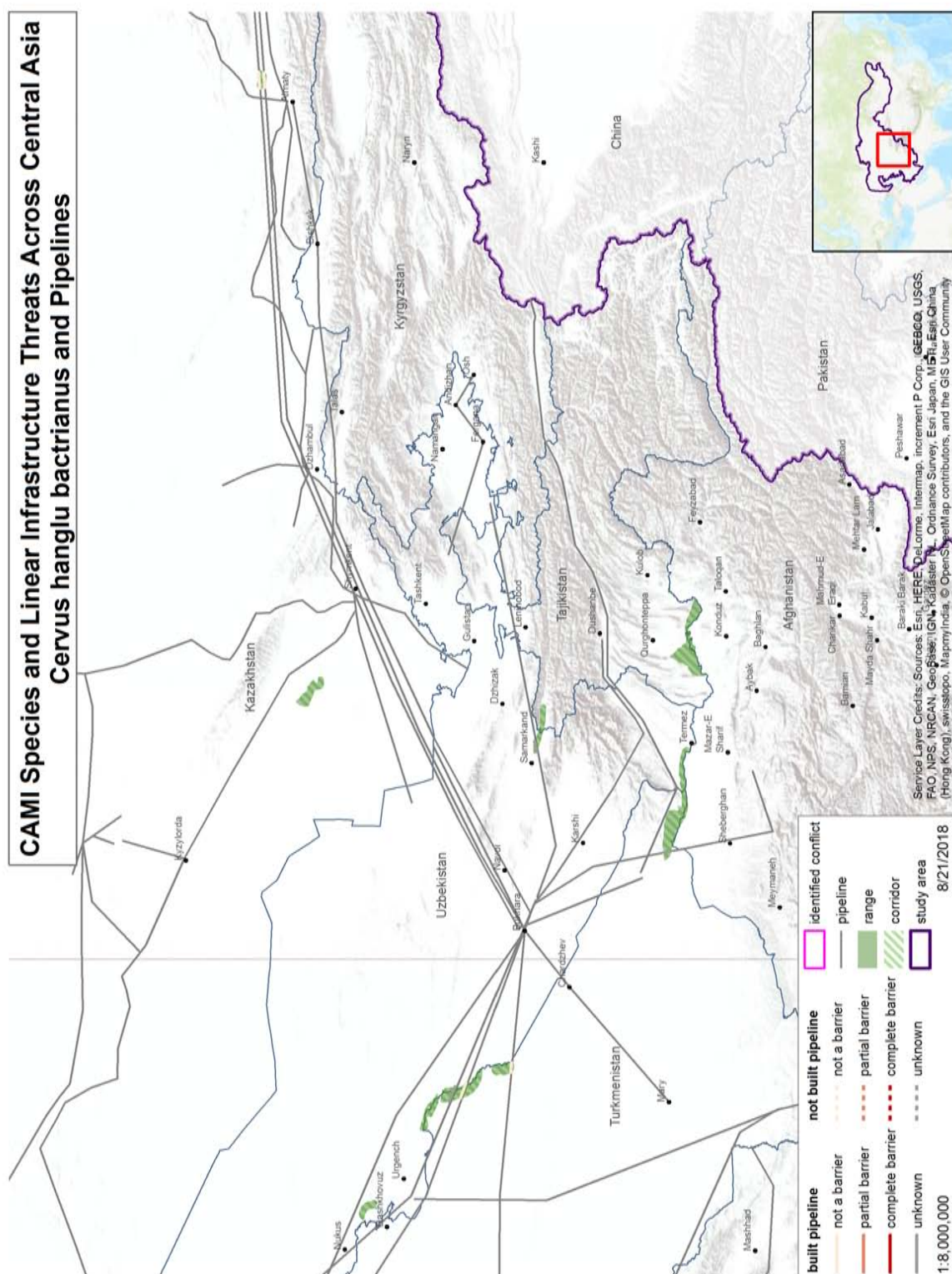
MAP: Bukhara Deer (*Cervus hanglu bactrianus*) || Fences



MAP: Bukhara Deer (*Cervus hanglu bactrianus*) || Railroads

CAMI Species and Linear Infrastructure Threats Across Central Asia

Cervus hanglu bactrianus and Pipelines



Fences

Conflict Areas

The border fence erected between Turkmenistan and Afghanistan could have some effect on transboundary movements of Bukhara Deer between these two countries. Yet, without recent field surveys in this restricted access area this hypothesis remains unconfirmed.

Mitigation/Remediation Strategies

Field surveys to investigate the effect of border fences on Bukhara Deer are needed. Currently no fence conflicts have been documented, but if they should arise, openings should be made in the fencing and deer/fence interactions should be monitored. Government, industry and lenders should be informed of the risk of a fence development project in Bukhara Deer habitat, and they should adhere to national legislation and, when relevant, international obligations, including the implementation of strategic environmental assessments and environmental impact assessments.

<u>Calculated Fence Barriers</u>	<u>km</u>
Complete barrier	163
Built	163
Partial	-
Unknown	-
Partial barrier	-
Abandoned/disrepair	-
Built	-
Unknown	-
Unknown	-
Built	-
Partial	-
Planned/construction	-
Unknown	-
Grand Total	163
Expert-highlighted barriers	-
Total known roads in range	163

Roads

Conflict Areas

Currently roads have not been identified as a significant threat to Bukhara Deer. However, the development of road networks within Bukhara Deer riparian habitat, or adjacent to it, is likely to increase the risk of poaching - a major threat for the species (Karlstetter and Mallon, 2014) - and of collisions with cars.

Mitigation/Remediation Strategies

- Install effective signage that is close to the road and reflective.
- Align signage with official policy.
- Inform government, industry and lenders of the risk of road development projects in or adjacent to Bukhara Deer habitat, and ensure that projects adhere to national legislation and international obligations, including the implementation of strategic environmental assessments and environmental impact assessments.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	48
Built	35
Built, planned improvements	13
Disrepair	-
Planned, under construction	-
Not a barrier	276
Built	276
Disrepair	-
Partial barrier	154
Built	154
Built, planned improvements	-
Disrepair	-
Planned/construction	-
Unknown	-
Grand Total	478
Expert-highlighted barriers	19
Known roads in range	4,135

Other

Fewer or no conflicts were identified for railroads, pipelines and canals. Railroads and pipelines did appear in the study range and those maps are therefore presented below.

<u>Calculated Railroad Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Planned, under construction	-
Not a barrier	24
Built	24
Unknown	-
Partial barrier	128
Built	128
Planned/construction	-
Unknown	194
Built	153
Planned/construction	41

Grand Total	345
Expert-highlighted barriers	-
Known railroad in range	486

Note: pipelines are not found to present complete barriers but not all information was available. Further analysis is necessary.

<u>Calculated Pipeline Barriers</u>	<u>km</u>
Not a barrier	67
Built	67
Planned, under construction	-
Unknown	47
Built	47
Planned/construction	-
Grand Total	114
Expert-highlighted barriers	-
Known pipelines in range	114

4.4 Asiatic Wild Ass

Current Range States: China, India, Iran (Islamic Republic of), Israel, Mongolia, Kazakhstan, Turkmenistan, Uzbekistan

Current Global Population: 55,000

Overview: The Asiatic Wild Ass, also referred to as Gobi Khulan, Turkmen Kulan, Persian Onager and Indian Khur (CMS Appendix II) is listed as Near Threatened on the IUCN Red List. With an estimated 42,000 individuals, Mongolia's population comprises 76 per cent of the total global population (Buuveibaatar et al. 2017, Kaczensky et al. 2015, Ransom et al. 2012). Although fully protected, Asiatic Wild Asses are actively chased away or illegally killed by people in parts of their range and the presence of people and their livestock at water points can limit or block access for Asiatic Wild Asses to this critical resource. Competition with domestic livestock for resources and anthropogenic disturbance also poses a threat to the species (Burnik Šturm et al. 2017, Buuveibaatar et al. 2016).

Infrastructure Threats: Asiatic Wild Asses use a nomadic movement strategy to find forage that is of better quality at different locations between seasons

and years because of the high variation in precipitation that occurs in the Central Asian Rangelands. Group size is typically very fluid, existing in groups of one to thousands. Some of their movements can be across great distances, spanning thousands of kilometres in just a few weeks in search of food and water, and their annual range can cover up to 70,000 km² (Tucker et al. 2018, Kaczensky et al. 2011). Their movements are easily blocked by fences; as an example, the corridor fencing along the Trans-Mongolian Railroad is a complete barrier and now defines the easternmost range of the species in Mongolia (Batsaikhan et al. 2014, Kaczensky et al. 2011). Asiatic Wild Ass are also impacted by border fences which already effectively separate populations between Mongolia and China and fragment the range within Turkmenistan and with neighbouring countries (Linnell et al. 2016). Movements of Asiatic Wild Asses are also negatively affected by high-volume traffic axis, the development of which is associated with increasing resource extraction and the aim towards connecting Asia to global markets (e.g. China's Belt and Road Initiative).

More information:

Asiatic Wild Ass and CMS

Asiatic Wild Ass on the IUCN Red List



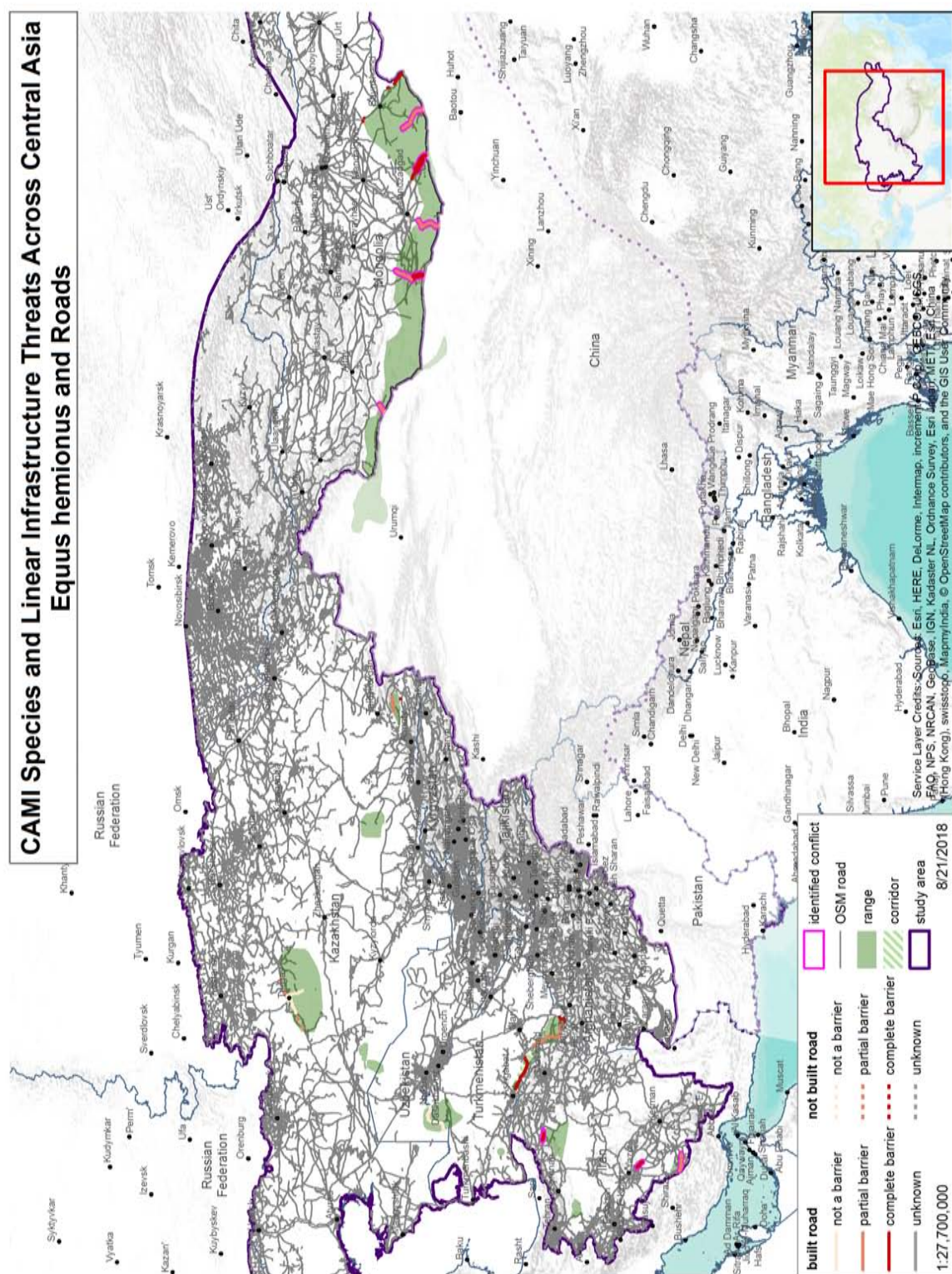
Asiatic Wild Ass © Endre Sos

CAMI Species and Linear Infrastructure Threats Across Central Asia

Equus hemionus and Fences

Service Layer Credits: Source: Esri, HERE, DeLorme, Intermap, increment p, GEBCO, USGS, FAO, NPS, NRCAN, GeBCO, IGN, Kadaster NL, Ordnance Survey, Esri, Air Photo, USDA, Swisstopo, Mapbox India, © OpenStreetMap contributors, and the GIS User Community

127,700,000 8/21/2018

MAP: Asiatic Wild Ass (*Equus hemionus*) || Roads

[illegible]

[illegible]

Fences

Conflict Areas

Fences fragment populations, obstruct access to seasonally important resources, cause mortality, and thereby reduce effective population size.

In Mongolia, the fenced Trans-Mongolian Ulaanbaatar–Beijing railway line cuts Asiatic Wild Ass off from former habitat in the Eastern Steppe. Although the fence is interrupted by small under- and over-passes for vehicles and herders and their livestock, none of these structures have been designed for wildlife use and there has never been a documented attempt to use such structures by Asiatic Wild Ass in the more than 70 years of their existence. The security fence along the Mongolian–Chinese border constitutes an absolute barrier for movements of Asiatic Wild Asses and other large herbivores.

In Turkmenistan, the border fence is often located 5–10 km inside the main territory of Turkmenistan and results in a rather large “no man’s land” between the fence line and the actual border. This has resulted in the fragmentation of the small, remaining populations of Asiatic Wild Ass into separate groups within the border security zones and on Turkmen territory proper along the border to Iran in the south and Uzbekistan in the north (in the Kaplankyr/Lake Sarykamysh region). The border fence also cuts off Asiatic Wild Ass from access to water sources.

Asiatic Wild Ass around Sarykamysh Lake in Uzbekistan can enter the border security zone on Turkmenistan territory, but are cut off from any remaining Asiatic Wild Ass on the Turkmen territory proper (beyond the border fence).

In Iran, a fence along parts of the western edge of Bahram-e Goor protected area was erected to reduce Asiatic Wild Ass-vehicle collision and damage to agriculture, but it also limits movements and population expansion of this increasing population.

Mitigation/Remediation Strategies

- Remove fences that are not directly serving a purpose within Asiatic Wild Ass range (redesign is not an option) wherever possible.
- Develop default policies for segments of new roads and railways that are away from human settlement and other zones requiring greater safety measures to be “unfenced”.
- All proposed fencing along transport infrastructure or other linear features should undergo an EIA;
- Ensure that if fences cannot be avoided, planned fences have 100-metre gaps every 20 kilometres

(some uncertainty with gap width and distance);

- Explore possibilities of remote surveillance to allow gaps in border security fences which do not compromise national security needs/requirements.

<u>Calculated Fence Barriers</u>	<u>km</u>
Complete barrier	2,614
Built	2,614
Partial	-
Unknown	-
Partial barrier	-
Abandoned/disrepair	-
Built	-
Unknown	-
Unknown	921
Built	921
Partial	-
Planned/construction	921
Unknown	-
Grand Total	3,534
Expert-highlighted barriers	4,064
Total known roads in range	3,534

Roads

Conflict Areas

Road networks are present throughout much of the range. It appears that a critical factor in a road being a barrier or not is the density and temporal distribution of road traffic. Roads with high traffic volume are problematic for Asiatic Wild Ass as they are unable to cross except during breaks in traffic.

In Mongolia, six new mining roads dissect the Asiatic Wild Ass range in a north-south direction and thus threaten to dissect the range if traffic picks up and together with local roads and other parallel infrastructure development may cause cumulative effects reducing landscape permeability. Currently, traffic volume and impact on Asiatic Wild Asses is only systematically monitored along one of these roads (the Oyun Tolgoi road).

In Kazakhstan, existing populations of Asiatic wild ass are very much restricted to protected areas. The National Park “Altyn Emel” is crossed by a road, but the animals manage to use habitats on both sides of it according to ranger observations. A newly reintroduced population in Central Kazakhstan would only be affected, if it expands to the North, which is unlikely to happen.

In Iran, the road along the western edge of Bahram-e Goor protected area has seen Asiatic Wild Ass-vehicle collisions (Mahmoud Hemami and Saeideh Esmaeili pers.

comm.). A fence has been erected to reduce this risk and stop Asiatic Wild Asses from entering agricultural areas, but obviously also impeded Asiatic Wild Ass movements. The road north of Touran protected area complex could impede Wild ass movements, but currently little information is available.

Mitigation/Remediation Strategies

- On Mongolian mining roads, explore measures to stop traffic when larger aggregations of Asiatic Wild Asses are passing, especially during extreme weather conditions like snow covered by ice (dzhut) or drought events. This could include education and awareness raising for drivers about wildlife, requiring them to reduce speed when seeing wildlife close to the road, especially large aggregations.
- Reduce traffic volume significantly during extreme weather events (e.g. droughts or dzhut) to allow large aggregations of animals to cross high traffic roads in search for forage.
- Evaluate options for traffic curfew. The situation should be evaluated annually and an inventory of options should be taken to adjust to changing traffic patterns.
- Build over- or underpasses at regular intervals over high-volume traffic axis and explore possibilities to guide Wild Ass movements to these crossing structures e.g. using strategic fencing to funnel movements or artificial water points to attract animals (field experiments are urgently needed!).
- Consider installation of speed bumps or rumble strips to slow down trucks.
- Build regular gaps into guardrails.

Calculated Road Barriers km

Complete barrier 796

Built	796
Built, planned improvements	-
Disrepair	-
Planned, under construction	-

Not a barrier 381

Built	190
Disrepair	191

Partial barrier 1,183

Built	930
Built, planned improvements	-
Disrepair	49
Planned/construction	204

Unknown -

Grand Total 2,360

Expert-highlighted barriers 1,136

Known roads in range 14,099

Railroads

Conflict Areas

The effects of railway lines or embankments on Asiatic Wild Ass movements are not well understood. If the embankment is not too steep and train traffic is moderate, it is believed that it is unlikely to prevent Asiatic Wild Ass from crossing. However, if the rail corridor is fenced, a railway becomes an absolute barrier (see previous point Fences).

In Mongolia, the fenced Trans Mongolian Railroad (TMR) connecting Ulaanbaatar and Beijing currently prevents the species from accessing suitable habitat that exists east of the railroad from where it disappeared after TMR completion in the 1950s. Within the current Asiatic Wild Ass range there is a single railroad line under construction and a number of planned railway lines and if they are fenced the range would be significantly fragmented and the risk local extirpation would arise.

In Kazakhstan, the newly reintroduced population in Central Kazakhstan might easily be stopped in its movement southwards by the Zhezkazgan-Beyneu railway, when it extends its range. There is no fence along the railway, but the embankment is in many parts high with steep slopes and the animals may avoid crossing it.

Mitigation/Remediation Strategies

- Ensure that existing standards and guidelines for infrastructure including those described in the [CMS Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia](#) are followed.
- Ensure that the default for new roads and railways is “no fence” and that the use of fences in strategic places needs to be approved by EIAs
- Ensure embankment slopes are not too steep (1:4 or 1:5 ratio; field experience is needed to obtain threshold values).
- Wherever fences cannot be avoided build over- or underpasses at regular intervals and explore possibilities to guide Wild Ass movements to these crossing structures e.g. using strategic fencing to funnel movements or artificial water points to attract animals (field experiments are urgently needed!).
- Railway underpasses should be considered.

<u>Calculated Railroad Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Planned, under construction	-
Not a barrier	1,104
Built	183
Unknown	921
Partial barrier	-
Built	-
Planned/construction	-
Unknown	261
Built	261
Planned/construction	-
Grand Total	1,365
Expert-highlighted barriers	645
Known railroad in range	680

Other

Fewer or no conflicts were identified for pipelines and canals. Pipelines did appear in the study range and the map is therefore presented below.

<u>Calculated Pipeline Barriers</u>	<u>km</u>
Not a barrier	67
Built	67
Planned, under construction	-
Unknown	47
Built	47
Planned/construction	-
Grand Total	114
Expert-highlighted barriers	-
Known pipelines in range	114

Note: The impacts of pipelines and the related infrastructure on Asiatic Wild Ass movements have not been robustly investigated to date and therefore sound data is lacking. Further analysis is necessary. The pipelines in northern Iran could potentially limit northern movement from animals in the Khar Touran National Park and additionally impact a future transboundary population with Turkmenistan.

4.5 Chinkara

Current Range States: Afghanistan, India, Iran (Islamic Republic of), Pakistan

Current Global Population: est. <80,000 (Mallon and Kingswood 2001)

Overview: Chinkara, also known as Jabeer in Iran, are adapted to thrive in very dry landscapes including sand deserts, flat rocky plains and hills, dry scrub and light acacia forest (Mallon and Kingswood 2001, Akbari et al. 2014). The conservation status of this species is classified as Least Concern by the IUCN, but there are very few studies of this species and its conservation threats are poorly quantified. Although it is fully protected across its range, it is exposed to a heavy pressure of illegal hunting -- contributing in Iran to the decline of the Asiatic cheetah.

Infrastructure Threats: The development of infrastructures is responsible of the fragmentation of its habitat, and border fences conflict with its movements, which are determined to a great extent by rainfall and associated rangeland changes in food availability. As with other gazelle species, fencing is probably the linear infrastructure with the greatest impact on Chinkara, and may cause direct mortality through entanglement or starvation of food/water-stressed individuals.

More information:

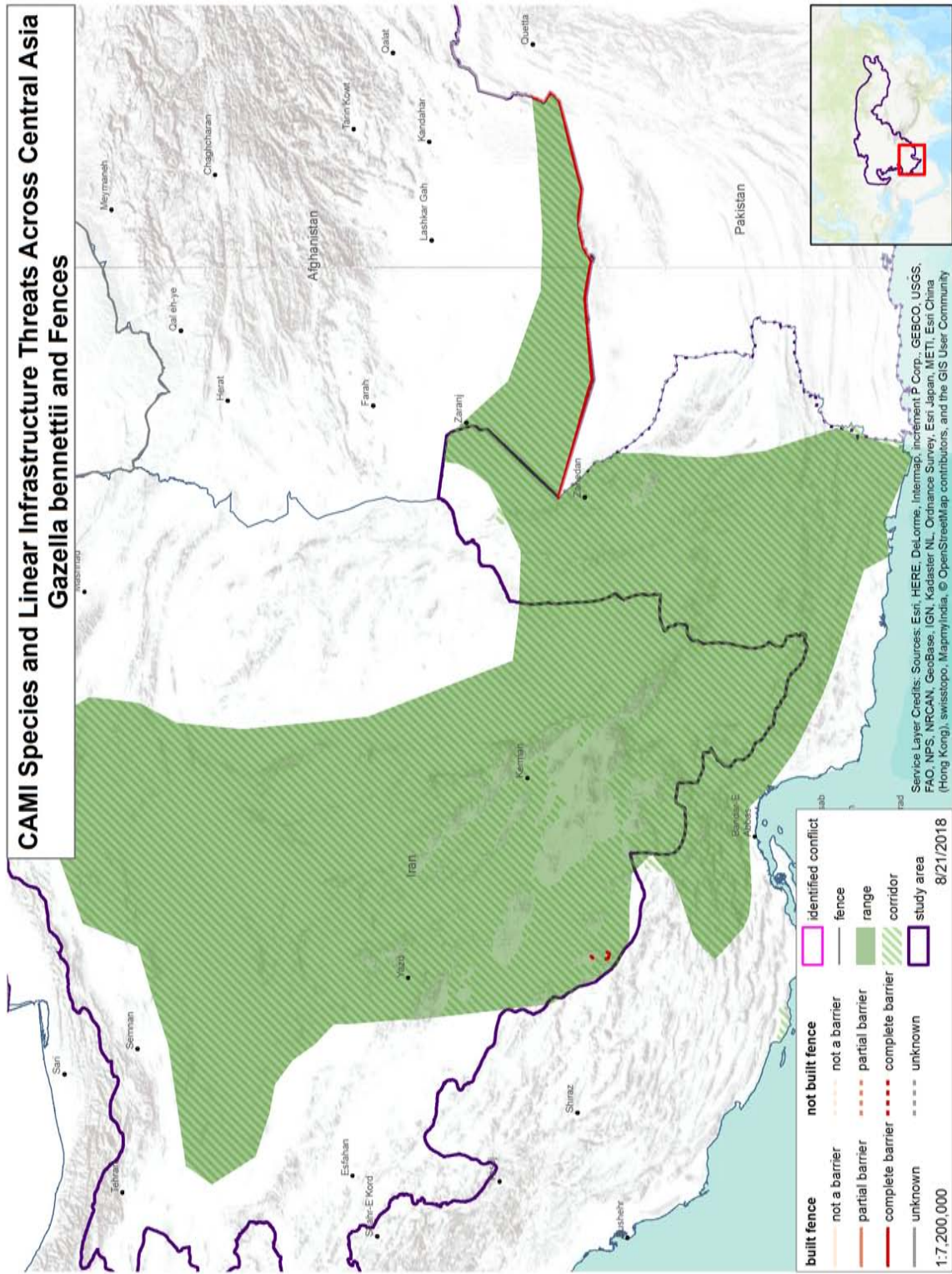
Chinkara and CMS

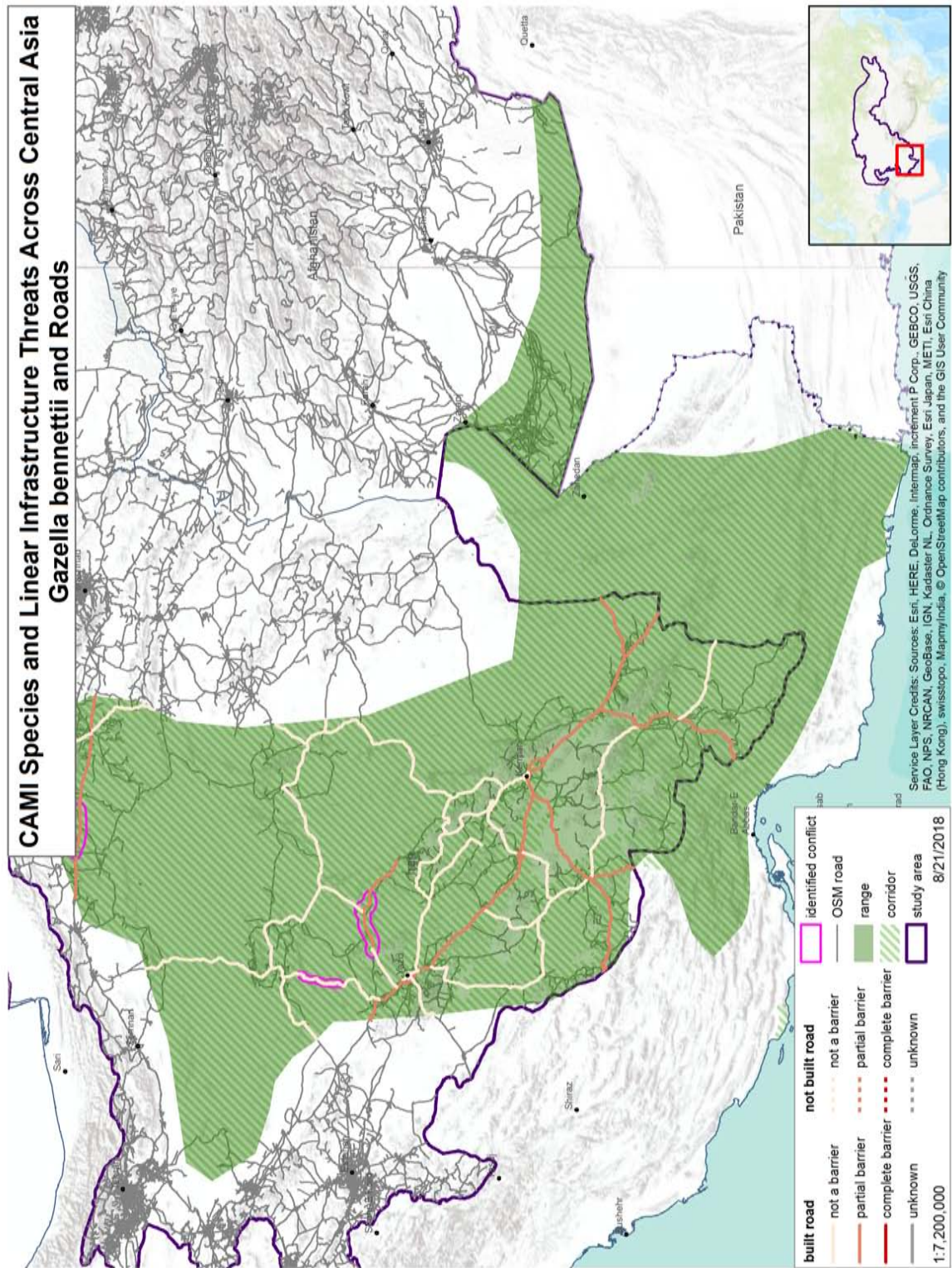
Chinkara on the IUCN Red List



Chinkara © AI Wabra Wildlife Preservation

MAP: Chinkara (*Gazella bennettii*) || Fences



MAP: Chinkara (*Gazella bennettii*) || Roads

CAMI Species and Linear Infrastructure Threats Across Central Asia
Gazella bennettii and Railroads

Legend:

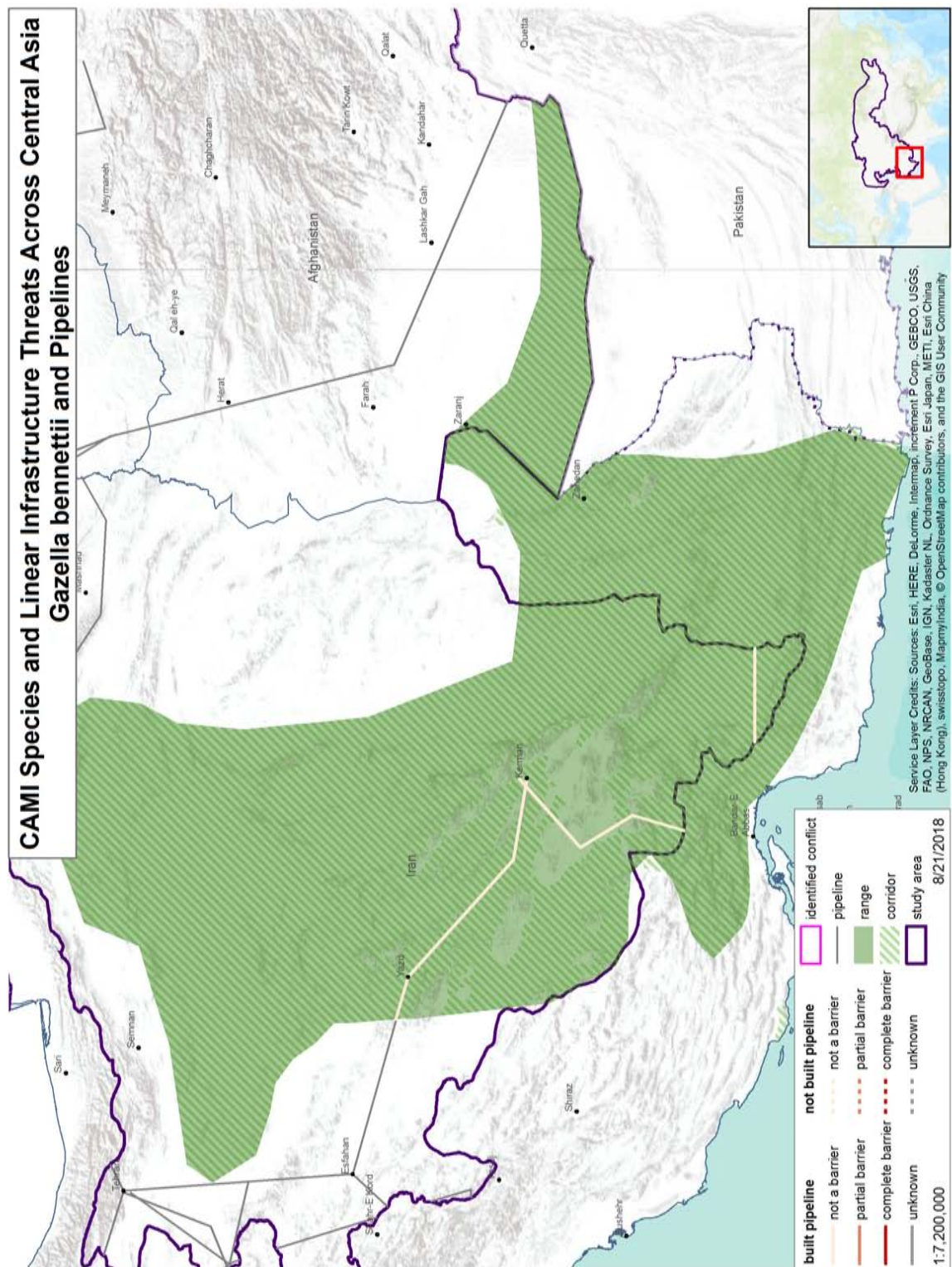
- built railroad**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- not built railroad**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- identified conflict**
- OSM railroad**
- range**
- corridor**
- study area**

Map Labels: Tehran, Sanj, Saman, Esfahan, Shiraz, Bandar-E Abbas, Zabol, Zaranj, Farah, Herat, Qat el-yeh, Chaghchavan, Maymaneh, Gahat, Lashkar Gah, Kandahar, Tarn Kowt, Queshta, Afghanistan, Pakistan, Iran.

Scale: 1:7 200 000

Date: 8/21/2018

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swissltopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

MAP: Chinkara (*Gazella bennettii*) || Pipelines

Fences

Conflict Areas

The border fence between Pakistan and Afghanistan transects part of the distribution range. The effects of this border fence on Chinkara are not documented but can be inferred from the effect of fencing on the sympatric *Gazella subgutturosa*. In case of drought, weakened gazelles have a tendency to aggregate and die along stretches of fence that prevent their movements in the direction of a better forage area (e.g. Zafar-ul Islam et al. 2010).

In Mongolia, the fenced Trans Mongolian Railroad (TMR) connecting Ulaanbaatar and Beijing currently prevents the species from accessing suitable habitat that exists east of the railroad from where it disappeared after TMR completion in the 1950s. Within the current Asiatic Wild Ass range there is a single railroad line under construction and a number of planned railway lines and if they are fenced the range would be significantly fragmented and the risk local extirpation would arise.

Mitigation/Remediation Strategies

- Dismantle decaying fences and new fences if possible.
- Create fence gaps/openings or promote cable fences that allow gazelles to pass safely through (i.e. no barbed wire).
- Control illegal hunting along border fence road and gaps.
- Raise awareness in government, industry and lenders of the risk of a fence development project to Chinkaras and ensure adhere to national legislation and international obligations.

<u>Calculated Fence Barriers</u>	<u>km</u>
Complete barrier	552
Built	552
Partial	-
Unknown	-
Partial barrier	-
Abandoned/disrepair	-
Built	-
Unknown	-
Unknown	-
Built	-
Partial	-
Planned/construction	-
Unknown	-
Expert-highlighted barriers	-
Total known roads in range	552

Roads

Conflict Areas

A growing network of roads with large volumes of traffic could impede Chinkara passage. The frequency of collisions may be underestimated as incidental take of species prized for the quality of their meat is rarely reported. More importantly, roads provide easy access and fast escape to otherwise poorly accessible areas. In Iran, Chinkara survive best in rugged terrain far from roads, and poorly accessible for poachers, where chasing Chinkara by motorbikes and refueling is a real challenge (Jowkar pers. comm.).

Mitigation/Remediation Strategies

- Install small obstacles/bumpers on the road to force drivers to slow down on local roads where Chinkaras occur frequently.
- Install more lights along roads and/or reflective signage.
- Develop underpasses or bridges for highways.
- Improve awareness of government, industry and lenders of the risks and of importance of strategic environmental assessments and environmental impact assessments.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Built, planned improvements	-
Disrepair	-
Planned, under construction	-
Not a barrier	3,588
Built	3,588
Disrepair	-
Partial barrier	1,958
Built	1,958
Built, planned improvements	-
Disrepair	-
Planned/construction	-
Unknown	-
Grand Total	5,546
Expert-highlighted barriers	122
Known roads in range	41,604

Other

Fewer or no conflicts were identified for railroads, pipelines and canals. Railroads and pipelines did appear in the study range and those maps are therefore presented below.

Note: The effects of railroads on Chinkara movement are not known, and it is suggested that currently this infrastructure is not of major concern as it is usually not fenced. However, as a result of the growing mining industry within the Chinkara habitat, the railroad network is projected to grow accordingly and may cause a suite of conservation threats in the future, such as a fragmentation of the habitat.

<u>Calculated Railroad Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Planned, under construction	-
Not a barrier	-
Built	-
Unknown	-
Partial barrier	-
Built	-
Planned/construction	-
Unknown	2,125
Built	1,808
Planned/construction	317
Grand Total	2,125
Expert-highlighted barriers	-
Known railroad in range	2,384

Pipelines

Note: As they mostly occur underground within the species' range, pipelines have not been identified as infrastructures of concern for the Chinkara.

<u>Calculated Pipeline Barriers</u>	<u>km</u>
Not a barrier	805
Built	805
Planned, under construction	-
Unknown	-
Built	-
Planned/construction	-
Grand Total	805
Expert-highlighted barriers	-
Known pipelines in range	805

4.6 Goitered Gazelle

Current Range States: Afghanistan, Azerbaijan, China, Iran (Islamic Republic of), Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, Uzbekistan

Current Global Population: According to a recent IUCN Red List assessment, the number of mature individuals is estimated at 42,000-49,000 (IUCN SSC Antelope Specialist Group 2017).

Overview: Goitered Gazelle (CMS Appendix II) are the widest-ranging gazelle species in the world, occurring from the Arabian Peninsula across the Middle East and Asia including Pakistan, Kazakhstan, Mongolia, and China. The Goitered Gazelle is classified as Vulnerable by the IUCN. They are not known to form very large groups, unlike Saiga or Mongolian Gazelle. Goitered Gazelles typically occupy arid desert and desert-steppe habitat and found in mixed sex groups. In Mongolia, where the largest population survives, they have been observed exhibiting both range residency and migratory behaviour.

Infrastructure Threats: Goitered Gazelle populations are extremely fragmented due to the presence of infrastructure, habitat loss from agriculture, and high live-stock numbers across their range across all range states.

The threats are the same as those for Saiga Antelope, Mongolian Gazelle and Asiatic Wild Ass. Fences for agriculture, railroads as well as canals block access and prevent movement to important habitats and also entangle individuals. Individuals are struck by vehicles on high-speed roads, especially at night. Border fences prevent transboundary movements.

More information:

Goitered gazelle and CMS

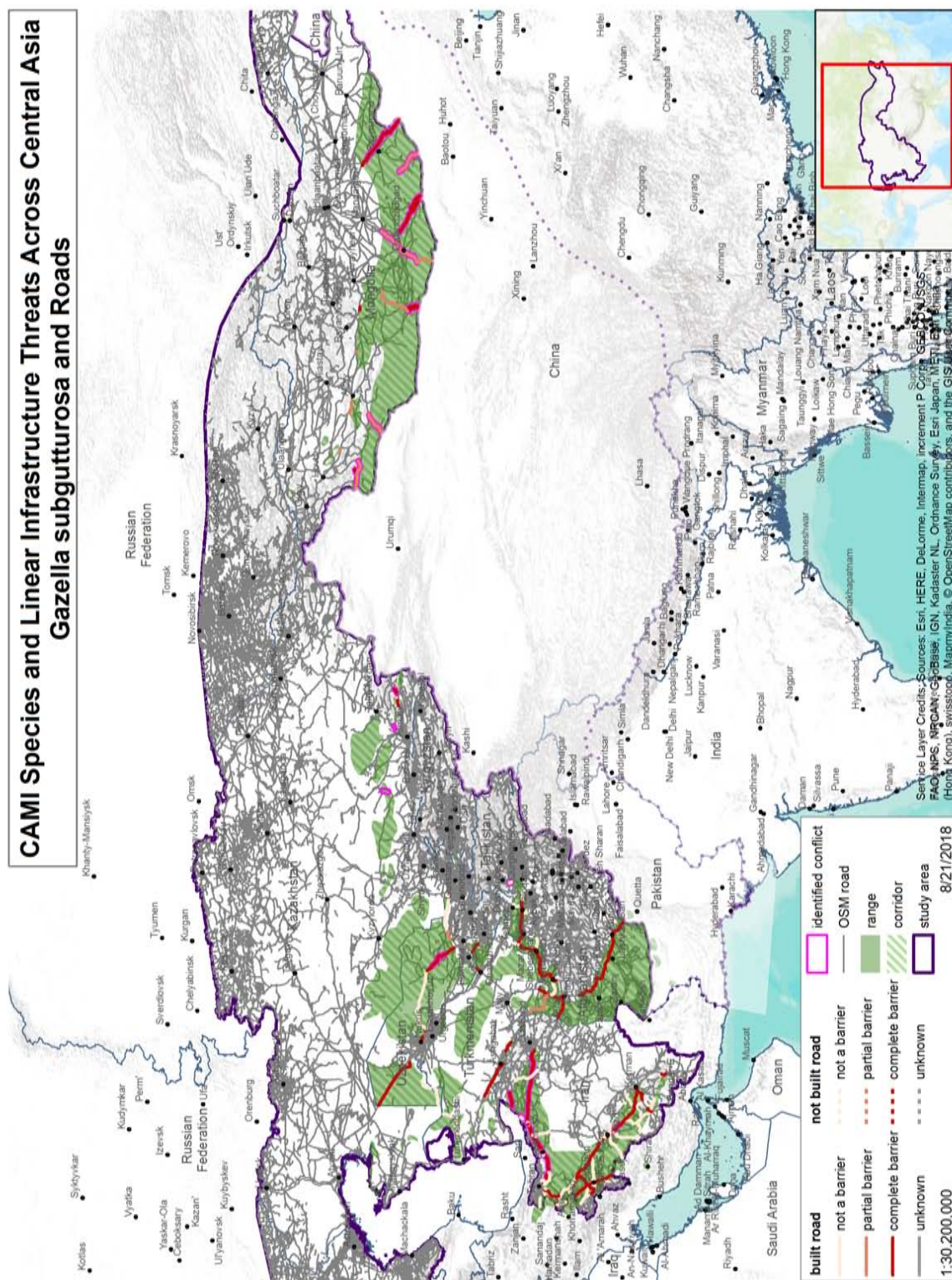
Goitered gazelle on the IUCN Red List



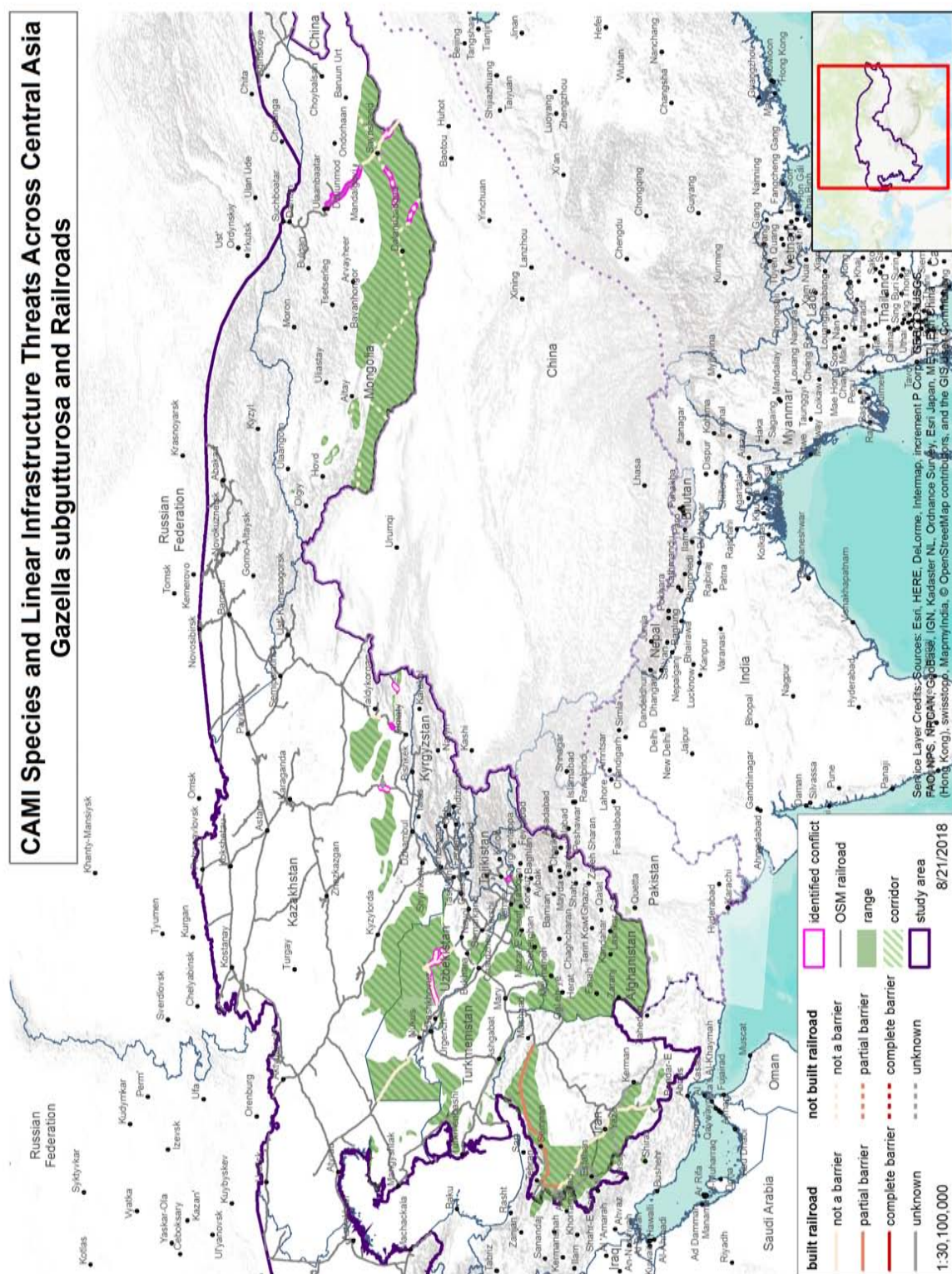
Goitered Gazelle © Petra Kaczensky

CAMI Species and Linear Infrastructure Threats Across Central Asia

Gazella subgutturosa and Roads



MAP: Goitered Gazelle (*Gazella subgutturosa*) || Railroads



CAMI Species and Linear Infrastructure Threats Across Central Asia

Gazella subgutturosa and Pipelines

Legend:

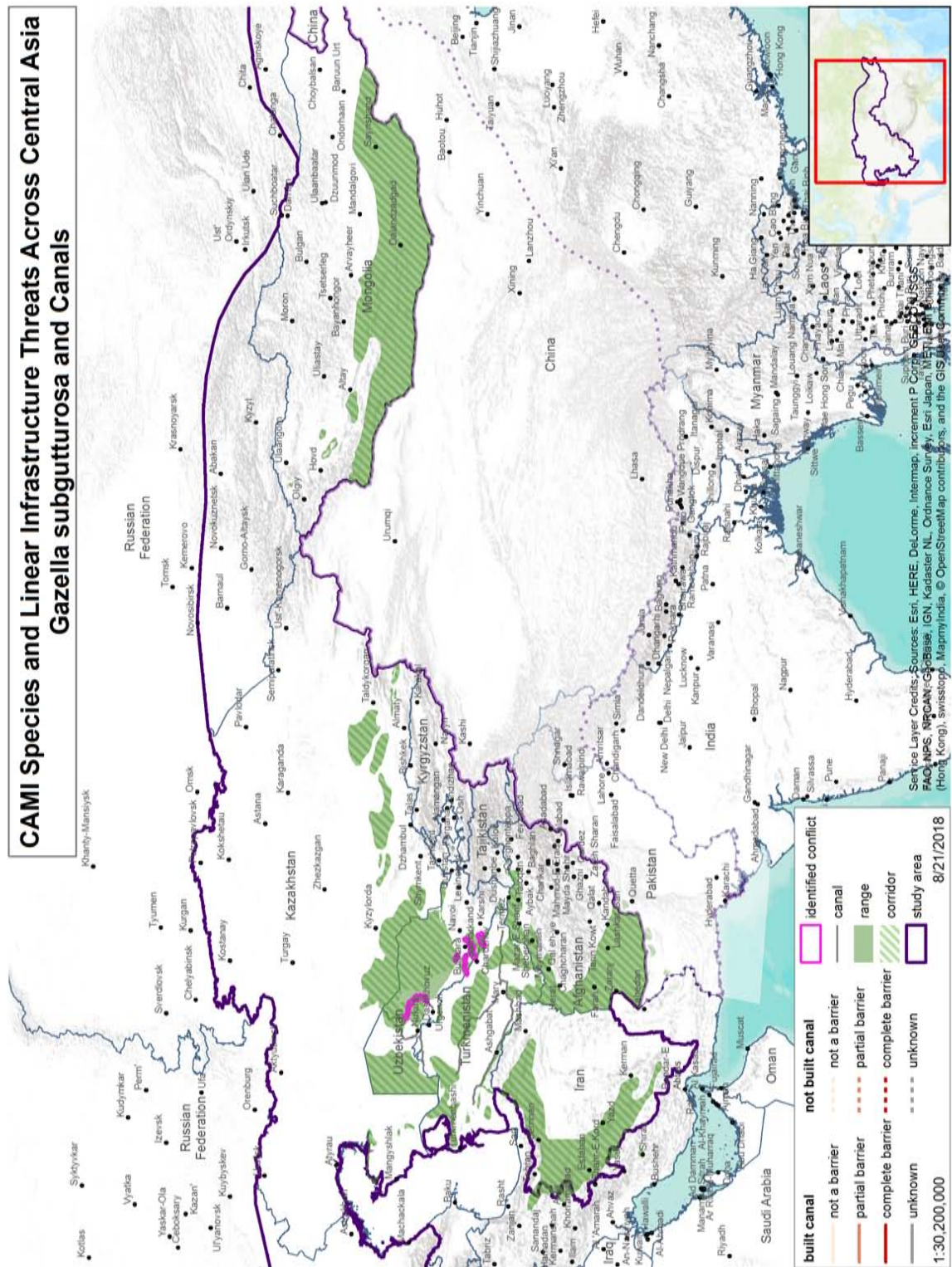
- built pipeline**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- not built pipeline**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- identified conflict**
 - pipeline
 - range
 - corridor
 - study area

Scale: 1:30,200,000

Date: 8/21/2018

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, AIGAN, CDBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri (The World Map), Swisstopo, Mapbox, OpenStreetMap contributors, and the GIS User Community (Hong Kong).

8/21/2018

MAP: Goitered Gazelle (*Gazella subgutturosa*) || Canals

Fences

Overview

Border fences present the most significant threat to the connectivity of Goitered Gazelle habitat. Planned railroads in Mongolia and elsewhere may be accompanied by fences.

Mitigation/Remediation Strategies

- Avoid building any fences (especially important for the planned railroad projects in Mongolia).
- Remove fences that no longer serve their intended purpose.
- Where fences are present in their range and are necessary, modify them to wildlife friendly fence designs outside of heavily settled areas (see Mongolian Gazelle).

<u>Calculated Fence Barriers</u>	<u>km</u>
Complete barrier	4,406
Built	4,406
Partial	-
Unknown	-
Partial barrier	-
Abandoned/disrepair	-
Built	-
Unknown	-
Unknown	2,717
Built	-
Partial	755
Planned/construction	1,962
Unknown	-
Grand Total	7,122
Expert-highlighted barriers	471
Total known roads in range	552

Roads

Overview

Across the species range, roads are already causing or are predicted to cause severe habitat fragmentation. There are three large areas where roads are not identified as a threat: Central Kazakhstan, Central/Western Mongolia, and North-west Pakistan.

Mitigation/Remediation Strategies

- Remove green vegetation around the roads in order to discourage gazelles from feeding along or near roads (applicable for all herbivores).
- Close (mining) roads during times of increased

gazelle movement.

- Ensure that existing standards and guidelines for infrastructure, including the CMS Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia are followed.
- Include regular gaps in guardrails.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	6,128
Built	6,058
Built, planned improvements	70
Disrepair	-
Planned, under construction	-
Not a barrier	-
Built	3,831
Disrepair	3,831
Partial barrier	1,411
Built	1,400
Built, planned improvements	-
Disrepair	-
Planned/construction	11
Unknown	-
Grand Total	11,370
Expert-highlighted barriers	2,795
Known roads in range	130,842

Railroads

Overview

Railroads by themselves act as partial barriers to Goitered Gazelle migration, if they are built with underpasses at regular intervals, which is usually the case. Identified conflicts are greatest in Iran, Mongolia and Uzbekistan. Unmitigated, railroads probably play an important role in population fragmentation and range shrinkage and this should serve as a warning of anticipated effects of future railroads.

Mitigation/Remediation Strategies

- Raise awareness of habitat fragmentation in Mongolia with significant negative impacts on Goitered Gazelles and other wildlife, caused by existing and planned railroads
- Identify conflict areas in Uzbekistan to develop solutions
- Determine what partial barriers may be in place in Iran to mitigate conflicts with gazelle movements.

Calculated Railroad Barriers **km**

Complete barrier	-
Built	-
Planned, under construction	-
Not a barrier	4,143
Built	2,181
Planned/construction	1,962
Partial barrier	908
Built	908
Planned/construction	-
Unknown	1,919
Built	884
Planned/construction	1,035
Grand Total	6,970

Expert-highlighted barriers	1,108
Known railroad in range	6,073

Other

Pipelines are mostly buried and few conflicts have been identified. However, the existing canal system in some parts of the range of Goitered Gazelles form an effective barrier preventing the movements of the gazelles and can have significant impact.

Overall, pipelines are not considered a threat to the mobility of this species. There are minor conflicts identified in Tajikistan, Turkmenistan and Uzbekistan.

Calculated Pipeline Barriers **km**

Not a barrier	3,360
Built	2,654
Planned, under construction	705
Unknown	1,791
Built	1,145
Planned/construction	646
Grand Total	5,151
Expert-highlighted barriers	-
Known pipelines in range	5,151

Canals have been identified as barrier to movements of Goitered Gazelles in Uzbekistan.

Calculated Canal Barriers **km**

Complete barrier	1,083
Planned/Construction	234
Grand Total	1,317
Expert-highlighted barriers	662
Total known roads in range	1,317

4.7 Argali Sheep

Current Range States: Afghanistan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russian Federation, Uzbekistan, Tajikistan

Current Global Population: est. 50,000 – 100,000 (Mallon et al., 2014)

Overview: There are currently nine different recognized subspecies of Argali, the world's largest sheep species, seven of which are on Appendix II of CMS. Argali is classified as near threatened by the IUCN. Argali sheep live on highlands, e.g. mountains, steppe valleys, and rocky outcrops (Fedosenko and Blank 2005). Argali are highly proficient at moving quickly across mildly steep, open outcrops as one of their defense mechanisms. Their movements are also in response to changes in altitude as they search for water and pasture, as well as to avoid deep snow and seasonally for mating (Mallon et al. 2014).

Infrastructure Threats: Fences erected between countries, e.g. between China and Tajikistan and other adjacent countries, affect movements and range use (Mallon et al. 2014). It has also been suggested that the lower heterozygosity and allelic richness of Argali in Taxkorgan

(China) could result to some extent from the reduced connectivity with Tajik population because of the border fence (Luikart et al. 2011). Border fences can also result in direct mortality when Argali get stuck and starve along stretches of fences that they fail to contour, such as was observed recently in Tajikistan. Fences within or between countries including those along railroads are the most impactful linear infrastructure so far identified for Argali. Roads, railroads and pipelines are relatively rare in their remote, often high elevation habitats, and their effects on argali sheep remain largely unknown, except for a few conflict areas identified in the following sections.

More information:

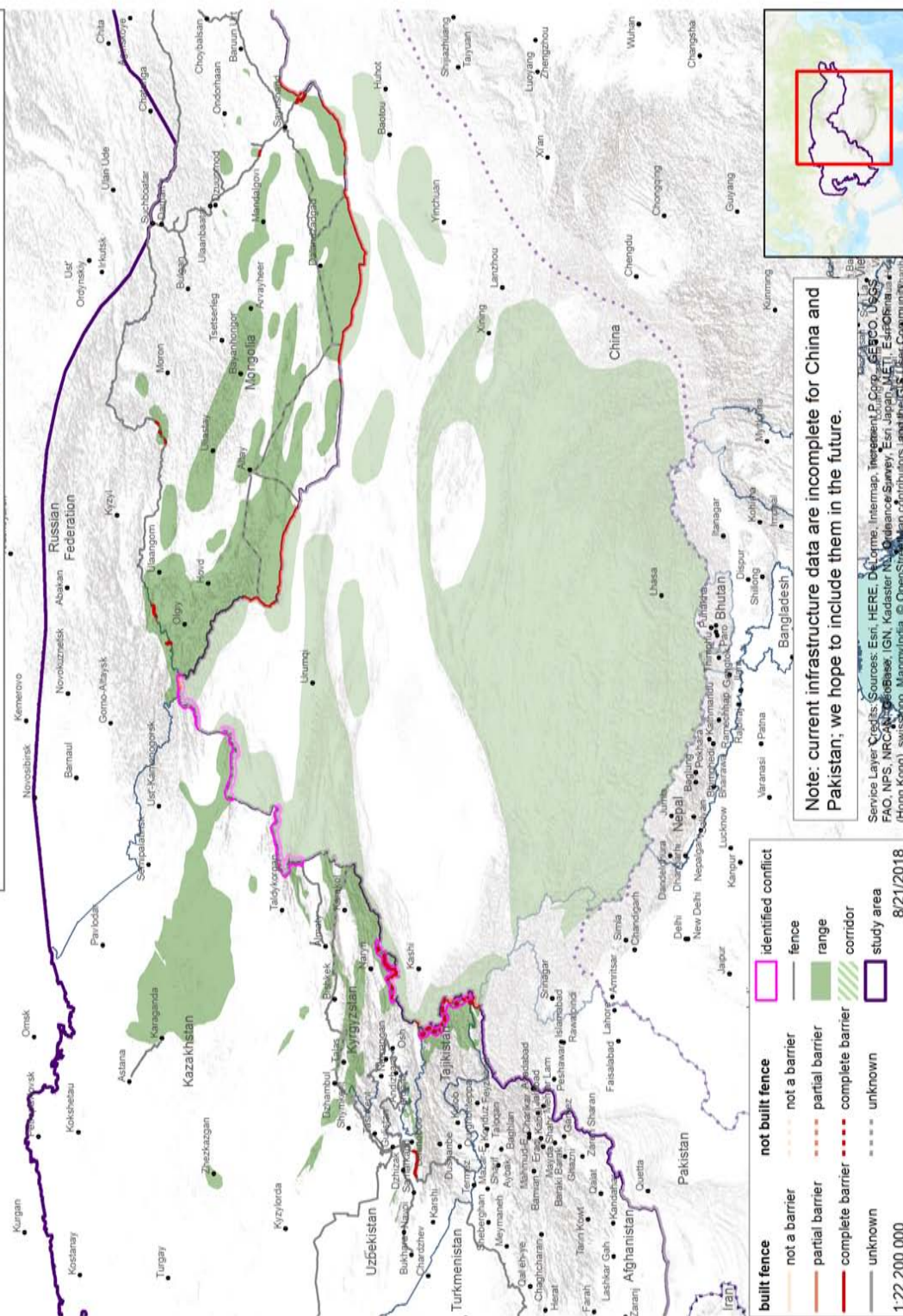
Argali Sheep and CMS
Argali Sheep on the IUCN Red List



Argali Sheep © Askar Davletbakov

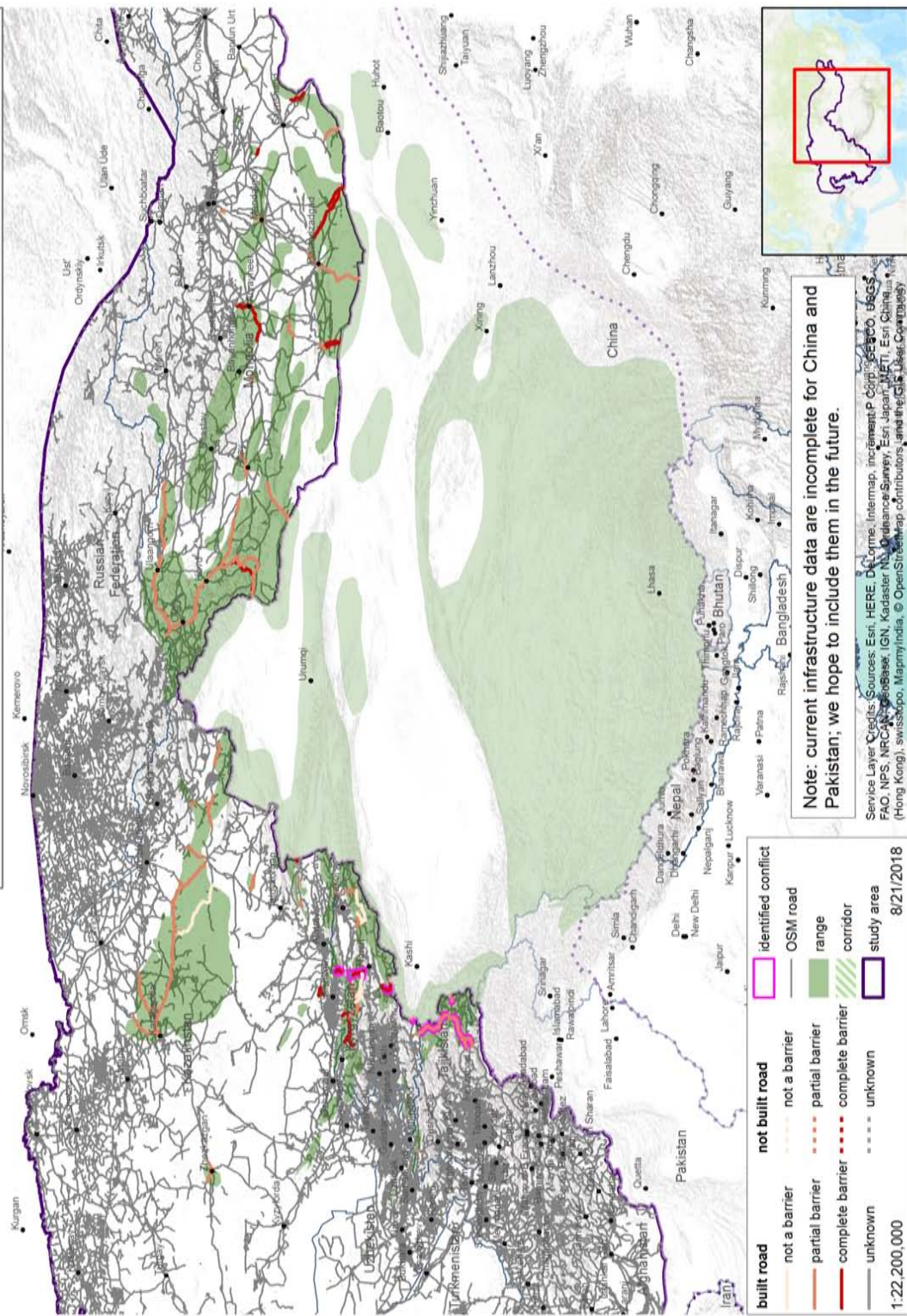
CAMI Species and Linear Infrastructure Threats Across Central Asia

Ovis ammon and Fences

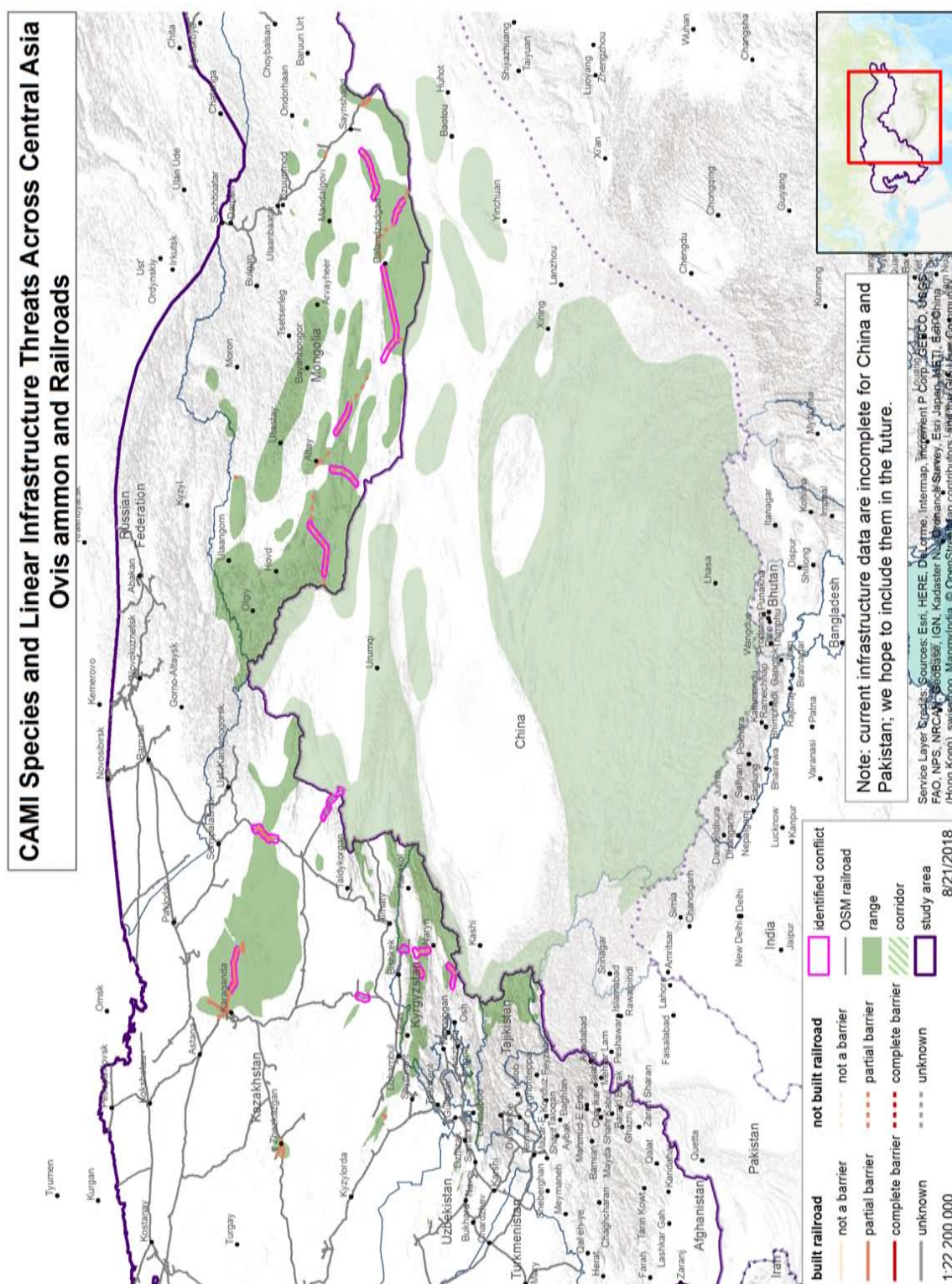


CAMI Species and Linear Infrastructure Threats Across Central Asia

Ovis ammon and Roads



CAMI Species and Linear Infrastructure Threats Across Central Asia



CAMI Species and Linear Infrastructure Threats Across Central Asia

Ovis ammon and Pipelines

Legend:

- built pipeline**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- not built pipeline**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- identified conflict**
 - pipeline
 - range
 - corridor
 - study area

Note: current infrastructure data are incomplete for China and Pakistan; we hope to include them in the future.

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, Swisstopo, FAO, NPS, NRCAN, GEBCO, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China, Swisstopo, (Hong Kong), Swisstopo, Mapbox India, © OpenStreetMap contributors, and the GIS User Community

8/21/2018 22:20:00

Fences

Overview

Secure, well-maintained, high fences -- currently deployed by China along its international borders with Afghanistan, Tajikistan, Kyrgyzstan, Kazakhstan and Mongolia -- can present an impassable obstacle to Argali, especially during movements to seasonal pastures. Fences erected in Soviet times at the border with China are still well maintained in Eastern Kazakhstan and form impermeable barriers. Stretches of old fence between Tajikistan and Afghanistan have nowadays largely collapsed, but still cause Argali mortality.

Mitigation/Remediation Strategies

- Dismantle remaining stretches of unused/decaying fences (e.g. between Tajikistan and Afghanistan);
- Remove border fences, where possible;
- Create fence openings on a seasonal basis;
- Control any illegal hunting along border fence road and openings;
- Research whether salt blocks could attract Argali to fence openings.

<u>Calculated Fence Barriers</u>	<u>km</u>
Complete barrier	2,845
Built	2,206
Partial	415
Unknown	224
Partial barrier	60
Abandoned/disrepair	-
Built	60
Unknown	-
Unknown	3,166
Built	-
Partial	1,140
Planned/construction	1,756
Unknown	-
Grand Total	6,072
Expert-highlighted barriers	1,610
Total known roads in range	6,072

Roads

Overview

Roads present at least partial barriers and in many cases, they are an incomplete barrier to Argali movement, depending on the traffic volume.

Mitigation/Remediation Strategies

- Monitor for roadkill and identify zones of frequent collision between Argali and vehicles.
- Build overpasses for Argali; or tunnels for roads in identified hotspots.
- Prevent poaching facilitated by road access.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	1,807
Built	1,536
Built, planned improvements	261
Disrepair	-
Planned, under construction	11
Not a barrier	675
Built	410
Disrepair	265
Partial barrier	4,537
Built	4,149
Built, planned improvements	-
Disrepair	362
Planned/construction	27
Unknown	12
Grand Total	7,031

Expert-highlighted barriers	376
Known roads in range	55,442

Railroads

Overview

In two locations to the East of Mongolia and in Western part of Mongolia, railroads are a complete barrier. Planned railroad development could present partial barriers to migration near state borders of Mongolia with China.

Mitigation/Remediation Strategies

- Monitor collisions between trains and wildlife to identify high collision zones for Argali.
- Build overpasses for Argali; or tunnels for railroads.
- Discourage fences alongside railroads.

<u>Calculated Railroad Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Planned, under construction	-
Not a barrier	-
Built	-
Unknown	-
Partial barrier	2,763

Built	765
Planned/construction	1,998
Unknown	31
Built	31
Planned/construction	-
Grand Total	2,795
Expert-highlighted barriers	1,711
Known railroad in range	1,217

Other

Fewer or no conflicts were identified for pipelines and canals. Pipelines did appear in the study range and are therefore presented below.

Note: Pipelines are not currently a significant barrier to Argali movements. In order to mitigate impacts, stakeholders should monitor construction sites, during construction of pipelines to limit illegal hunting. After construction, options include: restoring soil and grassland on disturbed land; locating compression stations away from core habitat; monitoring compression stations for illegal hunting; avoiding above-ground pipelines unless measures are taken to avoid barriers to wildlife movement (e.g. constructing overpasses for wildlife).

<u>Calculated Pipeline Barriers</u>	<u>km</u>
Not a barrier	1,024
Built	640
Planned, under construction	384
Unknown	151
Built	23
Planned/construction	127
Grand Total	1,175
Expert-highlighted barriers	-
Known pipelines in range	1,175

4.8 Mongolian Gazelle

Current Range States: Mongolia, Russian Federation, China

Current Global Population: There were approximately 1.125 million individuals in 2005 (Olson et al. 2011). Except for an isolated few to the west, and perhaps in China, the population is panmictic (Okada et al. 2012).

Overview: Mongolian Gazelles (Appendix II of CMS) are one of few species of large mammals that are known to be nomadic migrants, demonstrating extremely large life range sizes without site fidelity for their wintering and calving locations (Nandintsetseg et al. in prep). Protected areas are too small to cover the life range of even a single gazelle. They occur in groups from several individuals up to megaherds of 250,000 (Olson et al. 2009) and their conservation status is Least Concern, according to the IUCN. Gazelles move in search of patches with high-quality forage driven by highly variable precipitation patterns during summer (Mueller et al. 2008). Less than 5 per cent of their range has been granted formal protected area status.

Infrastructure Threats: Due to the wide ranging, nomadic movements of Mongolian Gazelles, there are

numerous conflict zones for this species. The corridor fencing of the Trans-Mongolian Railroad is responsible for blocking the movements of gazelles, and there have been thousands of reports of gazelles being injured and killed each year (Takehiko et al. 2017). Herds that did cross segments in disrepair, have been trapped between fences on either side of the railroad and/or killed by passing trains. Border fencing with the Russian Federation is also known to entangle large numbers of animals while the border fence with China is believed to be a near impenetrable barrier (Olson et al. 2009). In China, habitat fragmentation due to fencing of pasture limits, has compromised the ability of Mongolian Gazelles to move, and has contributed to the decline of the species in the country. Mongolian Gazelles are also struck by speeding vehicles on paved roads, especially at night time. In addition, indirect effects associated with roads, such as increased access for poachers, need to be closely monitored.

More information:

Mongolian Gazelle and CMS

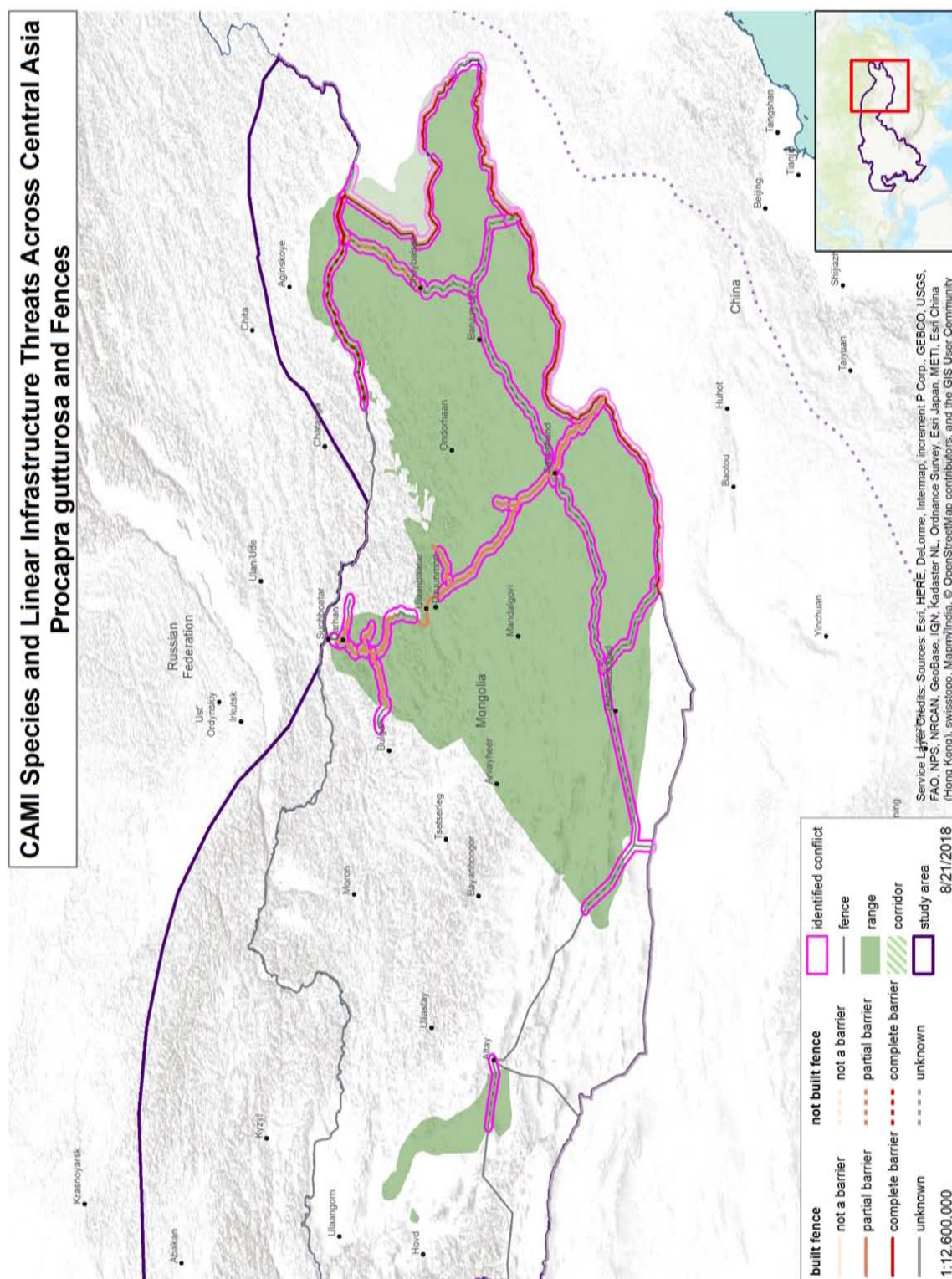
Mongolian Gazelle on the IUCN Red List



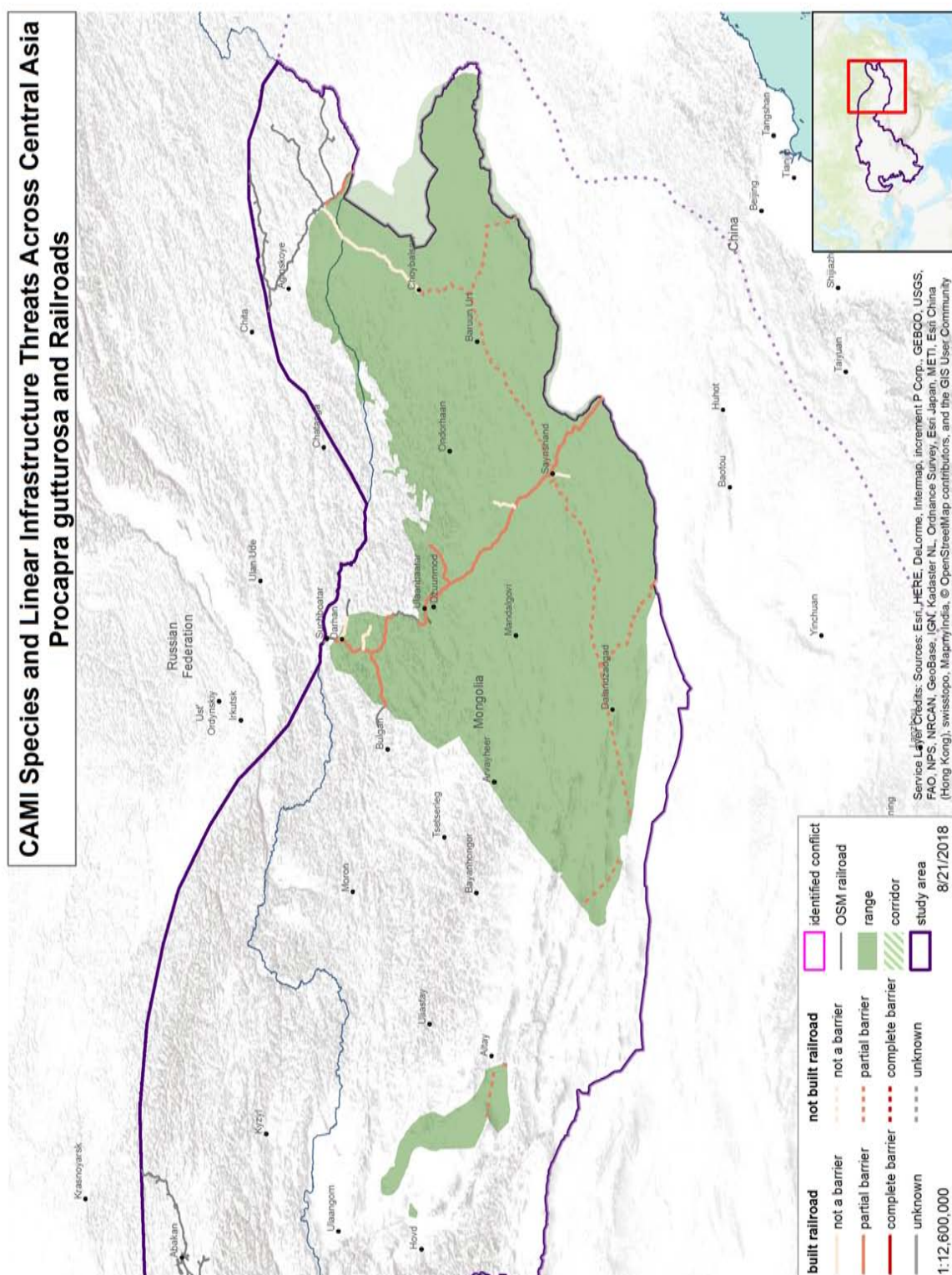
Mongolian Gazelle © Thomas Müller

CAMI Species and Linear Infrastructure Threats Across Central Asia

Procra gutturosa and Fences



CAMI Species and Linear Infrastructure Threats Across Central Asia Procpra gutturosa and Railroads



Fences

Overview

The Mongolian Gazelle's range appears to be bounded by fences associated with the border between China and Mongolia in the South-East and partially between Mongolia and the Russian Federation in the North-East. Over 3,000 kilometres of fencing associated with railroads may additionally dissect Mongolian Gazelle habitat, if the projected railroads are built and fenced. This is equivalent to the total length of barriers to Mongolian Gazelles currently known to exist. Given our knowledge of Mongolian Gazelle movements, fencing can lead to significant negative consequences for the species' populations.

Mitigation/Remediation Strategies

- Avoid any fencing outside of human population centers.
 - Design existing and planned railroad fences in a way so that small wildlife can pass, while large cattle (cows, camels, etc.) are deterred
 - Where fences do exist and are necessary, modify them so that they comply with wildlife friendly standards.
 - Remove fences that are no longer serving their purpose
 - Remove fences from critical sites for wildlife, whenever feasible.
 - New linear barriers must have frequent crossing options that will provide landscape permeability for their population persistence

<u>Calculated Fence Barriers</u>	<u>km</u>
Complete barrier	2,151
Built	1,821
Partial	-
Unknown	330
Partial barrier	1,678
Abandoned/disrepair	265
Built	-
Unknown	-
Unknown	2,099
Built	47
Partial	-
Planned/construction	2,053
Unknown	-
Grand Total	5,928
Expert-highlighted barriers	6,997
Total known roads in range	5,928

Roads

Overview

Roads (both planned and existing) extend across the entirety of the range of Mongolian Gazelles, although large regions remain without roads. Roads, at their current traffic levels, and in absence of fencing, are only partial barriers. There is currently only one major road that has been identified to be in conflict with Mongolian Gazelle movements. This road is parallel to the Trans-Mongolian Railroad. However, paved roads with high traffic volume are becoming increasingly problematic, such as the Petro China road. Preliminary analyses show that gazelle avoid these roads and observations in the area in 2017 suggest these to be a conflict zone for Mongolian gazelles.

Mitigation/Remediation Strategies

- Avoid construction of new roads in areas without roads;
- Follow existing standards and guidelines for infrastructure in Mongolia, including CMS Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia;
- Increase awareness of drivers, about the dangers of high speed driving especially at night, and gazelle collisions;
- Do not fence existing and planned highways outside of settled areas.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	1,966
Built	1,966
Built, planned improvements	-
Disrepair	-
Planned, under construction	-
Not a barrier	1,930
Built	1,930
Disrepair	-
Partial barrier	2,445
Built	2,227
Built, planned improvements	-
Disrepair	-
Planned/construction	218
Unknown	-
Grand Total	3,905
Expert-highlighted barriers	383
Known roads in range	2,573

Railroads

Overview

Planned railroads extend across the entirety of this species' range and have the potential to cause severe impacts. Railroads, at their current traffic levels and in absence of associated corridor fencing, are only partial barriers.

Mitigation/Remediation Strategies

- Avoid construction of railroads through important Mongolian Gazelle habitat, or bundle transport corridors such that they are aligned with existing travel corridors.
- Ensure that all existing and planned railroads meet existing requirements for linear infrastructure as outlined in CMS Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia.
- In the case of planned railroads, avoid long raised-earth embankments and use raised viaduct-style track.
- Address indirect effects of railroads such as an increasing presence of human activity.
- Develop integrated land management that considers movements of wildlife, herders, livestock, habitat quality, connectivity between protected areas and landscape permeability for nomadic ungulates.
- Nandintsetseg et al. (in prep) show that on average, an individual gazelle moved 11 km along the linear barrier. Therefore, crossing structures should be placed at least every 11km for the planned railway.

Other

Fewer or no conflicts were identified for pipelines and canals. Pipelines did appear in the study range and are therefore presented below.

Note: Pipelines are not considered a major obstacle to migration at this time.

<u>Calculated Railroad Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Planned, under construction	-
Not a barrier	566
Built	566
Unknown	-
Partial barrier	3,339
Built	1,286
Planned/construction	2,053
Unknown	-
Built	-
Planned/construction	-
Grand Total	3,905
 Expert-highlighted barriers	 383
Known railroad in range	2,573

4.9 Saiga Antelope

Current Range States: Kazakhstan, Mongolia, Russian Federation, Turkmenistan, Uzbekistan

Current Global Population: There are approximately 223,000 Saiga Antelopes as of spring 2018 across the entire range.

Overview: Saiga Antelope (CMS and CITES Appendix II) undertake long distance movements which have some predictability. The Saiga is listed as Critically Endangered in the IUCN Red List, and hunting is banned in all Range States. In addition to habitat fragmentation, illegal trade in saiga horns, originating from poached animals is a critical threat for the species. The antelopes are subject to unsustainable and illegal hunting, particularly for the horns of male animals, which are highly valued by practitioners of traditional Asian medicine. The Saiga is furthermore susceptible to disease outbreaks leading to mass mortality events, but also have high fecundity and their populations, when protected from poaching, can recover rapidly.

Infrastructure Threats: Several barriers to migration currently fragment Saiga habitat. Border fences, specifically between Uzbekistan and Kazakhstan and partly between

the Russian Federation and Kazakhstan, restrict regular movements. Linear infrastructure, such as railroads and paved roads are already impeding or completely blocking Saiga movements. Planned roads and railroads threaten to fragment the habitat further, reducing the species' current range and closing gaps, which are currently still used by the antelope. In Mongolia, paved roads, passing through Saiga range are a partial barrier, a planned railroad will also pass through their range and based on preliminary observations of railroad effects in Kazakhstan, it can become a complete barrier. Indirect effects of linear infrastructure also constitute threats to this species. These include facilitating access to formerly remote areas for poachers and cattle, as well as disease transfer.

More information:

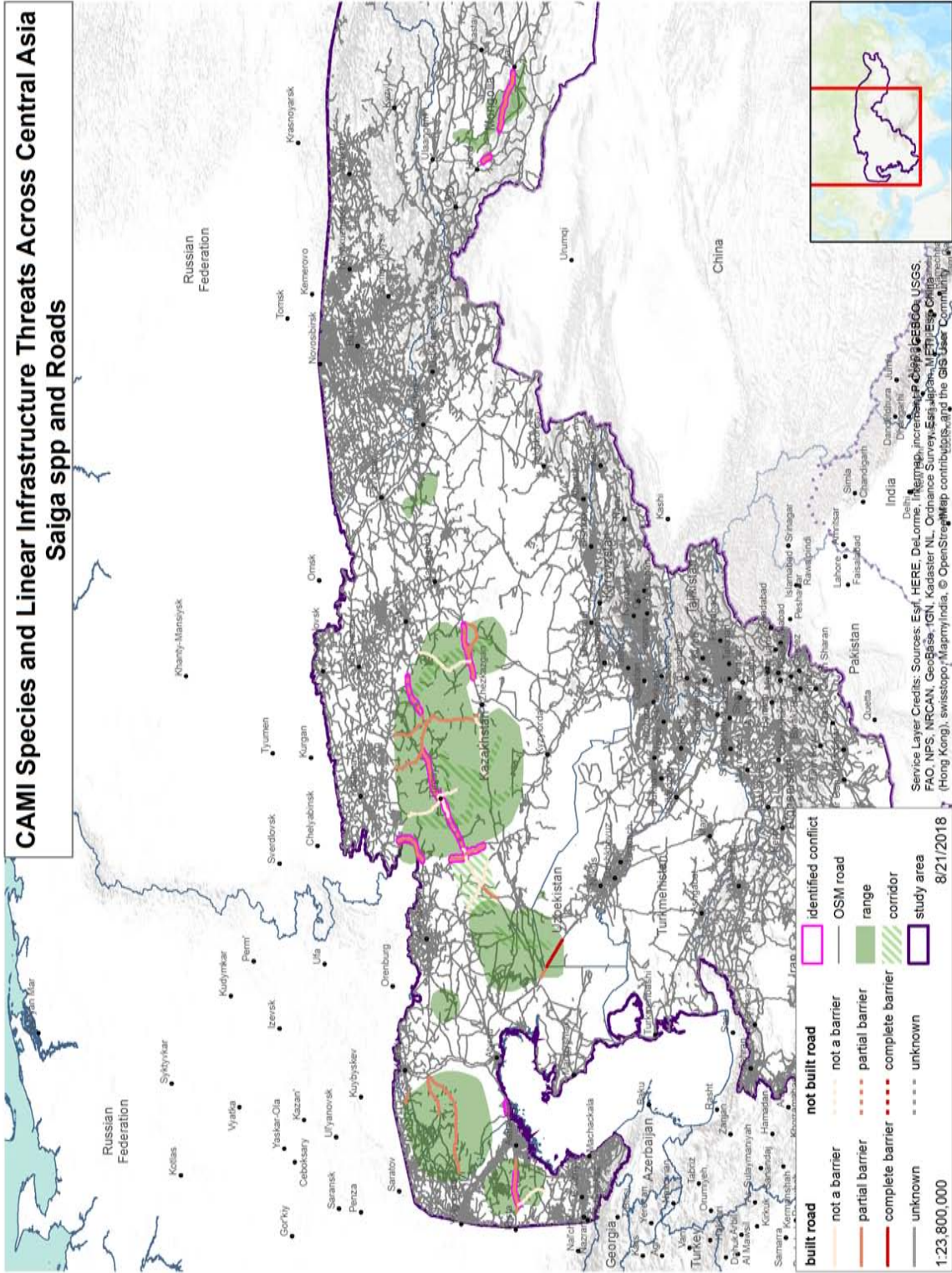
Saiga Antelope and CMS

Saiga Antelope on the IUCN Red List



Saiga Antelope © E. Polonskiy, Stepnoi Reserve

MAP: Saiga Antelope (*Saiga tatarica*) || Roads



CAMI Species and Linear Infrastructure Threats Across Central Asia

Saiga spp and Railroads

Legend:

- built railroad**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- not built railroad**
 - not a barrier
 - partial barrier
 - complete barrier
 - unknown
- identified conflict**
 - OSM railroad
 - range
 - corridor
 - study area

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment Corp., GEBCO, USGS, FAO, NPS, NRCAN, Geobase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, Swisstopo, China (Hong Kong), swissplot, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community.

Scale: 1:283,000,000

Date: 8/21/2018

CAMI Species and Linear Infrastructure Threats Across Central Asia Saiga spp and Pipelines

Fences

Overview

Currently, fences do not widely occur throughout Saiga range. The Ustyurt population is most affected by the presence of the border fence between Kazakhstan and Uzbekistan. Measures to make the fence permeable to Saiga were taken by the Kazakh Government. Further modification of the fence would benefit the vulnerable Ustyurt population. Another fence exists at the border between Kazakhstan and the Russian Federation at the very north-western edge of the Ural population range. This fence is mainly a reason for injuries of the animals, which squeeze through it to reach Russian territory in spring and summer.

Mitigation/Remediation Strategies

- Completely remove the border fence between Kazakhstan and Uzbekistan to allow saiga passage;
- If not possible to remove, continue redesigning the fence to provide additional openings;
- Completely remove border fence between Kazakhstan and the Russian Federation, or, if not possible, consider redesign to allow saiga passage;
- Avoid building any fences in open range, outside of settled areas.

<u>Calculated Fence Barriers</u>	<u>km</u>
Complete barrier	275
Built	275
Partial	-
Unknown	-
Partial barrier	-
Abandoned/disrepair	-
Built	-
Unknown	-
Unknown	255
Built	-
Partial	-
Planned/construction	224
Unknown	31
Grand Total	530

Expert-highlighted barriers	176
Known fences in range	530

Roads

Overview

There are several thousands of kilometres of roads that are built or planned across the Saiga range. It was shown that some paved roads already pose complete barriers to

movement (also between populations), some with less traffic are partial barriers. Planned roads could become partial or complete barriers to Saiga, depending on the traffic volumes and type of construction. Research shows that Saiga Antelopes choose areas with lower road densities.

Mitigation/Remediation Strategies

- Follow CMS Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia for all existing and planned linear infrastructure projects that exist within Saiga range.
- Avoid planning new roads in currently undeveloped areas within Saiga Range.
- If roads cannot be avoided, test construction of longer parts of elevated road, to let Saiga cross underneath.
- Consider speed limits or road curfews for existing and planned roads.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	127
Built	126
Built, planned improvements	-
Disrepair	<1
Planned, under construction	-
Not a barrier	-
Built	1,398
Disrepair	1,152
Partial barrier	3,638
Built	2,078
Built, planned improvements	203
Disrepair	700
Planned/construction	657
Unknown	-
Grand Total	5,162
Expert-highlighted barriers	2,011
Known roads in range	41,686

Railroads

Overview

Railroads are primarily partial barriers to saiga migration, though in some cases they can become complete barriers (especially with two or more tracks). In Kazakhstan, the railroad between Aktobe and Kyzylorda appears to dissect the migration corridor separating Betpak-dala and Ustyurt populations. Preliminary telemetry studies suggest that Saiga do not cross the railroad between Shalkar and Beyneu, currently preventing the migration of Saiga southward to wintering grounds in Uzbekistan. The railroad between Saksaulskiy and Zhezkezhgan and further to Karaganda impedes saiga

migration. A planned railroad in Mongolia additionally threatens to fragment the species range.

Mitigation/Remediation Strategies

- Avoid planning new railroads in currently undeveloped parts of the saiga range.
- Construct crossing points for Saiga, including longer parts of elevated railroad with passages underneath (test guiding the animals to these crossing points with strategic fencing).
- Evaluate the presence of and options for removing of railroad fencing where the railroad passes between Saiga populations or mapped corridors.
- Test temporary traffic stops at nighttime, including turning off all illumination along the railroad.
- Avoid fencing the planned railroad in Mongolia.
- Monitor effectiveness of any planned or current measures and adjust.

<u>Calculated Pipeline Barriers</u>	<u>km</u>
Not a barrier	3,521
Built	1,981
Planned, under construction	1,540
Unknown	90
Built	90
Planned/construction	-
Grand Total	3,612
Expert-highlighted barriers	-
Known pipelines in range	3,612

<u>Calculated Railroad Barriers</u>	<u>km</u>
Complete barrier	330
Built	330
Planned, under construction	-
Not a barrier	-
Built	-
Unknown	-
Partial barrier	2,667
Built	1,983
Planned/construction	683
Unknown	164
Built	164
Planned/construction	-
Grand Total	3,161
Expert-highlighted barriers	2,357
Known railroad in range	3,910

Other

Fewer or no conflicts were identified for pipelines and canals. Pipelines were detected in study range and are therefore presented below.

Saiga easily fall into uncovered pipeline ditches in large groups and are unable escape. Uncovered pipeline ditches thus should be avoided in Saiga range. Presently pipelines do not pose important barriers to Saiga, as they are buried underground. However, planned pipelines may present obstacles in the future during the construction phase.

4.10 Snow Leopard

Current Range States: Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russian Federation, Tajikistan, Uzbekistan

Current Global Population: The most recent set of national estimates comes from country chapters in the comprehensive book *Snow Leopards*: 7,463 to 7,980 (McCarthy and Mallon, 2016).

Overview: The Snow Leopard (CMS and CITES Appendix I) lives in the mountain ranges of Central Asia, comprising twelve countries and 1.2 million km² of potential habitat. With an estimated population of 7,463 to 7,980 individuals, and a projected global population decline of 10 per cent over the next three generations, the species is listed as Vulnerable on the IUCN Red List.

Infrastructure Threats: Snow Leopards are solitary, territorial cats, which naturally live at low densities and occupy large home ranges (130 km² and 220 km² on average for females and males, respectively, in Mongolia, Johansson et al. 2016) in very remote areas and often at high elevations (> 3,000 asl). Single sites, including most Protected Areas (PAs), are rarely large enough to harbour viable populations of this species. It has been

estimated that up to a third of the Snow Leopard's known or potential range is located less than 50-100 km from the international borders of the 12 Range States (Snow Leopard Network 2014). Thus, Snow Leopard territories often have a trans-boundary character. Linear infrastructure, such as border fences are a significant barrier to Snow Leopards and their prey, such as the Argali. Other types of linear infrastructure, such as roads and railroads can pose a threat, depending on the traffic volumes and location. Snow Leopards sometimes perform long-distance movements to find an appropriate home territory such as for their young, or to find food or a mate (McCarthy et al. 2005; Karlstetter and Mallon 2014), during which they are particularly vulnerable to the effects of linear infrastructure (Zahler 2016). For example, in Mongolia, Snow Leopards have been shown to move across large expanses of flatlands between small rocky mountain massifs (McCarthy et al. 2005).

More information:

Snow Leopard and CMS
Snow Leopard on the IUCN Red List



Snow Leopard © Julie Larsen Maher/WCS

[illegible]

CAMI Species and Linear Infrastructure Threats Across Central Asia

Panthera uncia and Railroads

This map illustrates the distribution of the snow leopard (*Panthera uncia*) across Central Asia, overlaid with various types of linear infrastructure. The study area covers parts of Russia, Kazakhstan, Kyrgyzstan, Tajikistan, Afghanistan, Pakistan, and China. The map includes a legend, a scale bar, a north arrow, and an inset map of China.

Legend:

- built railroad**: solid black line
- not built railroad**: dashed black line
- not a barrier**: light blue hatched area
- partial barrier**: orange hatched area
- complete barrier**: red hatched area
- unknown**: white area
- identified conflict**: pink outline
- OSM railroad**: thin grey line
- range**: green shaded area
- corridor**: yellow hatched area
- study area**: purple outline

Note: current infrastructure data are incomplete for China and Pakistan; we hope to include them in the future.

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, inc./Swiss P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL - Ordnance Survey, Esri Japan, ENVI, Esri China (Hong Kong), Swisstopo, Mapbox, OpenStreetMap contributors, and the GIS User Community.

Scale: 0 18 300 600 km

Date: 8/21/2018

Fences

Overview

For Snow Leopards living near international frontiers, border fences are significant barriers to movement as well as for their prey— especially Argali, which are known to make seasonal movements in parts of their range (Mallon et al. 2014).

Mitigation/Remediation Strategies

- Dismantle existing fences whenever possible.
- Create gaps in fencing at the bottom (research captive Snow Leopards to determine the required height) at important crossing points (drainages, ridge lines).
- Investigate prey species entanglement in fences, and its indirect impact on Snow Leopards
- Funnel Snow Leopards toward best available crossing points (avoid blind bends or high traffic areas).
- Manage illegal hunting along border fence roads.
- Incorporate wildlife passages for prey species in border fences to ensure sufficient prey availability

<u>Calculated Fence Barriers</u>	<u>km</u>
Complete barrier	963
Built	411
Partial	418
Unknown	134
Partial barrier	1,224
Abandoned/disrepair	-
Built	936
Unknown	228
Unknown	2,976
Built	-
Partial	1,648
Planned/construction	1,328
Unknown	-
Grand Total	5,162
Expert-highlighted barriers	1,610
Total known roads in range	5,162

Roads

Overview

In most parts of the Snow Leopard range, roads are currently few and rarely support large volumes of traffic. However, in several places there exist roads with large volume of traffic such as the Karakoram Highway in northern Pakistan where possible road-kills have been reported (Hussain Ali in Ostrowski and Gilbert 2016). Roads render remote areas more accessible and increase

the risk of poaching of Snow Leopard and prey during both the construction phase by builders and subsequently by motorized poachers. Increased road networks may have important growth-inducing effects, such as improving market access for livestock products (along with livestock numbers), encouraging remote area tourism and enabling accelerated mineral exploration.

Mitigation/Remediation Strategies

- Build tunnels under high speed and/or heavily utilized night-time roads.
- Prevent poaching of prey species facilitated by road access.
- Limit night-time traffic especially if high-volume (frequency)/large transport and mining traffic.
- Discourage fences (especially in rugged terrain and on plains between frequently utilized mountain habitat patches, or movement corridors).
- Educate mining companies and their staff, especially those operating in remote areas on the importance of protecting wildlife.

<u>Calculated Road Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Built, planned improvements	-
Disrepair	-
Planned, under construction	-
Not a barrier	-
Built	292
Disrepair	292
Partial barrier	4,249
Built	4,241
Built, planned improvements	-
Disrepair	-
Planned/construction	8
Unknown	10
Built	10
Disrepair	-
Grand Total	4,551
Expert-highlighted barriers	783
Known roads in range	46,580

Railroads

Overview

Railroads are suspected to restrict movements of Snow Leopards when they occasionally cross lowlands in search of prey and mates.

Mitigation/Remediation Strategies

- Build overpasses over railroads having impenetrable fencing.
- Discourage building fences alongside railroads.
- Monitor during construction phase to limit illegal hunting.

<u>Calculated railroad Barriers</u>	<u>km</u>
Complete barrier	-
Built	-
Planned, under construction	-
Not a barrier	-
Built	-
Unknown	-
Partial barrier	1,681
Built	126
Planned/construction	1,555
Unknown	10
Built	10
Planned/construction	-
Grand Total	1,691
 Expert-highlighted barriers	 1,427
Known railroad in range	336

Other

Fewer or no conflicts were identified for pipelines and canals, except possible disturbance during the construction phase. Pipelines were detected in study range and are therefore presented below.

Currently pipelines do not seem to pose a significant threat to Snow Leopards but more research is warranted.

<u>Calculated Pipeline Barriers</u>	<u>km</u>
Not a barrier	237
Built	118
Planned, under construction	119
Unknown	181
Built	-
Planned/construction	181
Grand Total	418
 Expert-highlighted barriers	 -
Known pipelines in range	418

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Annex I. List of Participants of the Migration and Infrastructure Mapping Workshop

Name	Institution
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Badamjav, Lkhagvasuren	Institute of General & Experimental Biology, Mongolian Academy of Sciences
Bayarbaatar, Buuveibaatar	Wildlife Conservation Society, Mongolia Program
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Kaczensky, Petra	Norwegian Institute of Nature Research NINA & Fiwi
Kubanychbekov, Zairbek	Panthera Foundation
Marmazinskaya, Natalya	Zoological Society of Uzbekistan
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Roettger, Christiane	CMS
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Spagnoli, Christopher	Wildlife Conservation Society
Strauss, Andrea	Federal Agency for Nature Conservation
Yadamsuren, Adiya	Wild Camel Protection Foundation Mongolia
Zahler, Peter	Wildlife Conservation Society
Zuther, Steffen	ZGF / Association for the Conservation of Biodiversity of Kazakhstan (ACBK)

Annex II. Mitigation Strategies by Species and Infrastructure

Species	Infrastructure	Remediation strategy
ARGALI SHEEP	fence	Dismantle fences
		Create fence gaps/openings seasonally (fences are meant to stop people, so winter openings for argali shouldn't interfere)
		Manage for illegal hunting along border fence road
		Perhaps salt blocks to attract Argali to openings?
	pipeline	Monitor during construction to limit illegal hunting
		After construction, restore soil to disturbed land (revegetate?)
		Place compression stations to avoid core habitat; monitor compression stations for illegal hunting
		Avoid aboveground pipelines unless properly mitigated (e.g. overpasses)
		Overpasses for sheep; tunnels for road
		Monitor for roadkill and identify high collision zones
		Discourage fences
	road	Overpasses for sheep; tunnels for road
		Monitor for roadkill and identify high collision zones
		Prevent poaching facilitated by road access
ASIATIC CHEETAH	road	Fence along the road/highway at "hotspots" to prevent Cheetah going on the road
		Effective signage (needs to be close to the road so that drivers see it and it is important that they also reflect light at night)
		Use existing underpasses for the Cheetah to cross and monitor whether it works
BUKHARA DEER	fence	Currently no fence, but if it comes gaps should be left. There also should then be cameras to monitor.
	road	Effective and official signage together with and in agreement with policy
CHINKARA	road	Small obstacles/bumpers on the road to force drivers to slow down on local roads.
		Remove the green vegetation around the roads to not attract the gazelles to come close to the road and feed along and near the roads (a general recommendation for herbivores)
		Install more lights to light the bigger roads so that drivers have a better sight and can hopefully react faster if an animal runs on the road.
		Effective signage (as for Cheetah) near the road, reflecting light

GOITERED GAZELLE		Special training for the drivers; when people acquire their driver's license there should be obligatory part of the exams that include wildlife
		Special training for the drivers; when people acquire their driver's licence there should be obligatory part of the exams that include wildlife
		Underpasses, maybe using the existing ones (however, no evidence currently that the chinkara would use these).
	canal	Build bridges/passes for the Gazelles to cross
	fence	Best option is not to build fences (especially important for the planned railroad projects in Mongolia).
		If fences already exist, remove them, if this is not possible redesign them to wildlife-friendly design (less or no barbed wire, gap height at the bottom of at least 35 cm, upper line and lower line without barb).
	road	Small obstacles/bumpers on the road to force drivers to slow down on local roads.
		Remove the green vegetation around the roads to not attract the gazelles to come close to the road and feed along and near the roads (a general recommendation for herbivores)
		Install more lights to light the larger roads so that drivers have a better sight and can hopefully react faster if an animal runs on the road.
		Effective signage (as for cheetah) near the road, reflecting light
		Special training for the drivers; when people acquire their driver's licence there should be obligatory part of the exams that include wildlife
		Increase the number of rest houses along the road to allow especially truck drivers to rest and stay overnight to get sleep for them to be more vigilant (there was a study about this).
		Underpasses, maybe using the existing ones (however no evidence currently that the chinkara would use these).
		Close mining roads during times of increased movement
		Existing standards / guidelines for infrastructure in Mongolia should be followed
		Block during dzhut events
		Educate drivers to stop when groups of Asiatic Wild Ass are passing, especially in times of dzhut.
		Maintain options for traffic curfew, e.g. at night or for trucks, and enforce them (Reevaluate situation and options in 5-7 years, depending on traffic situation then).

		Consider speed bumps or rumble strips to slow down trucks.
		Include regular gaps in guardrails.
		Create underpasses; the species would use underpasses more easily than Asiatic Wild Ass.
ASIATIC WILD ASS	fence	Existing standards/guidelines for infrastructure in Mongolia should be followed
		Existing fences: remove them as redesign is not an option
		Planned fences: include gaps at minimum every 20 kilometers, of unknown width (100s of meters). There is uncertainty about the concrete necessary gap width and distance between gaps.
		Railway fences: 3-4 m high and wide underpasses should be considered
	pipeline	Existing standards / guidelines for infrastructure in Mongolia should be followed
	railroad	Existing standards/guidelines for infrastructure in Mongolia should be followed
		Should not be fenced, embankment slopes should not be too steep (1:4 or 1:5 ratio)
	road	Existing standards/guidelines for infrastructure in Mongolia should be followed
		Temporarily block traffic during dzhut events
		Educate drivers to stop when large groups of Asiatic Wild Ass are passing, especially in times of dzhut.
		Maintain options for traffic curfew, e.g. at night or for trucks, and enforce them (Reevaluate situation and options in 5-7 years, depending on traffic situation then).
		Consider speed bumps or rumble strips to slow down trucks.
		Include regular gaps in guardrails.
MONGOLIAN GAZELLE	fence	Best option is not to build fences (especially important for the planned railroad projects in Mongolia).
		If fences already exist, remove them, if this is not possible redesign them to wildlife-friendly design (less or no barbed wire, gap height at the bottom of at least 35 cm, upper line and lower line without barb).
	road	Existing standards/guidelines for infrastructure in Mongolia should be followed
		Block during dzhut events
		Educate drivers to stop when groups of Asiatic Wild Ass are passing, especially in times of dzhut.
		Maintain options for traffic curfew, e.g. at night or for trucks, and enforce them (Re-evaluate situation and options in 5-7 years, depending on traffic situation then).

		Consider speed bumps or rumble strips to slow down trucks.
		Include regular gaps in guardrails.
		Create underpasses; the species would use underpasses more easily than Asiatic Wild Ass.
SAIGA ANTELOPE	fence	Avoid fence construction
	railroad	Construction of saiga crossing points
		Temporary traffic stop (night)
		Speed limit
		Evaluation of mitigation measures ongoing
	road	Temporary traffic stop (night)
		Speed limit
		Road signs
		Change alignment
		Build long bridges to let Saiga pass underneath
SNOW LEOPARD	fence	Dismantle fences
		Create bottom gap of fence – at least 35-40 cm (do some experiments with captive Snow Leopards to fine tune actual gap); not everywhere needs a gap, just important crossing points (e.g. drainages, ridge line)
		Paint fence posts to blend in with natural surroundings (not stand out)
		Would dead wildlife caught in fence attract Snow Leopards? Monitor where roadkill frequencies are high
		Funnel Snow Leopards toward crossing points (avoid blind bends or high traffic areas)
		Manage for illegal hunting along border fence road (see road recommendations)
		Facilitate access for wild prey species (e.g. Argali, Urial, Ibex etc.) across border fence (as a way to support prey base for Snow Leopards)
	pipeline	Monitor during construction to limit illegal hunting
		Place compression stations to avoid core habitat; monitor compression stations for illegal hunting
		Avoid aboveground pipelines unless properly mitigated (bottom gap height)
	railroad	Tunnels on the road
		Discourage fences
		Monitor during construction to limit illegal hunting
	road	Tunnels on the road
		Prevent poaching of prey facilitated by road access
		Limit night-time traffic especially if high-volume (frequency) large transport & mining traffic

		Discourage fences (especially in rugged terrain and plains between frequently utilized "stepping stone" outcroppings/ small mountain habitat patches
WILD CAMEL	fence	Remove fences partially to have regular gaps, every 30 kms, of 200 m width.
	road	Build new roads underground.



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