Saiga Crossing Options

Guidelines and Recommendations to Mitigate Barrier Effects of Border Fencing and Railroad Corridors on Saiga Antelope in Kazakhstan.

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To what degree are the processes of nature threatened by human activity?

A question posed in 1864 by George Perkins Marsh
'Man and Nature'

Center image from W.E. Webb's 1872 illustration: 'Wanton Destruction of Bison'
The Transcontinental Railroad in North America is one factor which contributed to the elimination of Great Plains Bison; barbed wire was the other.

Will Kazakhstan be able to develop its economy and preserve its wild natural heritage or is their fate left to be preserved only as a symbol engraved in money?

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Executive Summary

The barrier effect of linear infrastructure on open plains ungulates has become a problem of global significance. Species which undertake long distance terrestrial movements are particularly vulnerable. During the existence of the Soviet Union, saiga antelope were once an important economic resource but are now critically endangered due to intensive poaching and development initiatives. Today they are further threatened by the recent installation of a border fence between Kazakhstan and Uzbekistan and the construction of a rail corridor. Both bisect two distinct saiga populations and threaten their future existence.

Data from GPS collared saiga in the Ustyurt region have confirmed that saiga cross the border into Uzbekistan. Although this fence is not an absolute barrier, saiga have been tracked wandering parallel to the fence in search of crossing opportunities. Observations of saiga crossing paved highways and a single track railway as well as data showing that saiga are capable of negotiating their way through the border fence are encouraging that these linear structures are not absolute barriers. However, it is not known how permeable these corridors are and how much of a barrier effect they are having on the populations. Given the dramatic declines in saiga numbers and current endangered status, a precautionary approach should be taken.

Although development initiatives discussed within this report are far along in their implementation or nearly complete, alternatives do exist and should be incorporated to maintain habitat connectivity for saiga antelope. Incorporating successful habitat conservation measures for a species such as saiga which require access to huge areas over the course of a year requires a range of activities. These activities coupled with sound monitoring and research will enable the development of Kazakhstan's economy so that it does not occur at the expense of its wild heritage. A planned railroad corridor and border fence will need to be mitigated to maintain high habitat connectivity for the Ustyurt and Betpak-Dala saiga populations.

There are numerous examples around the world that can be used to guide mitigation of linear infrastructure in Kazakhstan. Apart from avoiding new developments within undeveloped habitat, there is no single 'best' solution that can be pointed to. Understanding the range of options that are available to stakeholders involved in both the conservation of biodiversity and development of Kazakhstan will be important to achieving development that is truly sustainable.

Given the current situation on the border and the state of construction of the railroad, the following recommendations will help minimize the negative influences of the border fence and railroad corridor:

Border fence

- Modify the border fence by removing the bottom two wires.
- Fasten visible markers to the top and lowest wire.

Railroad

- Promote alternative routes that avoid core saiga range.
- Work with the construction team to determine optimal locations for saiga crossing embankments.
- Obtain profile maps of the Shalkar – Beyneu segment and estimate how many are needed and determine the optimal locations of earth embankments.
- Place railroad livestock guards at the edges of the embankments.
- Limit additional railroad employee housing to existing settlements.
- Offset the disturbance created by the railroad by developing a mechanism to incorporate a 'saiga conservation' fee that is assessed to each container travelling through saiga habitat.

Habitat

- Establish a working group to develop policy recommendations to identify problem areas along existing infrastructure and restrict additional development within known saiga range for the purpose of maintaining habitat connectivity.
- Establish official former and current saiga habitat and range boundaries for the purpose of developing a comprehensive saiga habitat management strategy outside of traditional place based protected area reserve models.

Stakeholders

- Work with the Ministry of Environment Protection on development of a stakeholder engagement strategy.
- Identify key departments within the Ministry of Transportation and Communication and the National Center for Transport and Logistics that are willing and capable of having discussions at reasonable intervals regarding upcoming development needs with the goal of introducing concerns for biodiversity at the initiation of new projects rather than at the end.
- Liaison with country offices of multinational development banks as well as with appropriate members of the United Nations Development Program so

that the concerns are known and options for mitigation can be incorporated into budgeting.

- Hold regular discussions with the appropriate staff members of government development agencies and so that they are aware of any potential negative impacts to biodiversity their programs may have.
- Engage private stakeholders with the purpose of informing them of potential impacts of habitat fragmentation on saiga antelope.

Monitoring

- Continue to monitor saiga movements using GPS tracking technology to determine how much of a barrier the border fence is for saiga migration.
- Evaluate the need for additional modifications to the border fence from tracking studies and fence surveys.
- Develop a data collection protocol for train conductors to record observations of saiga and other species of interest along all active rail corridors within saiga range.
- Initiate an evaluation of the earth embankments using camera trap technology to compare embankments with randomly chosen locations along the RR.
- Investigate causes for separation of the existing 3 saiga populations within Kazakhstan and develop a mitigation strategy for restoring connectivity between them.

Section 1. Introduction

Habitat fragmentation and declines in migratory ungulates.

1 Large mammals (>20 kg) have been eliminated from more than 80% of the terrestrial ecosystems in which they were formerly present (Morrison *et al*. 2007). Prior to post industrial expansion of agricultural activities and livestock husbandry approximately 150 years ago Earth's grazing ecosystems were dominated by large migratory ungulates (Frank *et al*. 1998). Now many of these migrations have been eliminated or are threatened due to habitat loss, construction of linear infrastructure, and new or expanding settlements (Berger 2004; Harris *et al*. 2009).

2 Anthropogenic habitat fragmentation is "the dissection of the earth's surface into spatially isolated parts" and takes three forms 1) habitat dissection 2) habitat conversion or loss and 3) compression or sedentarization (Hobbs *et al*. 2008). Transport corridors such as roads and railroads and barriers to movements such as fences are major contributors to habitat fragmentation due to their barrier effects and less from direct habitat loss (Boone & Hobbs 2004; Foreman & Alexander 2008).Habitat fragmentation is a major contributor to the decline of biodiversity and sustained today partly due to the effects of infrastructure development needed to sustain an increasingly integrated world economy and is a global issue (Krausse *et al*. 2010).

3 Barriers do not have to be absolute to have an impact on wildlife. Semi-permeable barriers can alter the timing of an animal's migratory movements by delaying its progress or forcing it to take a longer route. Disturbances levels associated with a barrier may cause an animal to avoid the vicinity of a barrier prior to or after passing through (Sawyer *et al*. 2013). This may reduce the amount of time an animal has to rest during migration or affect its ability to forage while in the area.

4 Large scale road and railroad projects are being planned and built across Central Asia and the Tibetan plateau. These projects are intended to increase overland trade between Europe and China, transport raw materials from source to markets, and to connect distant population centers. These projects are aligned through some of the largest grassland habitats in the world. Additionally, disruption of traditional nomadic pastoral systems through changing land use policies are resulting in an increasing amount of fencing being erected in once open rangelands.

5 The problems created by linear infrastructure are evident across much of Central Asia and the highlands of Tibet. In China, the Qinghai - Lhasa railroad disrupts the

migrations of Chiru antelope (*Pantholops hodgsonii*), wild ass (*Equus hemionus kiang*), and the little known Tibetan antelope (*Procapra picticaudata*) across the Tibetan plateau. Fencing policies around Qinghai Lake have driven one of the most endangered gazelle species - Przewalski's gazelle (*Procapra przewalski*) to near extinction. Wild Bactrian camels (*Camelus ferus*) have been reduced to a few remnant populations due to harassment and construction of border fences. They are considered to be one of the most endangered large mammals alive. In Mongolia, the last stronghold for khulan (*Equus hemionus hemionus*) a sprawling network of roads and railroads to facilitate a mining boom is being built. The 50 year old Trans Mongolian Railroad has prevented khulan from returning to their former range in the eastern steppes and the great herds of Mongolian gazelle (*Procapra gutturosa*) are frequently turned back or find themselves entangled in the adjacent fencing. Saiga antelope (*Saiga tatarica spp.*) have faced obstacles from canal development, pipeline construction, and busy intercontinental transport corridors and the settlements that they support. Development continues and the threats increase.

Saiga and their current status in Kazakhstan

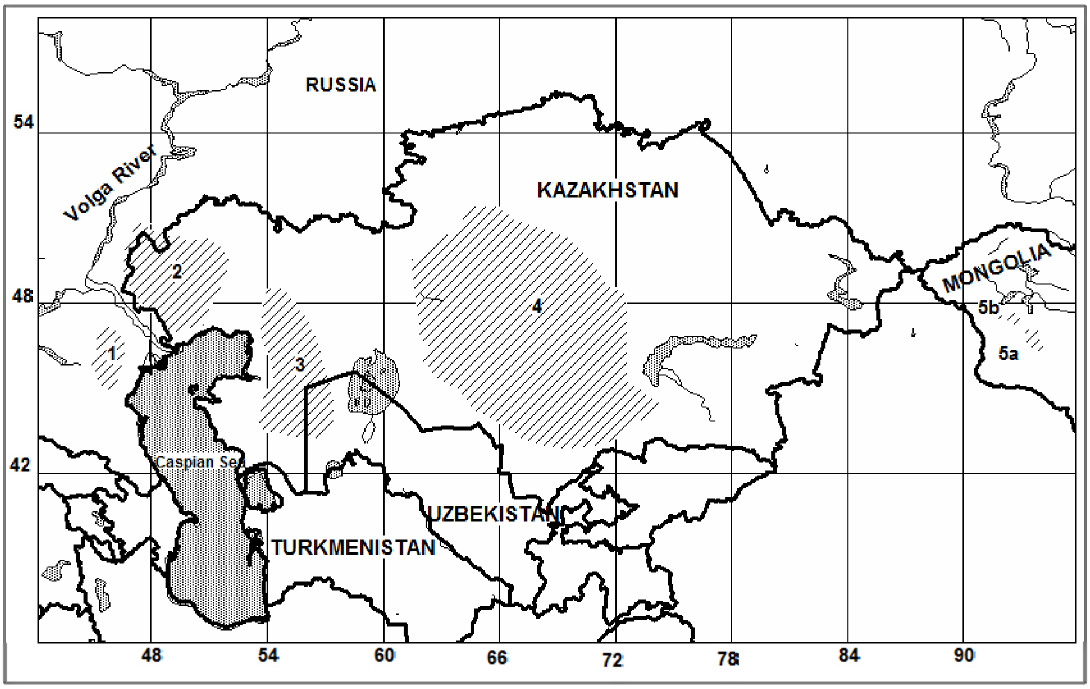
6 Recent initiatives to create a new east-west rail corridor and the construction of a border fence in Kazakhstan threaten to further decrease habitat connectivity for saiga antelope and other wildlife. This will add to the growing list of the negative effects that linear infrastructure is having on open plains ungulates and their habitats around the world.

7 Saiga antelope are one of the oldest living mammal species, that as recently as two decades ago numbered more than 1.5 million. Saiga were once an important economic resource through sales of horns, meat, and hides. Today they are currently assessed by the IUCN as critically endangered and listed by CITES as an appendix II species. The government of Kazakhstan now spends millions of dollars each year on monitoring and conservation related activities.

8 Saiga antelope are found in 5 widely distributed populations in four countries (Mongolia, Kazakhstan, Uzbekistan, Russia) with the species range spanning an east-west distance of 3,350 kilometers (Singh *et al*. 2010a; Mallon 2008) (Fig. 1). During severe winters, saiga have been known to travel as far south as Turkmenistan but this has not been observed for decades and saiga do not permanently reside there. All populations within Kazakhstan are believed to undertake long distance movements along a north - south axis within large, loosely defined ranges (Bekenov *et al*. 1998; Singh *et al*. 2010b). Since the mid 1990's the population has dropped substantially; mainly due to unsustainable hunting for their horns and meat (Milner-Gulland *et al*. 2001; Mallon, 2008).Their economic significance exhausted, saiga are now classified by the IUCN as a critically endangered species (Mallon 2008). Efforts

to raise awareness of the conservation status have prompted several conservation initiatives and actions. The conclusion of the saiga memorandum of understanding (MOU) concerning the restoration, conservation and sustainable use of the saiga antelope under the Convention on the Conservation of Migratory Species of Wild Animals (CMS) elevated the conservation needs of saiga onto a global stage. The Saiga Conservation Alliance was established and NGO's such as the Association for the Conservation of Biodiversity of Kazakhstan, Frankfurt Zoological Society, Fauna & Flora International initiated research and conservation activities to improve knowledge of saiga ecology to make better informed conservation and development policy decisions. The GEF has also supported a UNDP/Gov't of Kazakhstan steppe conservation project, which partially addresses saiga conservation issues. Betty White has even become concerned over such dramatic declines.

Figure 1. Global saiga antelope distribution within Kazakhstan, Uzbekistan, Mongolia, and Russia (Kalmykia) (Bekenov & Milner-Gulland 1998).



Within the framework of CMS, the saiga MOU between five saiga range states came into effect in 2006. This includes a long list of agreed activities to be carried out within this MOU. First, among them are:

> *Provide effective protection for the Saiga antelope and, where feasible and appropriate, conserve, restore and sustainably use those habitats and ecosystems that are important for its long-term survival;*

Implement the provisions of the Action Plan that shall aim to (a) restore numbers of the Saiga antelope to ecologically and biologically appropriate levels, (b) restore range and habitats of saiga antelope to ecologically and biologically appropriate levels and (c) enhance transboundary and international cooperation through inter alia a regional conservation and management strategy

At the second meeting of the signatories in September 2010, a medium-term international work program (MTIWP) for 2010-2015 was adopted and is currently being implemented.

9 Conservation measures were further strengthened in 2010 when president Nazarbayev of Kazakhstan and president Karimov of Uzbekistan pledged to work together to improve the conservation outlook for the saiga antelope populations whose range is shared between the two countries (Uzbek News, 04/28/2012). This is in addition to a 2007 agreement between the two countries which included an action plan for saiga conservation.

10 While measures to reduce poaching have been an urgent priority, new threats from the effects of fencing and transport corridors are emerging. As a result of Kazakhstan's entry into a customs union with Russia and Belarus the nation has been strengthening its borders by constructing a fence. The purpose is border demarcation and to slow smuggling of narcotics. This fenced border will be an obstacle for saiga in their attempts to access habitat critical for their survival during the region's harsh winters. To add to the increasing difficulties facing saiga, a new railroad corridor is under construction (Shalkar – Beyneu and Zhezkazgan – Saksaulskiy) through the Ustyurt and Betpak-Dala saiga populations.

11 These actions contradict pledges to protect saiga and are in direct conflict with conservation measures outlined in the CMS saiga MOU agreed upon by the range states, as well as conservation agreements made between the governments of Uzbekistan and Kazakhstan. Completed as currently panned, these additional threats could have devastating consequences; the risk that the Ustyurt and Betpak-Dala saiga population to ecologically negligible numbers and increase the risk of outright elimination runs high.

What can be done to mitigate the effects of these developments?

12 In response to the threats that saiga are facing due to these developments, the CMS Secretariat, Frankfurt Zoological Society, and Fauna and Flora International initiated

this review. These threats are not unique to saiga in Kazakhstan; the barrier effect due to linear infrastructure and habitat fragmentation is driving many of the observed declines of aggregated migrations of terrestrial vertebrates. For some populations, the problems have been identified and the solutions applied. Lessons learned from these examples can be valuable in developing conservation actions for saiga threatened by similar developments. The purpose of this report is to provide a summary of current best practices of the mitigation of railroads and fences for maintaining habitat connectivity for open plains ungulates.

Ustyurt saiga population

13 The Ustyurt saiga population is found in the arid and semi-arid rangelands west and northwest of the Aral sea and bounded on all sides by major rail and highway corridors (the exception being the railway extending into Uzbekistan where saiga reportedly cross). The main winter range for the Ustyurt saiga is in the region of the 200,000 km^2 Ustyurt Plateau that lies in Uzbekistan. The Ustyurt Plateau is a former sea bed now raised ~150 meters above the surrounding landscape. There are no protected areas within the Ustyurt saiga population range, although a proposal for a saiga winter habitat reserve in Uzbekistan is being considered.

14 Vegetation surveys on the Kazakhstan side of the Ustyurt plateau assessed vegetation and pasture and found a large portion to be in normal to good condition (Temirbekov & Gintzburger 2012). Human population in the region is sparse with most living in the area in small villages located around the periphery of the Ustyurt saiga range. The oil and gas industry has had an increasing influence and activities associated with this are scattered throughout (Temirbekov & Gintzburger 2012).The most recent population estimates (April 2012) were 6,500 saiga, down from as many as 250,000 as recently as 1998 (Grachev 2012). The population was once large enough to sustain a managed harvest of occasionally up to 50,000 saiga each year.

15 The Ustyurt saiga population migrates to the northern extent of their range during the warmer growing season and south during the colder winter (Bekenov *et al*. 1998). Ongoing research tracking the movements of saiga antelope from the Ustyurt plateau support the existence of a north south long distance movement pattern (Fig. 3). During extreme winters the Ustyurt saiga population has been observed migrating as far south as Turkmenistan. Although not common, prior to agricultural intensification and expansion of transport corridors movements of saiga outside of the current range were known to occur (Bekenov 1998).

Betpak Dala saiga population

16 The Betpak Dala saiga population is located to the north and east of the Aral Sea in a large >500,000 km^2 region of Central Kazakhstan (Fig. 2). This population is currently the largest of all saiga populations both in population size and range. The population boundaries appear to be defined by major transport corridors and agricultural development. The population size is approximately 110,000, down from an estimated 300-500,000 prior to the mid 1990's (Grachev 2012). The Altyn Dala Conservation Initiative has a goal of extending the current protected are network to include an additional 30,000 - 40,000 km^2 of critical habitat within this region (5-7% of the total area).

17 Relocation data from individually marked saiga confirmed that saiga in the Betpak Dala population migrate along in a general north-south direction. This pattern is believed to be driven by a precipitation gradient which drives changes in vegetation quality (Bekenov *et al.* 1998; Singh *et al.* 2010). The Betpak Dala saiga population is contained entirely within the borders of Kazakhstan and concerns about the effects of the border fence that is located to south of this population have not emerged.

Figure 2. Kazakhstan and existing transport networks and the approximate range of the Ustyurt (A) and Betpak-Dala (B) saiga populations.

Main threats to the Ustyurt and Betpak-Dala saiga populations

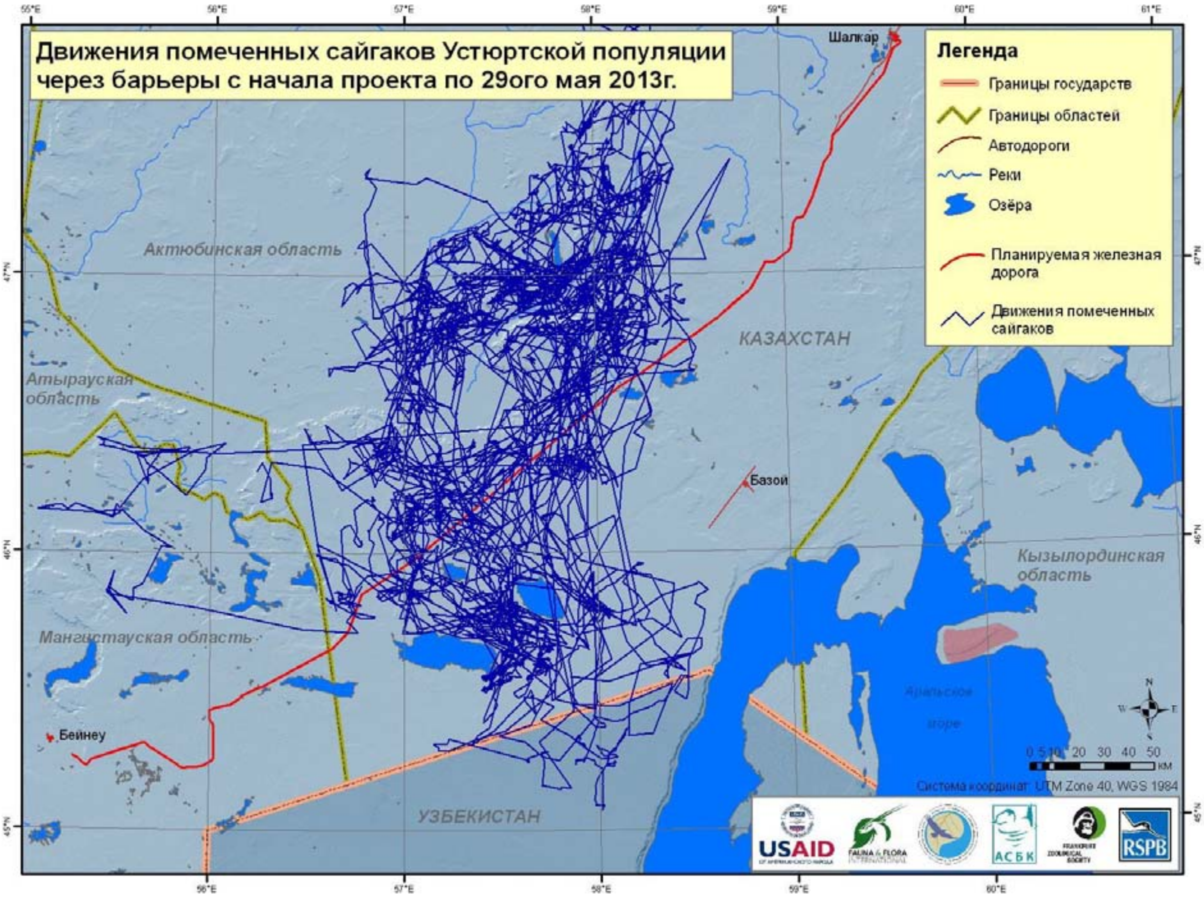
18 High levels of illegal hunting for horns and meat remain a chronic threat to both the Ustyurt and Betpak-Dala saiga populations. The government currently allocates approximately 650 million Tenge (150 T = 1 US$) towards anti-poaching activities. These increased efforts may be having a positive effect in the Betpak-Dala saiga as the population shows signs of increasing. However, the Ustyurt saiga population continues to decline and remains in critical condition.

19 Saiga avoid human settlements and have shown to be particularly sensitive to human activities during the calving season (Singh *et al*. 2010). Domestic stock are typically grazed within 20 km radius of village centers (horses and camels may wander further) and disease transmission between livestock and wildlife is an ever present threat. When the total saiga population size was highest, domestic free ranging dogs were believed to be responsible for tens of thousands of saiga calf mortalities and are known to be a contributor to the mortality in other open plains ungulates in Central Asia (Bekenov *et al*. 1998; Young *et al*. 2011). Settlements within and adjacent to saiga range are also believed to be a constant source of hunting pressure (Y. Grachov, pers. comm).

20 The Ustyurt saiga are experiencing increasing disturbance as a result of the increasing activity associated with the exploitation of oil and gas fields that occur throughout the region. Habitat that was once uninhabited may now be busy with truck traffic and infrastructure construction. Saiga appear to have disappeared from regions where humans have settled or altered the landscape and that saiga do not seem to venture into and cross areas where high volume transport corridors have been built (Bekenov *et al*. 1998).

21 The construction of new roads and the rehabilitation and improvement of roads and railroads threaten to limit access to critical resources by blocking migrations to important seasonal habitats threaten the long term viability of both populations. Additionally, the Ustyurt saiga population faces an additional threat from the construction of a fence along the Uzbekistan-Kazakhstan border.

Figure 3. Movement tracks of saiga fitted with GPS tracking devices within the Ustyurt saiga range prior to the construction of the border fence (source: ACBK/FFI).



The barrier effect of linear infrastructure on open plains ungulates

Fences

22 Fences are constructed to limit access by controlling movement (Boone & Hobbs 2004). Fences are used to delineate national borders, private property, to alert one to changes in land use regulations, to control domestic and wild animal movements, and for safety along high speed travel corridors (Boone & Hobbs 2004; Hayward & Kerley 2008).

23 Ungulates, especially those adapted to open plains, can easily become entangled in fencing after failing to clear a top wire during a jump over attempt or while maneuvering between wire strands which can easily kill (Fig. 4) (Harrington & Conover 2006). Fencing may also be used to funnel wildlife by dogs, coyotes, as well as by hunters (Fox *et al.* 2009). Fencing also impacts wildlife at the population level by reducing carrying capacity either abruptly through mass mortality during severe

drought or slowly over time from lower fecundity and reduced life expectancy (Ben-Shahar 1993; Boone & Hobbs 2004; Newmark 2008).

24 Open plains ungulates such as Mongolian gazelle, pronghorn antelope (*Antilocapra Americana*), chiru antelope, Asiatic wild ass (*Equus hemionus spp.*), and saiga are more vulnerable to the affects of fences than ungulates adapted to living in forested or more rugged habitats. They do not readily jump instead preferring to simply walk through to the other side. Newborns and yearlings are particularly vulnerable to mortality due to fence entanglements (Harringon & Conover 2006).

Figure 4. This Tibetan wild ass became entangled in a fence and died struggling to escape.

Railroads

25 Traffic volume along rail corridors is low compared to highways and as a result the barrier effects of railroads on ungulate populations have received less attention than other linear infrastructure. Collisions with wildlife by trains as individual events are a more frequently reported source of conflict rather than the barrier effects that a rail corridor can have on a particular population (Wells *et al.* 1999; Van Der Grift 2001).

26 Single track trains using automated signaling support a maximum of about 100 trains/day (Association of American Railroads 2007). Rail corridors approaching this volume of traffic are believed to begin to influence an animal's willingness to approach and cross the tracks (Hart *et al.* 2008). Double tracked rail corridors can

support up to four times the volume of rail traffic as a single tracked corridor and being wider also influences an animal's willingness and ability to cross (Amos 2009). Busy rail corridors have even been shown to limit the movements of bumblebees (Bhattacharya *et al*. 2003).

27 Wildlife is more vulnerable to train strikes in regions that have prolonged periods with deep snow or in regions where grain is stored and transported (Wells *et al*. 1999). During periods of deep snow the corridor is kept clear of snow and becomes a convenient path for animals which are then unable or unwilling to jump to the side when a train approaches and are subsequently overtaken (Rea *et al*. 2010). Wildlife can be attracted to a rail corridor if used frequently by trains carrying grain with faulty discharge gates causing grain to spill along the center of the track (Wells *et al*. 1999; Pissot 2007; Dorsey 2011). Although this problem has not been observed outside of North America, Kazakhstan transports harvested grain via rail and the potential for conflict does exist. Other factors which contribute to wildlife strikes are the speed of the train and the straightness of the track. Curves in the track and habitat changes alongside the tracks present animals with more opportunities to escape (Rea *et al*. 2010).

28 In most situations, for large mammals, a single track unfenced railroad is a crossable feature and habitat connectivity for large bodied mammals should remain relatively high (Olsson *et al*. 2010). Long steep embankments may be a barrier for some animals if they are unable or unwilling to climb over and cross or if the embankment is long enough that an animal will not walk to one end or another before turning back (Fig. 5). In a study of moose (*Alces alces*) and roe deer (*Capreolus capreolus*) movements in Sweden railroad there was little evidence of a barrier effect across a single track railroad, but effects were more obvious along double tracked railroads due to the greater corridor width and higher volume of trains (Olsson *et al*. 2010).

29 The presence of a rail corridor can also be problematic during extreme winter weather: wildlife and livestock might prefer to walk along a track cleared of snow and be struck by moving trains. During deep snow events, wild animals may walk along a rail corridor rather than in the snow. They then are unable or unwilling to leave the track when a train approaches and attempt to escape by running along the tracks (Rea *et al*. 2010).

Figure 5. This embankment is about 3 meters high and might be enough to prevent movements of gazelles and other open plains animals to the other side.

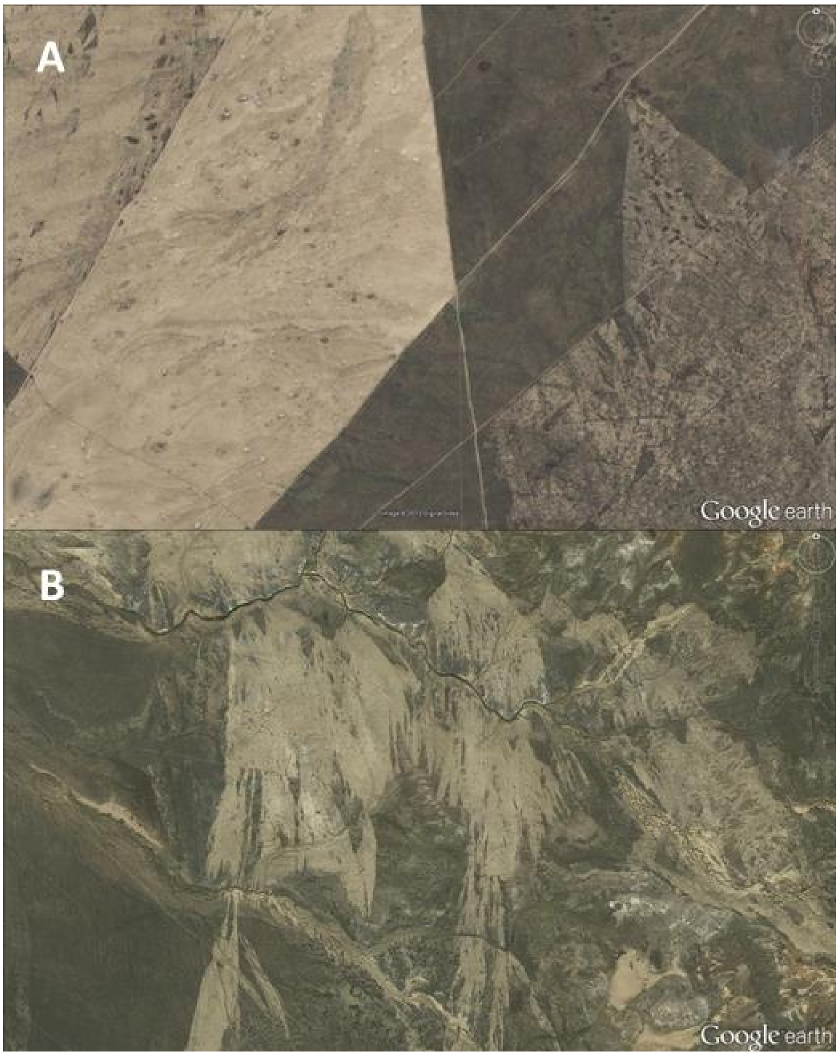
30 Behavior and reaction to a moving train can also lead to a collision as some animals, such as cows, are unaware of the threat or attempt to outpace the train to cross in front of it. These interactions normally cause little damage to the train, with the exception of train-elephant collisions where derailments have occurred. More often, any observed barrier effect is a result of secondary structures associated with the railroad such as fenced corridors, or roads and human settlements along stations.

31 A fenced rail corridor has four barrier components: 1) the embankment, 2) the railroad tracks, 3) the traffic volume (noise, speed), and possibly 4) a fence. The embankment may be too high or constructed of material which makes walking up difficult. The ballast and tracks may discourage animals from crossing if they are wary of the tracks and gravel. If the railroad is built for high speed rail it may have earth barriers on both sides to limit noise and discourage animals from crossing. In the case of smaller animals (turtles, hedgehogs, small mammals) they may not be able to climb over the rails. High train traffic or speed may simply deny animals the chance to approach and cross the tracks or are struck and killed by moving trains. A fence restricts animal movement into and across the rail corridor. If an animal happens to be inside a fenced corridor and becomes startled by an approaching train, it may become mortally injured or entangled in the fence if panicked and runs unknowingly into it.

32 A rail corridor can also be a barrier to natural processes such as the spread of natural steppe fires which are important for maintaining grassland health and could possibly influence saiga habitat (Fig. 6). Fires are one of the natural processes that help to maintain healthy and diverse grassland vegetation. A steep embankment can stop the spread of fire. If fires become less frequent, larger, hotter and more dangerous fires will occur. Changes in vegetation composition can occur if fire suppression happens over long periods of time. A natural fire regime will result in a

mosaic of burned and unburned vegetation patches which facilitates the growth of more nutritious plants and helps maintain the presence of fire dependent species.

Figure 6. Fire scars in the Betpak-Dala region whose spread was limited by a road corridor (A) and one able to burn naturally (B).



33 A fenced rail corridor can severely limit the ability of wildlife in open rangelands to move across the landscape to seek good habitat. For example, the Trans Mongolian Railroad corridor is fenced on both sides. Since its completion in the late 1950's it has been an absolute barrier for khulan movements to the point that this railroad corridor is now used to mark their easternmost range (Fig. 7). The fence is in various states of disrepair and is a semi permeable barrier (but effective enough to severely limit the frequency of successful crossings) for Mongolian gazelles (Ito *et al.* 2005; Ito *et al.* 2008; Kaczensky *et al.* 2011; Olson 2012; Ito *et al.* 2013) (Fig. 8).

Figure 7. A group of Khulan in Mongolia walking alongside the fenced Trans Mongolian Railroad.

Figure 8. The fenced corridor along the Trans Mongolian railroad entangles hundreds of gazelles each year and likely prevents tens of thousands from continuing their journey.

34 A railroad can also encourage animals to walk along the tracks if snow is deep enough to limit mobility. In North America moose, deer, and pronghorn are frequently struck and killed after being caught on the railroad tracks and unwilling or

unable to jump to the side to escape and are run down by a fast moving train (Fig. 9). During a harsh winter in Montana, snow reached depths enough to restrict movements of large animals such as deer and pronghorn. A group of pronghorn found temporary relief by walking along the rail corridor; when a train approached, the animals were unable to jump to the side due to deep snow which resulted in the deaths of 270 pronghorn (Billings Gazette 06 March 2011).

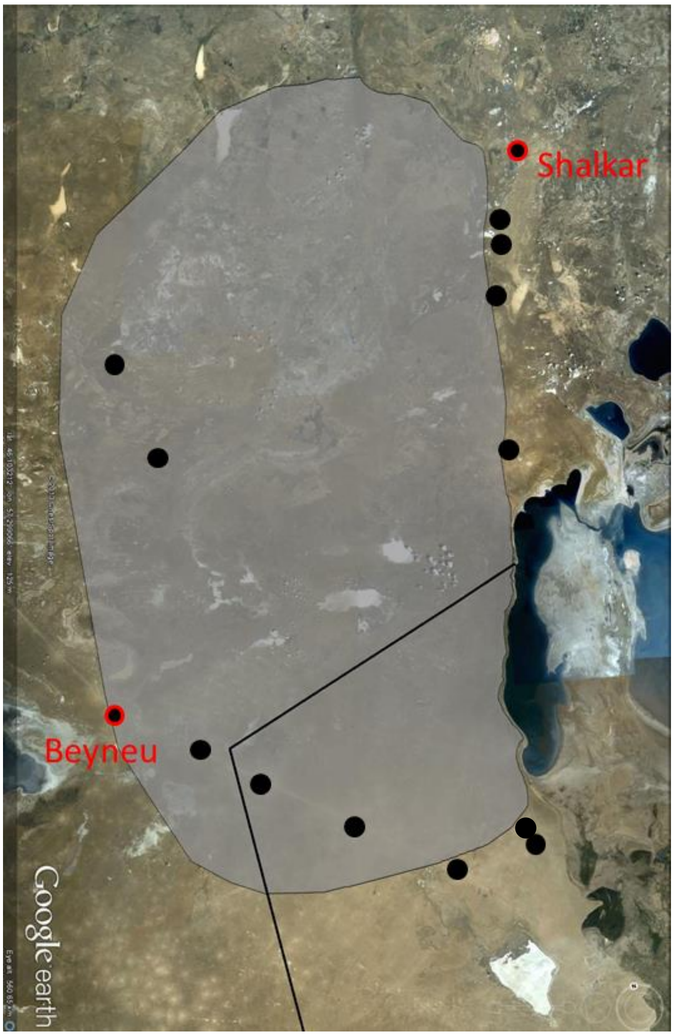
Figure 9. These pronghorn were struck by a train in Wyoming in 2003.

Section 2. Border fencing along the Kazakhstan Uzbekistan border in the Ustyurt region

35 Kazakhstan shares an approximately 2,200 kilometer long border with its southern neighbor-Uzbekistan. In April 2012, Kazakhstan announced its intentions to improve its tactical infrastructure along the border with Uzbekistan and Turkmenistan partly in response to concerns over insurgents leaving the conflict in Afghanistan, Uzbekistan's rebuilding its border security apparatus with neighboring Kyrgyzstan, and the formation of a new customs union consisting of Russia, Kazakhstan and Belarus (Jamestown Foundation 2011; Kalra & Varadzhakov 2012). The border fence affecting the Ustyurt saiga population is an approximately 215 km long fence along an approximately NE-SW alignment and an approximately 400 km long fence aligned North-South (Fig. 10). The purpose of the border fence is to better demarcate Kazakhstan's boundaries and to limit the smuggling of illicit goods such as narcotics.

36 Kazakhstan has installed border fencing along their border with Turkmenistan which consisted of 12 foot concertina wire fencing, guard towers, and vehicle patrols (Myles Smith pers. obs.). Other fenced segments along Kazakhstan's borders in eastern Uzbekistan consist of 8 foot barbed wire fencing with searchlights (Greenberg 2006).

Figure 10. The border with Uzbekistan (black line) with an approximation of the current range of the Ustyurt saiga population (shaded). Black circles indicate villages.



37 With the exception of a few locations, the border fence on the Ustyurt plateau has been completed. The fence design is approximately 1.7 meter high with 8 barbed strands and 2 barbed diagonal strands crossing from top to bottom. The distance between fence strands is approximately 20 cm's. Square metal fence posts are spaced approximately 2 meters apart (Fig. 11). The untreated hollow steel posts embedded directly into the ground will likely result in the posts rusting at the base and eventually fail. This will result in loose wires lying on the ground and increase chance of entanglement.

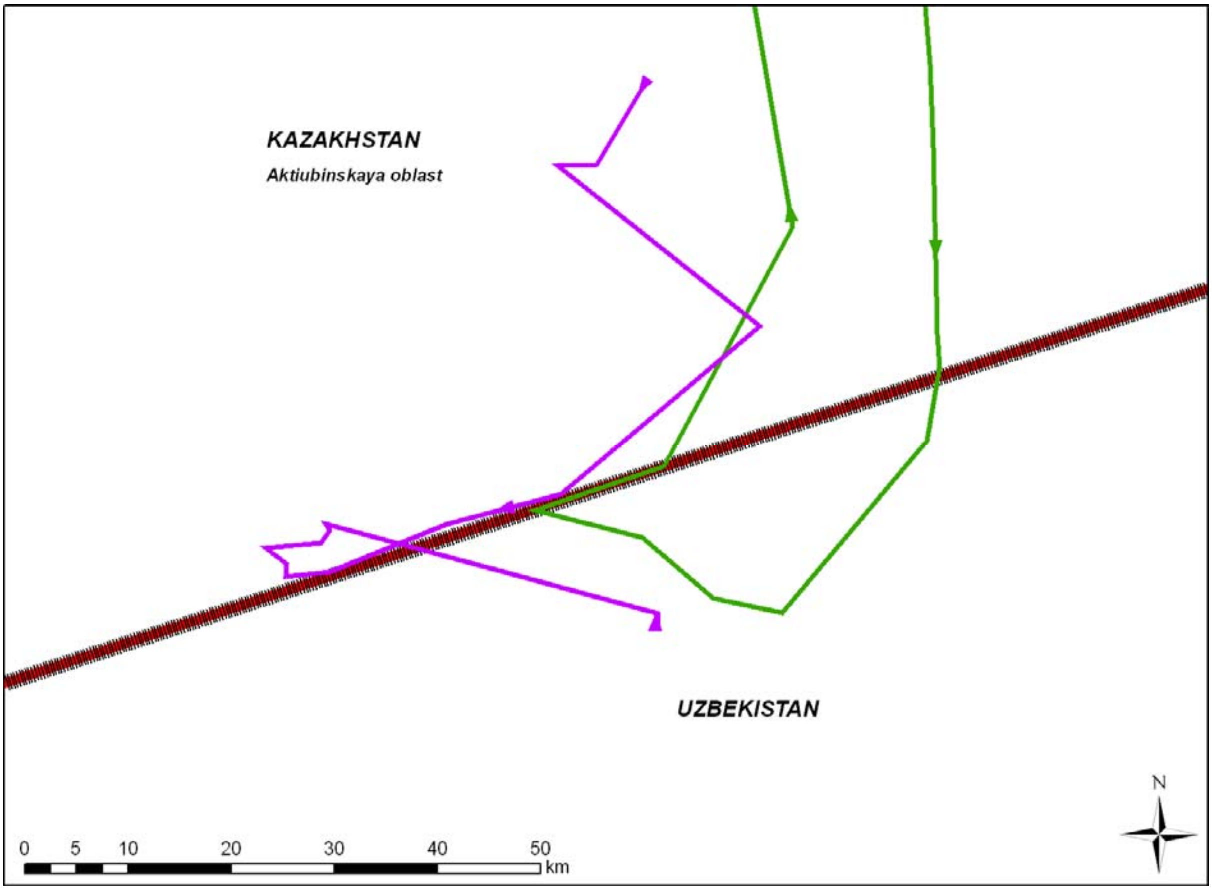
Figure 11. A section of the Kazakhstan-Uzbekistan border fence.

38 The fence threatens to reduce the range size of the Ustyurt plateau by limiting access to habitat that appears to be critical to saiga during the winter. Without being able to pass this fence with ease during winter (and return north before summer), a density independent reduction in population is likely to take place. Recent observations of a saiga fitted with a GPS tracking collar has shown the fence in its current state is not a complete barrier for saiga as one individual has successfully crossed twice; however it appears the individual did wander the fence line in search of a suitable crossing location (Fig. 12).

39 Saiga that attempt to pass through the type of border fence built on the Ustyurt plateau face a number of challenges. Wandering along the fence in search of a suitable crossing point uses additional energy and may weaken an animal to the point where it cannot continue. Also while trying to crawl under or between barbed wire a saiga is likely to snag hair and leave bare skin that is exposed directly to extremely cold temperatures. If the wires begin to loosen, it will be easier for a saiga to become entangled and die or escape with a serious injury. Animals that are unable to cross might either starve or experience a reduction in fitness due to poor body condition due to overwintering in less than optimal conditions (thus the reason

for saiga to initiate a seasonal movement). The fence might also be used to entrap saiga by predators or poachers. Two gaps of 15 km each have been incorporated into the fence construction. The purpose of the gaps is to facilitate saiga migration. However it is believed that one of the two gaps is located in an area which is unsuitable for saiga to cross. A single 15 km gap is not sufficient for a species such as saiga, which do not have predictable migratory patterns.

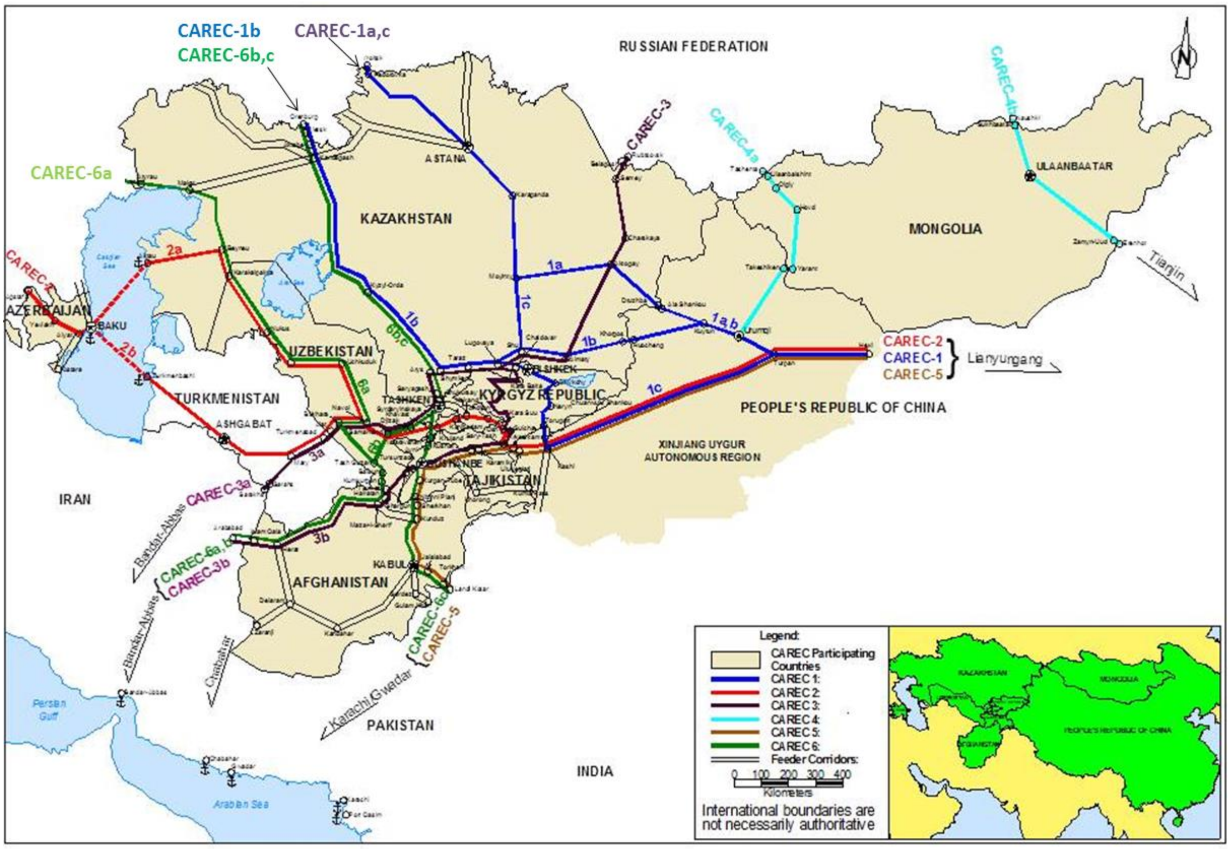
Figure 12. Relocations of two GPS marked saiga near the border fence demonstrate the difficulty saiga face in accessing the southern parts of their range.



Section 3. Railroad development within saiga range

40 Serving both domestic and international transit needs, there are slightly more than 15,000 km's of railway in Kazakhstan (The World Fact Book 2012). Kazakhstan is an important transit country for freight between EU and China and two of the six CAREC (Central Asia Regional Economic Cooperation) corridors are built through saiga habitat (Fig. 13). Although only a small fraction of the overall trade between EU and Asia-Pacific region is sent by rail (~1%, most goods are shipped by sea), maintaining smooth rail traffic between the two regions will always be important (ECE ESCAP 2008). Freight takes between 13 and 22 days to transit between Germany and China (Retrack web report). Cost per container are calculated at US$ 3,200.

Figure 13. Major rail corridors connecting Asia with Europe (Ee Khong Kie & Akhmet 2009).

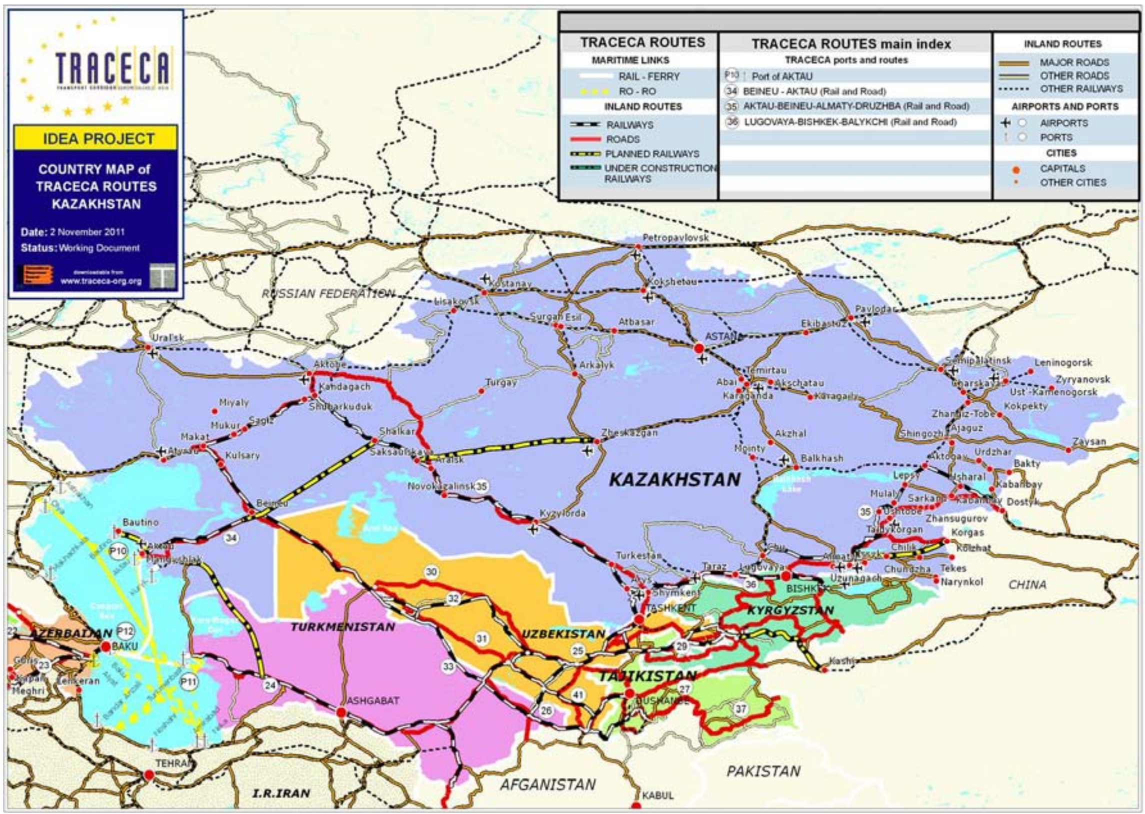


41 In support of increasing the usage of these corridors the government of Kazakhstan plans to construct 1,600 km's of additional rail routes as part of a 'New Silk Road' program to increase overland trade between Asia and Europe. It is widely believed that construction of a new corridor to connect the major CAREC routes will improve

transport times by allowing trains to switch corridors to relieve congestion and to improve travel along an east west axis within Kazakhstan. This will increase the amount of rail traffic that is on these corridors and result in a stronger barrier effect from the railroad.

42 Creating an east-west corridor to Aktau will introduce a new rail corridor that will impact two distinct saiga populations – the proposed Shalkar – Beyneu (Ustyurt saiga population) and Zhezkazgan – Saksaulskiy (Betpak-Dala saiga population) segments (Fig. 14). This will link two of the three major rail corridors between EU countries and China. The estimated construction cost of the entire corridor is 1.5 billion dollars (Kazakhstan Today 1/26/2009). This new corridor is expected to be fully functional by 2016 and will initially support 10 pairs of trains each day (20 trains). The railroad is expected to be unfenced. Housing for employees and their families will be constructed. Some of these housing areas will be constructed in parts of the steppe that are currently uninhabited. It is standard practice in Kazakhstan to construct railroad stations and employee housing at 75 km intervals along the railroad route.

Figure 14. TRACECA routes including the proposed routes (dashed yellow) that bisect saiga range (http://www.traceca-org.org/en/routes/).



43 As part of this initiative the government of Kazakhstan has invested heavily in upgrading the seaport of Aktau. Aktau is the largest city (~180,000) in Western Kazakhstan and the countries only international seaport. The new corridor will also provide an east-west link within Kazakhstan connecting with all the major European-Asian rail corridors and the Caspian seaport Aktau. One of the main products sent by rail to Aktau is steel produced in Northeast Kazakhstan in the city of Pavlodar which is partial justification for the new rail corridor (Parkash 2006).

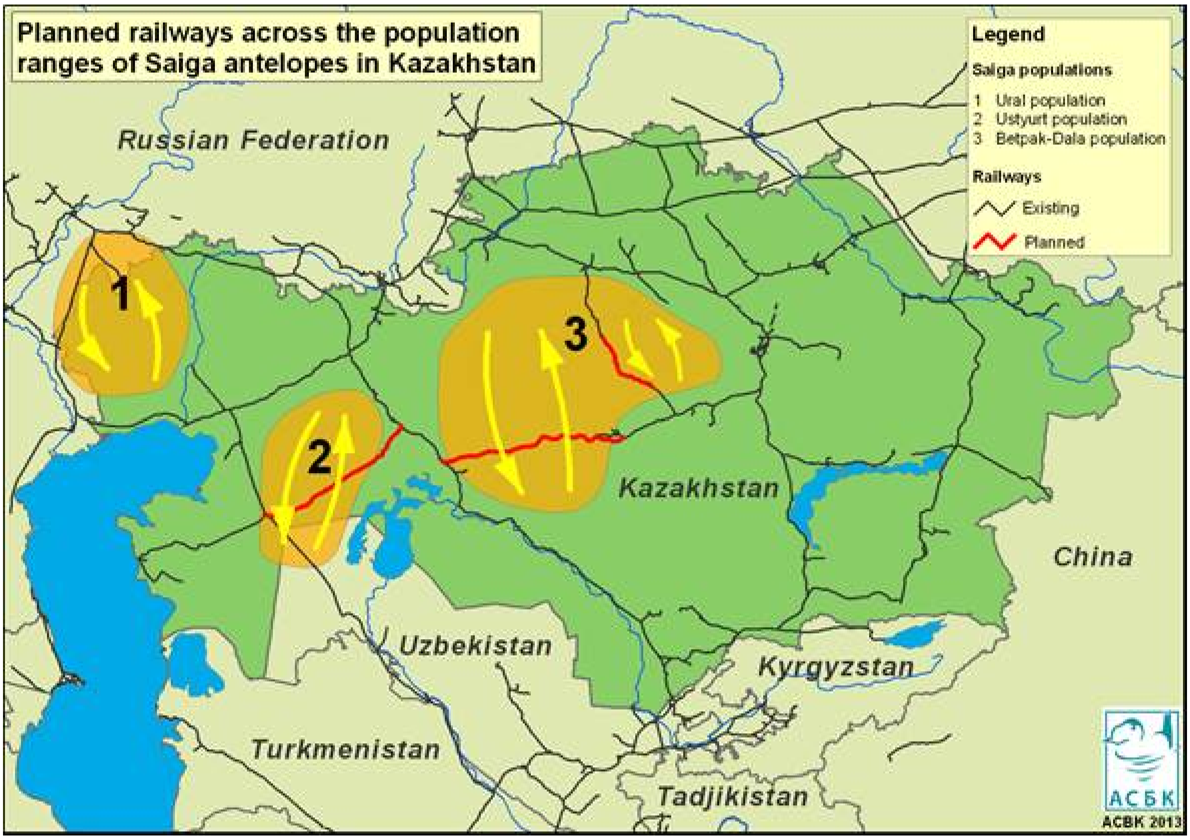
The barrier effect of the rail corridor on saiga

44 The current proposed routes will cut through ecologically intact and nearly uninhabited steppe habitat that is of great importance to migratory saiga antelope. This railroad has the potential to bring long term negative impacts to not only saiga antelope but to other wildlife such as the steppe tortoise (*Agrionemys horsfieldii*). Observations of how saiga antelope respond to such railway structures are few and thus a precautionary approach should be taken with respect to the impacts that may happen. Saiga numbers have been drastically reduced due to high rates of illegal hunting and are highly vulnerable to further population collapse with each additional threat imposed upon them.

45 Human disturbance influence saiga calving ground selection and likely influences other aspects of saiga habitat use (Singh *et al*. 2010). This is particularly evident in the Ustyurt population which appears surrounded by railroad corridors and natural gas fields. The existence of three distinct populations in Kazakhstan may be due to the historical alignment of such transportation corridors and the concentration of settlements and increased human disturbance along such routes (Fig. 15).

46 The corridor (CAREC 1b, 6b, 6c) through Shalkar is a double tracked railroad, while the corridor (CAREC 6a) through Beyneu consists of a single tracked railroad. There is very little data available to determine what affect these corridors and associated roads and villages may be having on saiga movements between the Ustyurt and Betpak-Dala populations. One saiga fitted with a GPS tracking device is known to have crossed a highway between the two populations but turned back before crossing the double tracked railway further to the west. It is well known that dogs associated with these villages have been responsible for thousands of mortalities (Bekenov & Milner-Gulland 1998). Additional corridors are likely to encourage more settlements and the threats that accompany them.

Figure 15. Railway alignment and overlap with saiga range.



47 Observations of saiga crossing a road and railway several decades ago in the Betpak-Dala region suggest that saiga are wary of these corridors and gather for periods of up to several days before finally crossing en masse (Y. Grachov, Pers. Comm.). Saiga that have been observed near railroads appeared to be unwilling to directly cross and waited for days before crossing. Saiga are known to be wary of train noise but have been observed lingering between 30 to 100 meters of the railroad while waiting to cross. Saiga also have been observed attempting to outrun a moving train and pass in front of it but often were unable to do so and give up in exhaustion. These observations suggest that saiga have not adapted to the presence of the railroad and trains and is causing saiga some challenges in crossing. If rail volume is high or if vehicle use along the corridor occurs (as is suggested with the future construction of an Astana-Aktau highway) a constant flow of vehicle traffic, the physical barrier of the railroad, and the noise of moving trains may result in conditions that prevent saiga from crossing.

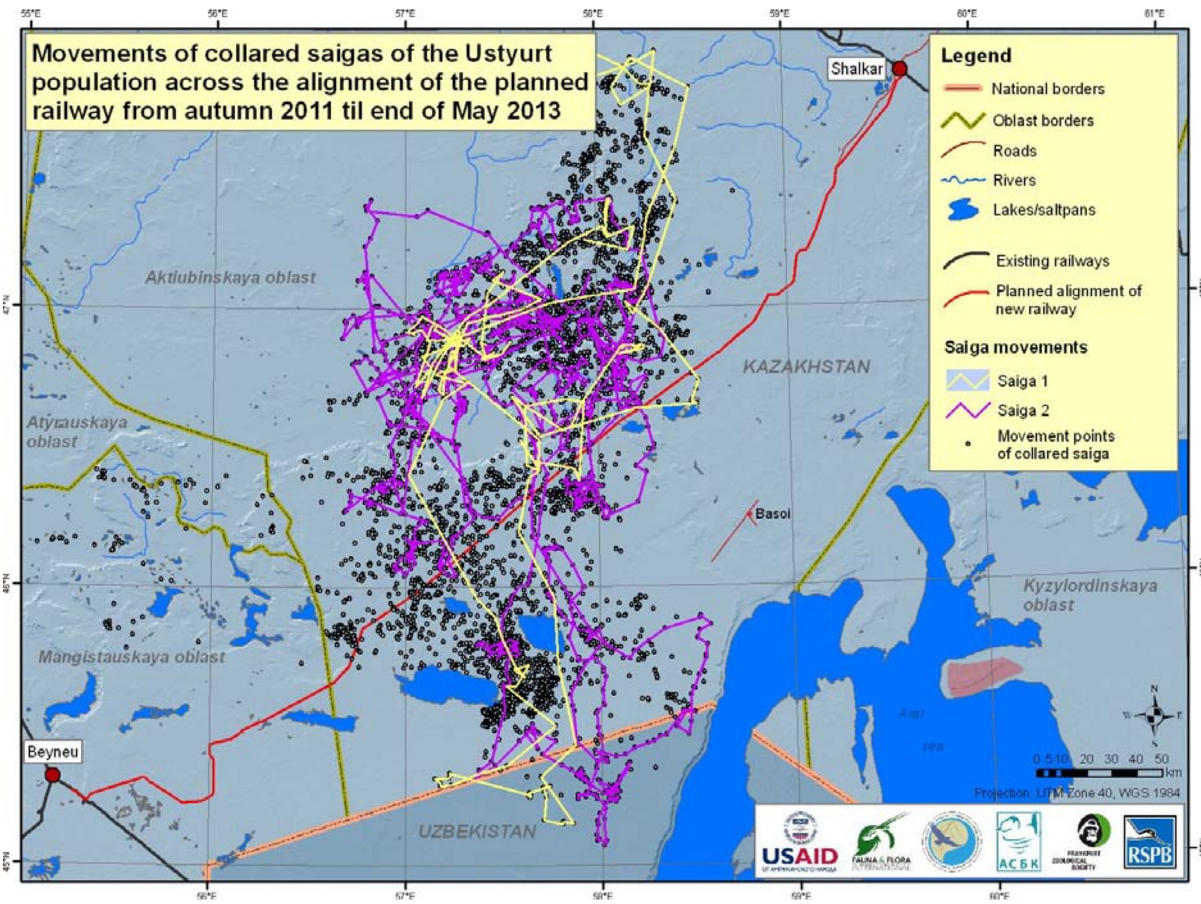
48 Long segments of the railroad which have tall embankments may prevent saiga from continuing their migration unless they are motivated enough to continue alongside the tracks until the embankment is low enough to cross. The topography for the proposed rail corridors is relatively flat and appears to have few intermittent drainages and it is likely that underpass options for saiga (and livestock) will be

limited (in addition, it is widely believed that saiga will not utilize underpasses). Therefore knowing the embankment heights along the routes will be important to know so that problem areas can be identified and solutions incorporated.

Shalkar – Beyneu rail corridor through the Ustyurt saiga population range

49 The proposed Shalkar - Beyneu rail corridor is an approximately 475 km long route, a segment of an east-west rail corridor throughout Kazakhstan to connect the CAREC corridor (1b, 6b,c) with the seaport of Aktau (Fig. 16). The city of Shalkar (~26,000) owes its existence to the presence of transport corridors, originally a road in the late 18th century and later a railroad. Cargo transits through Shalkar as the city is not a point of origin for any particularly essential natural resource that would require Shalkar to be a point of origin. Beyneu (Pop 33,000) has been growing rapidly due to the discovery and extraction of nearby natural gas fields. Beyneu is also the junction of the rail corridor to Aktau as well as another of 4 major rail corridors connecting Asia and Europe. It is expected that once the rail from Shalkar is operational that Beyneu will become a more important population center (Ee Khong Kie & Akhmet 2009).

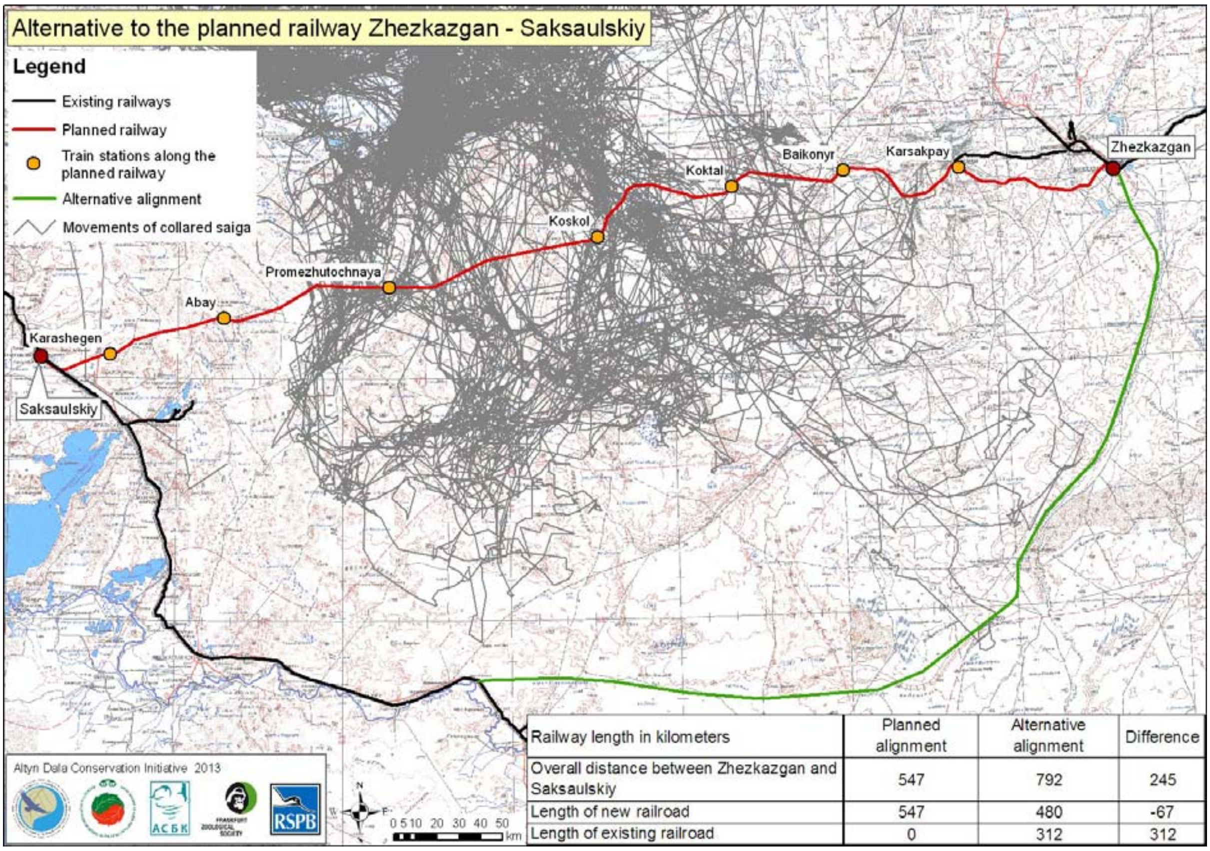
Figure 16. Current proposed alignment for the Shalkar-Beyneu railroad. The paths of two saiga are shown in yellow and purple lines and other saiga locations are represented by dots.



Zhezkazgan – Saksaulskiy rail corridor and the Betpak-Dala saiga population

50 The proposed Zhezkazgan-Saksaulskiy rail corridor is an approximately 550 km long rail corridor segment that will bisect the southern extent of the Betpak-Dala saiga population range (Fig. 17). There are approximately 150,000 inhabitants of Zhezkazgan and adjacent Satpaev. They are industrial cities at the terminus of a rail corridor which connects to the regional capital of Karaganda. The proposed corridor will be an extension of this rail line.

Figure 17. Current and proposed alternative alignment of the Zhezkazgan-Saksaulskiy corridor.



Railway length in kilometers	Planned alignment	Alternative alignment	Difference
Overall distance between Zhezkazgan and Saksaulskiy	547	792	245
Length of new railroad	547	480	-67
Length of existing railroad	0	312	312

Section 4. Mitigation Options for the Border Fence and Railroad

Border fence

51 A secure border between Kazakhstan and Uzbekistan can be achieved without becoming an obstacle to saiga movements. Technology to develop a 'virtual fence' is now available that would allow the border to be remotely monitored while detecting in real time attempts to cross. Vehicle barriers can be installed so that the border is uncrossable by vehicles but remains open for wildlife. Border fencing can be constructed to allow animals opportunities to pass underneath a barbless bottom strand. Existing fencing can be modified to minimize their barrier effect by removing sections and replacing with alternatives or simply re-fitting portions of the fence to raise a bottom wire.

Acoustic monitoring

52 Acoustic sensing using fiber optic technology has been used to carry out monitoring of high security facility perimeters, remote pipelines, and private wildlife game preserves on the Arabian Peninsula. The concept relies on buried fiber optic cables that are monitored from a base station. Vibrations triggered by pressure exerted from an object can be detected to within a meter and trained monitors are able to identify the differences in various objects such as between a horse and a motorcycle. Upon detection of an activity of interest, patrols can be deployed to investigate. Current technology allows for fiber optic cable to extend as far out as 125 km's in each direction from a single base station (thus a total length of 250 km's of virtual fence can be created). Costs to install and operate 125 kilometers of virtual barrier would cost US$ 2.25 million (18k/km) and ~50k/year for operation.

Advantage: Virtual barrier and would maintain 100% connectivity for wildlife.

Disadvantage: New technology that is still being tested and would require constant vigilance. High initial installation and continued operation cost.

Normandy Vehicle Barriers

53 Normandy vehicle barriers consist of large steel beams that have been welded together at their midpoint with a cross beam placed along the intersection to form a formidable barrier to vehicles but allow animals to pass underneath a main connecting beam (Fig. 18). A Normandy style barrier fence can stop a 4,500 kg vehicle moving 65 km's/hour. Cost of Normandy barriers along the US-Mexico border was approximately US$ 621,000 per kilometer. Adaptations can be incorporated so that motorbikes could not be driven through.

Advantage: Provides a formidable barrier for vehicles attempting to illegally cross while allowing wildlife to pass through.

Disadvantage: High material costs.

Figure 18. A Normandy barrier installed along the US-Mexico border.

Post on Rail (Anti-ram) Vehicle Barrier Fence

54 A vehicle barrier fence consists of vertical posts embedded in the ground connected by high tension cable or a steel beam (Fig. 19). Posts are embedded in the ground and filled with cement. There can be a great deal of flexibility with respect to post height and spacing to achieve the objective as an effective barrier and allow wildlife crossing opportunity. If available, wood can be used to replace metal to reduce costs. The design can also be adapted to make motorcycle crossing difficult. Cost is dependent on local obtained material prices.

Advantage: The fence is narrow, minimizing the barrier space that wildlife must pass between to get from one side to the other.
Disadvantage: High material costs.

Figure 19. A post on rail vehicle barrier helps to maintain connectivity for large mammals. Installation of a lower wire is optional.

Barrier Posts or Concrete Bollards

55 Barrier posts or bollards are concrete or steel posts that are embedded in concrete that is buried in the ground. These can be placed along the border at distances less than the width of a vehicle to prevent vehicle crossing but maintain maximum permeability for wildlife. Bollards can be placed individually or as multiple bollards embedded in a cement pad (Fig. 20). Bollards are typically installed in short segments. Cost is dependent on local material prices.

Advantage: No overhead barrier that animals would need to pass under.

Disadvantage: Bollards would need to penetrate deep into the ground or be large enough to prevent displacement and motorcycles can pass through easily.

Figure 20. Concrete bollards are effective at blocking vehicles.

Wildlife Friendly Fence

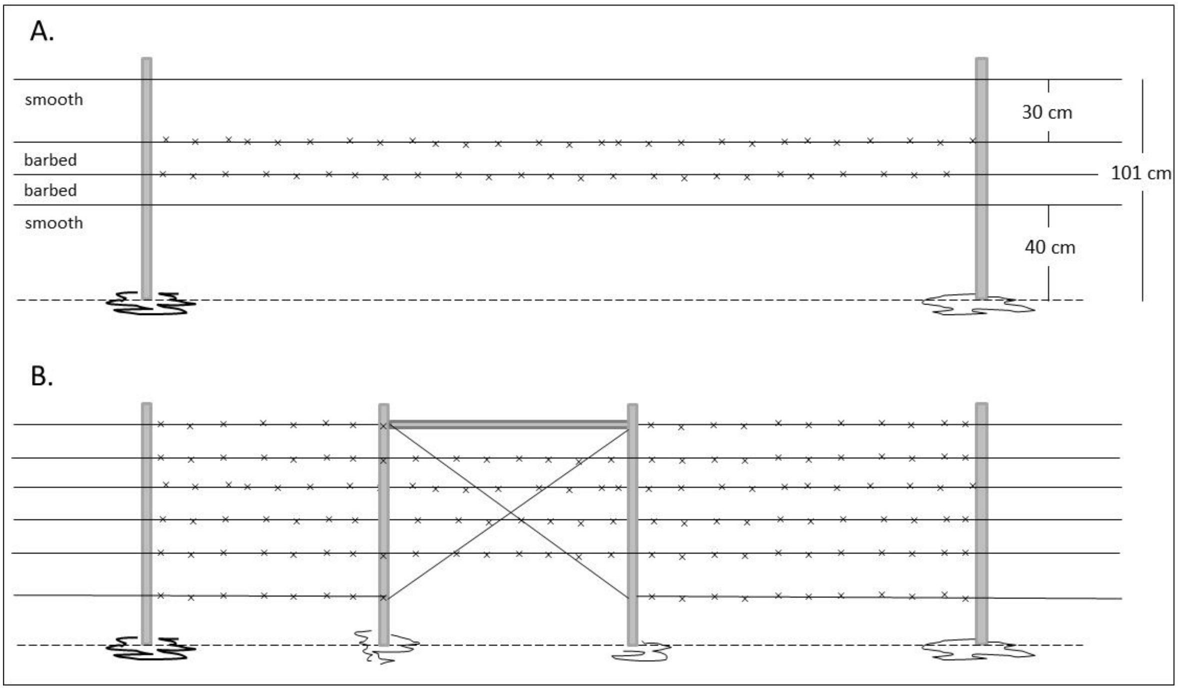
56 A traditional wildlife friendly fence design provides wildlife with the opportunity to pass from one side of a barrier to the other with relative ease while still maintaining the integrity of the fence (Paige 2008). Fence designs considered to be wildlife friendly are those that encourage animals to crawl under a bottom barbless strand (opposed to walking between middle strands or attempting to jump over the top strand) without risk of injury or entanglement. Replacement of fences with more pronghorn friendly design is becoming an increasingly common activity throughout pronghorn range (Fig. 21). Gaps can also be built into a fence to provide crossing locations at frequent intervals (Fig. 22).

57 In the case of an existing fence, modifications can be made after construction to meet these requirements by replacing and raising the bottom barbed wire or by fitting a plastic pipe sleeve over the bottom wire and fixing it to the next wire up by attaching wire clamps. This creates additional space to an existing fence while eliminating the risk of injury from the barbs. Costs estimates in the USA for wildlife friendly fence ranged between 3 – 5,000 $US/km. Estimated costs to modify the bottom wires of an existing fence that is in good condition are approximately 1,200 $US/km.

Advantage: Minimal cost, barbless lower wire eliminates chance of injury, proven effective for Pronghorn antelope.
Disadvantage: Wire strands can be easily and quickly cut.

Figure 21. A pronghorn antelope crawls under a fence designed to maintain permeability for wildlife.

Figure 22. A design for an ideal wildlife friendly fence (A) and a partially modified fence (B) designed to provide passages through a fence.



58 This list of options is not exhaustive. The option which is most appropriate will be one that achieves the objectives of securing the border from undocumented entry and maintain habitat connectivity within the available budget. The wildlife friendly fence design offers the advantage of offering an economical way to maintain an unbroken fence line while at the same time allowing saiga the opportunity to cross at any location.

Mitigation options for the railroad corridors through saiga range

59 Many railroads were built far before concern over ensuring habitat connectivity for wildlife and there is a limited number of examples of wildlife crossing structures for open plains ungulates built specifically for railroad crossing. Incorporating segments of elevated track to provide wildlife crossing opportunities is prohibitively expensive for long railroad corridors. In many cases culverts and bridges installed for drainage purposes are utilized opportunistically by small mammals, but are typically too small for ungulates (Rodriguez *et al*. 1996).

60 Mitigation actions to prevent collisions with individuals have attracted greater attention than the impact on wildlife movements and the need to improve permeability of a rail corridor. Grain spillage is responsible for attracting wildlife to the rails which results in collisions and the focus tends to be on repairs to doors and

hatches or replacement of grain hauling rolling; or fencing around grain elevators to prevent animals from entering (Pissot 2007). Another common mitigation strategy is to enforce a reduced train speed along areas where wildlife collisions are common so that animals have time to react and will choose to run off tracks rather than panic and run straight ahead (Rea *et al*. 2010).

61 In relatively flat open terrain an unfenced rail corridor is likely the best option for maintaining habitat connectivity. With a few exceptions it is likely that most large mammals will adapt to a rail corridor and cross. In Gujarat province, India, Asiatic wild ass have been observed crossing highways but not over a nearby rail corridor, instead preferring to cross underneath railroad bridges (Lea Associates, 2002).

62 Saiga have been observed crossing railroad tracks in the past. However these accounts suggest that the saiga remain wary of the structure and cross only after congregating until something triggers them to cross. Additionally, recent observations of saiga crossing rail corridors in the Betpak-Dala population as well as observation in the Uzbek region of the Ustyurt plateau are encouraging. The railroad that saiga were reported to have crossed was a single track railroad. There is no evidence that saiga are willing to cross a double tracked railroad.

63 Grade separation for a railroad usually only occurs at natural features such as wide drainages with steep slopes where a bridge or box culvert is installed (Fig. 23) or a long raised earth embankment may be used where the terrain is flat but has a long gradual slope. In areas with relatively flat terrain, there may be long stretches of railway at ground level with a relatively low embankment which could be suitable crossing opportunities for saiga such as shown in figure 24.

Figure 23. A typical bridge design over an intermittent drainage along the Trans Mongolian Railroad.

Figure 24. This portion of the Trans Mongolian Railroad occurs in relatively level terrain and did not require a large amount of fill and offers a relatively easy crossing opportunity if there were no fence.

64 Saudi Arabia is in the process of constructing an 817 km long high speed rail corridor which includes 22 large box overpasses to allow free roaming domestic camels to cross over the tracks. The railway remains under construction and the overpasses have yet to be completed (http://www.laingorourke.com/) (Fig. 25).

Figure 25. Preparation of an overpass crossing structure for camels across a single track line for a high speed rail in Saudi Arabia.

65 The first ever US Forest Service designated 'National Migration Corridor' is a newly protected 6,000 year old migratory pathway for pronghorn antelope in Wyoming. The mitigation along this migration corridor provides some of the few examples of successful mitigation of a transport corridor for open plains ungulates (Ostlind 2011). North America's longest and best known pronghorn migration routes had been in peril for years due to increased mining activity, busy highways, and increasing urban development (Berger 2004). A total of 8 crossing structures (2 overpasses costing $2.5 million each and 6 underpasses totaling $3.6 million) were built along a 21 kilometer section of a highway corridor in Wyoming (WY Dept of Transportation). Pronghorn antelope were quick to utilize overpasses (Fig. 26), but have been reluctant to use underpasses.

66 The recently completed Qinghai-Tibet railway has approximately 250 kilometers of bridge structures, mostly installed to solve engineering problems related to maintaining grade while crossing rivers and to avoid problems with permafrost than for wildlife considerations (Yang & Shia 2008). Chiru and Asiatic wild ass have been observed passing under some of the larger bridges built along the Tibetan railroad (Fig. 27) (Yang & Shia 2008).

67 In Little Rann Wild Ass Sanctuary in Gujarat State, India, wild ass frequently passed underneath railroad crossings which had a semi-open ceiling allowing light to pass

through and a natural dirt bottom, but did not use highway bridges that had a closed ceiling or non-dirt floor (Lea International, 2002).

Figure 26. Pronghorn adjusted quickly to use of a dedicated wildlife overpass structure in Wyoming.

Figure 27. A bridge built to cross a river bed is used by migrating chiru antelope along the Tibetan Railroad.

Section 5. Recommendations

Border fence in the Ustyurt region

68 Discussions with representatives from the border agency revealed a willingness to work with stakeholders and other government ministries to achieve a satisfactory solution. Removing the bottom two wires would create a 60 cm gap between the ground and the first wire strand and has been shown to be adequate for Pronghorn antelope, a slightly taller open plains ungulate.

69 The entire length of the border fence should be modified by raising the lower wire. Additional modifications or replacement of fence with alternative structures described above can be assessed with continued monitoring of saiga movements and conducting seasonal fence surveys.

70 Primary option:

- Modify the border fence by removing the bottom two wires to create a 60 cm space between the ground and lower wire (Fig. 28).
- Fasten markers (plastic, tin etc…) to the top and lowest wire to increase visibility and minimize accidental collision by both saiga and birds.

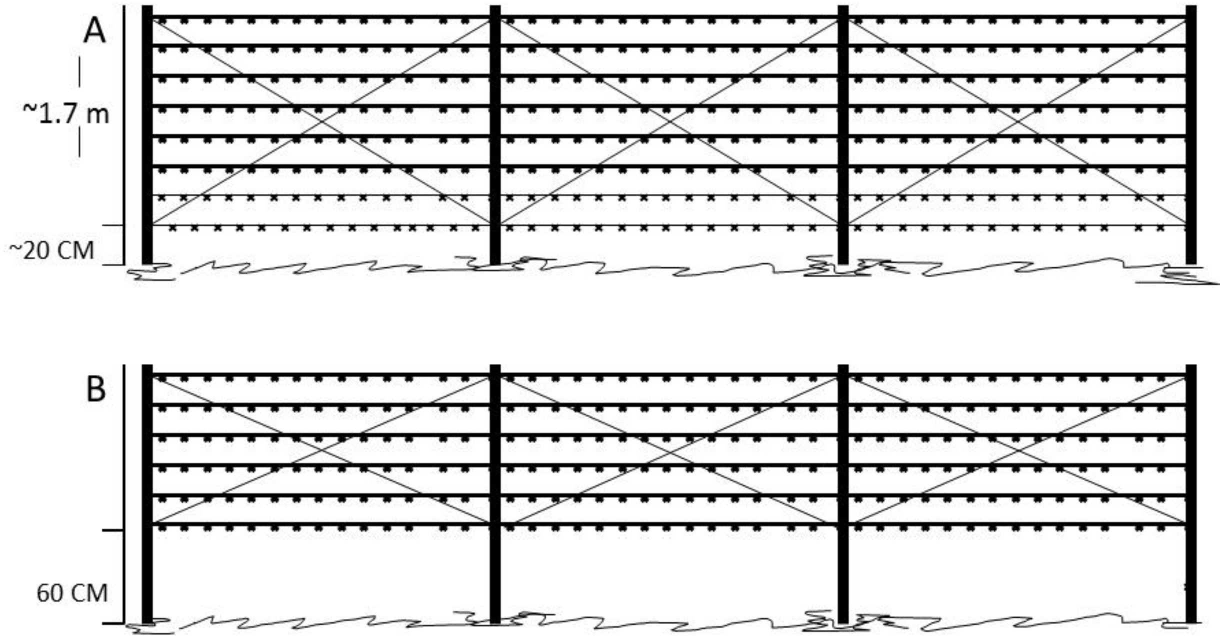
Alternative option #1:

- Remove the lower strand of barbed wire leaving a 40 cm gap. Injury caused by saiga scraping against the barbs can be eliminated by replacing the wire at 40 cm's with smooth strand wire, covering the barbed wire with plastic tubing (or some other material which can wrap around the wire to cover the barbs), or the barbs can be individually clipped off with wire cutters while the fence is being removed.

Alternative option #2:

- Incorporate gaps such as shown in figure 22B into the fence at one kilometer intervals. This leaves most of the original fence construction intact but creates spaces large enough for a saiga to pass through and small enough that would cause inconvenience for a motorcycle to be driven through.

Figure 28. Representation of current border fence design (A), and a modified version with the lowest two strands removed (B).



Railroad corridors in saiga range

71 Prior to discussing mitigation of the two railroad segments, it is important to point out that alignment options for the railroad (and other linear structures) that avoid being constructed through core saiga range (defined by the annual movements of GPS monitored individuals) is the best option. Mitigation and offset options should only be considered if there is no other possibility. The initial feasibility studies and planning make up approximately 2% of the total construction costs. Exploring alternatives at this stage of the railroad planning process would delay the project by 1-3 years. At a minimum the railroad is likely to be used for several decades and this additional up front cost and delay is insignificant and a worthwhile cost to ensure minimal impact to another valuable renewable resource for Kazakhstan.

72 A southern route connecting Zhezkazgan with Baikonur would avoid the majority of saiga habitat (Fig. 17). This route would require 67 less kilometers of new track. The construction of single track railroad costs between US $1-3 million/km (Bullpin Consulting). This alternative route would be between US $67 – 201 million cheaper to implement and only add an additional 3.9 hours of travel time for freight carriers passing through this route between China and Germany. This is <1% of the total travel time between China-Germany.

73 A more northern route between Shalkar and Beyneu would be preferable to the current proposed route (Fig. 29). This alternative route would add approximately 2

hours of transit time between Shalkar and Beyneu in comparison to the planned route. There would also be potentially less new track required, translating to a savings of millions of dollars. Trains destined for the port of Aktau would need to be transferred to a ship capable of transporting train cars or containers would need to be offloaded onto a container ship. The time to carry out these procedures likely dwarfs any additional transit time. Precedence to allow modifications to the original alignment has already been set in an attempt to accommodate the wishes of a local governor who was concerned over the social impact of railroad route passing through a village near Beyneu (thus the reason for the circular deviation in the southern end of the planned route).

74 Embankments along the majority of rail corridors will likely not be tall enough to physically alter saiga movements. To mitigate the possibility that saiga are not able to cross high embankments, a total of 66 at-grade saiga crossings are to be built along the Zhezkagan-Saksaulskiy segment and 20 along the Shalkar-Beyneu segment. This design resembles an at-grade vehicle crossing but modified for the needs of saiga and will not be for vehicle traffic. The expected dimensions are 50 meters in width and a 1:10 slope ratio (Fig. 30). The use of wide earth embankments is a novel concept that should be relatively inexpensive to install and monitor. The frequency of such structures can be determined from GPS relocation data as well as through an inspection of the proposed embankments heights to determine if there are locations which may benefit from such a structure.

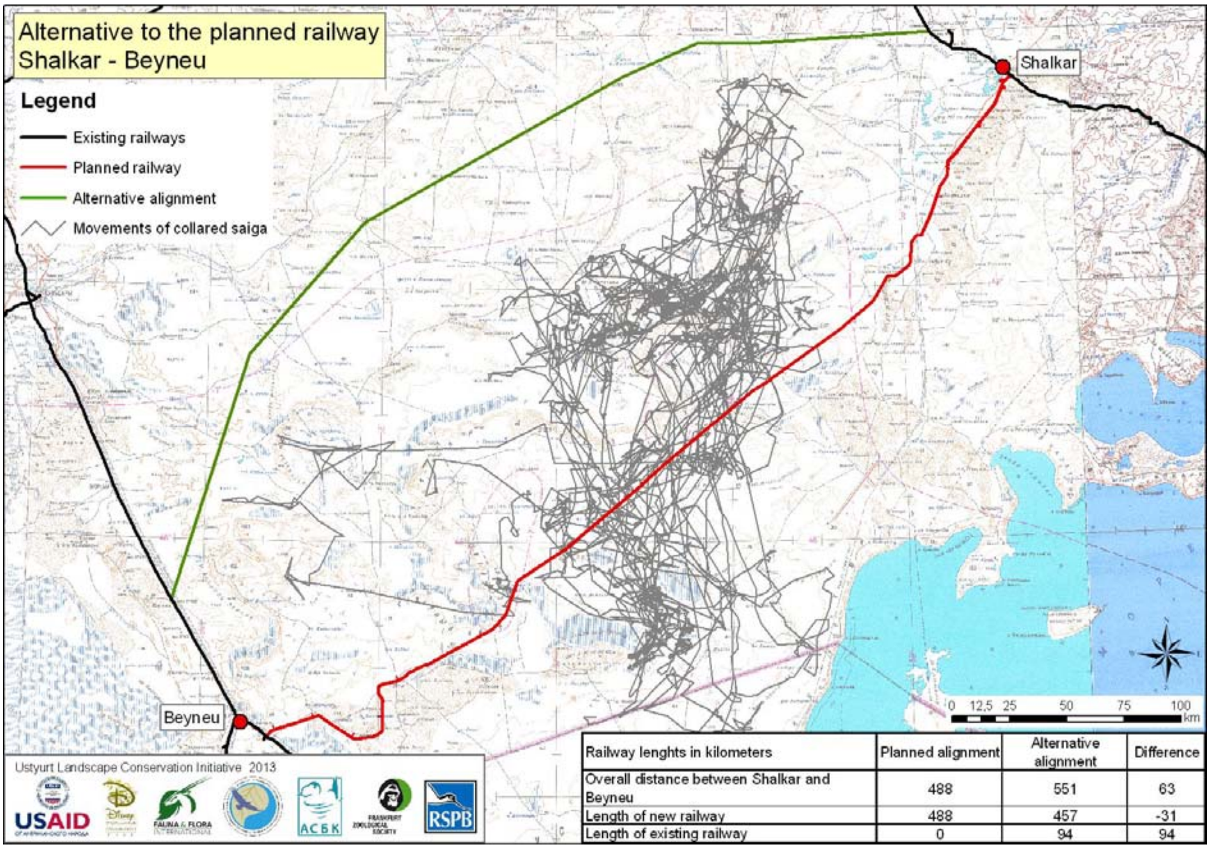
75 If saiga are more likely to use such crossing structures, this would prevent occurrences of saiga approaching the RR at the terminal ends of crossings' locations and turning and walking along the tracks away from the last crossing. Selection of specific locations should be based on a site visit along both proposed corridors or consultation with construction engineers to determine the height of the embankment along the rail corridor and identify segments that will have long and high embankments that would be problematic for saiga (>1.0 meters, but there is no data to support this height selection) and where embankments are likely to be minimal (flat terrain).

76 A number of railroad stations are planned along the railroad corridors. These stations are meant to offer convenient locations to carry out general monitoring and maintenance of the railroad. It appears that employees and their families are to be relocated to these settlements. This would create numerous additional disturbances that would be harmful to saiga. Traffic to and from the stations would increase, creating additional vehicle disturbance. Dogs and livestock are likely to be brought to the settlements. Temptation to hunt saiga would also be present.

77 Primary option:

- Construct an alternative to the Zhezkazgan-Saksaulskiy corridor along a more southern route, creating a Zhezkazgan-Baikonur corridor which avoids core saiga range identified from GPS collared saiga (see 13.4 in MTIWP).
- Reroute the Shalkar-Beyneu corridor further north to avoid core saiga range which has been identified from GPS relocation data from collared saiga (see 12.8 in MTIWP).

Figure 29. Alternative route between Shalkar-Beyneu (green).



Alternative option #1:

- Obtain profile maps of the Zhezkazgan-Saksaulskiy segment and work with the construction team to determine optimal locations for the 66 proposed saiga crossing embankments that have been agreed to.
- Obtain profile maps of the Shalkar-Beyneu segment and work with the construction team to determine optimal locations for the 20 saiga crossing embankments planned for this segment.
- Place railroad livestock guards at the edges of the embankments to prevent saiga or other animals from wandering onto the railroad (Fig. 31).

- Limit additional railroad employee housing to existing settlements only to minimize disturbance associated with the railroad (for example the planned "Премежуточная" and "Тассай" stations).
- Offset the disturbance created by the railroad by developing a mechanism to incorporate a 'saiga conservation' fee that is assessed to each container travelling through saiga habitat. The revenue generated could be used to enhance anti-poaching measures, conservation education, or research and monitoring programs.

Alternative option to eliminating railroad stations.

- Limit activity around new railroad settlements not associated with railroad related activities to within 5 km by putting up animal tight fencing around the perimeter of the settlement. This would prevent dogs and any livestock from wandering and chasing or coming into contact with saiga.

Figure 30. Earth embankment diagram to be constructed along railroads within saiga range.

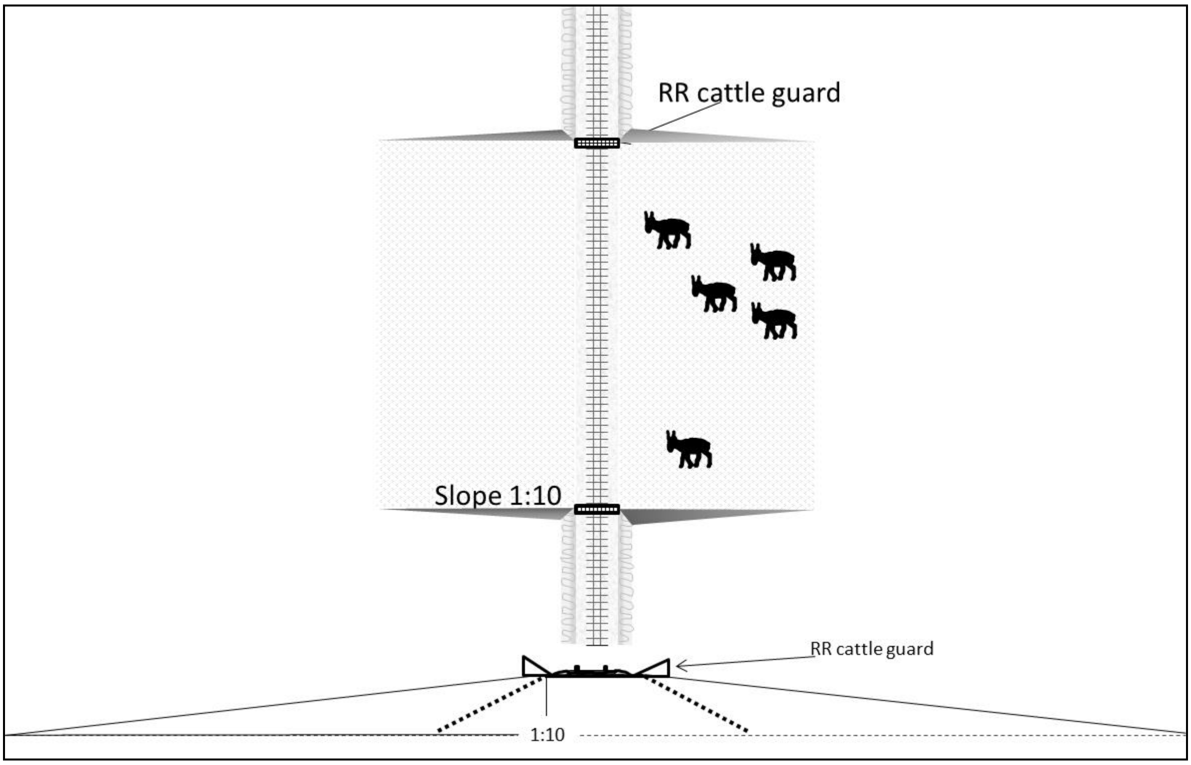


Figure 31. A railroad cattle guard prevents animals from walking on the tracks which reduces train strikes.

Saiga habitat conservation

78 It is unrealistic to create reserves large enough to encompass the habitat needs for a saiga throughout the year and throughout its lifetime. Strengthening the conservation status of all saiga habitat by advocating for additional land use policies that focus on limiting development and maintaining habitat connectivity will provide access between existing and planned reserves and will ensure important habitat outside of the reserve system remains suitable for saiga. These policies would guide development projects and land use guidelines and ensure a degree of openness is maintained throughout saiga range.

79 Primary option:

- Establish a working group to develop policy recommendations to identify problem areas along existing infrastructure and restrict additional development within known saiga range to maintain habitat connectivity (see 6.1, 6.5 in MTIWP).
- Establish official former and current saiga habitat and range boundaries for the purpose of developing a comprehensive saiga habitat management strategy outside of traditional static protected area reserve model. This could include core saiga range and movement corridors for all saiga populations based on relocation data from marked animals (see 7.1, 7.2, 13.4 in MTIWP).

Alternative option #1:

- Identify habitats that are important outside of the calving and breeding periods and establish reserves that encompass these habitats.

Stakeholder engagement

80 The mitigation phase of any project that will affect wildlife must begin at the project's inception, particularly when projects have layers that include multiple government stakeholders, large multinational companies, and development corporations. Years of planning go into large development projects and involve tens or hundreds of millions or even billions of dollars. It is difficult to incorporate additional concerns and options once planning discussions have finished. Advocates for biodiversity conservation must find a way to participate in the conversation from the beginning and stay involved to the end. It is likely that individuals charged with implementation of large development projects are unaware of the issues regarding biodiversity and do not consider the possibility of engaging in early discussions on such a topic.

81 The conservation community cannot operate in a vacuum and expect development oriented stakeholders to seek their opinion. It is the job of the conservation biologist to bring these issues to their discussion table and provide the necessary information on available mitigation measures.

82 The initiative to construct new rail corridors is led by governments typically to facilitate trade and increases taxable revenue. However private companies also benefit financially from lower transport costs. Many of these companies issue corporate responsibility statements regarding their environmental position and may support conservation projects that have a focus on the areas in which they do business. Many logistics companies thrive on efficient connections and should be able to understand the importance of connectivity for a migratory species.

83 Options:

- Work with the Ministry of Environment Protection on development of a stakeholder engagement strategy (see 12.8 in MTIWP).
- Identify key departments within the Ministry of Transportation and Communication and the National Center for Transport and Logistics that are willing and capable of having discussions at reasonable intervals regarding upcoming development needs with the goal of introducing concerns for biodiversity at the initiation of new projects rather than at the end.
- Liaison with country offices of multinational development banks (ex. Asian Development Bank, World Bank, Islamic Development Bank, European Bank

for Reconstruction and Development) as well as with appropriate members of the United Nations Development Program so that the concerns are known and options for mitigation can be incorporated into budgeting.

- Hold regular discussions with the appropriate staff members of government development agencies, so that they are aware of any potential negative impacts to biodiversity their programs may have.
- Engage private stakeholders with the purpose of informing them of potential impacts of habitat fragmentation on saiga antelope. This may be a way to generate support for alternatives that could lead to changes in rail corridor alignment or mitigation actions along saiga habitat impacted by any major transport corridor that exists within saiga range. Such a list might include but not be limited to the following corporate partners that rely on rail travel through Kazakhstan:

Maersk	TABLOGIX	Toyota
Panalpina	DB Schenker	DP World
LG	RZHD Logistics	Kuehne+Nagel
UPS	SinoTrans	Pantos Logistics
GM Korea	Cosco	Hyundai
DPD	Hanjin	InterRail Holding
Itella	DHL	
TNT	Samsung	

List source: Kazakhstan Temir Zholy. 2012. The development of transport logistics system of the Republic of Kazakhstan. PPT presentation. Astana, Kazakhstan.

Monitoring

84 Monitoring is an important activity for any species or ecosystem based conservation initiative. The information obtained is critical to being able to understand and develop a response to observed changes. Monitoring provides the field presence and expertise necessary to achieve credibility for promoting conservation positions.

Options:

- Monitor saiga movements using GPS tracking technology to determine how much of a barrier the border fence is for saiga migration.

- Evaluate the need for additional modifications to the border fence from tracking studies and fence surveys (see 8.2, 8.3 in MTIWP).
- Develop a data collection protocol for train conductors to record observations of saiga (species, time & date, GPS location, track side, group size estimate) and other species of interest along all active rail corridors within saiga range (see 8.3 in MTIWP).
- Investigate causes for separation of the existing 3 saiga populations within Kazakhstan and develop a mitigation strategy for restoring connectivity between them (see 13.1 in MTIWP).

Section 6. Conclusion

85 Across the globe, wild rangelands and the populations of large ungulates which depend on them are in danger of disappearing. Grassland ecosystems are being modified and fragmented to such an extent that the occurrence of natural processes that are necessary for healthy grassland diversity is lost (MacDougall *et al*. 2013). The degradation and diminishment of wild rangelands and ungulate populations from modern infrastructure development and improvement of transport corridors can be avoided with forward thinking and careful planning. The development of many Central Asian countries is progressing rapidly due to expanding overland trade between China and Europe and the discovery of major mineral, oil, and natural gas deposits. The region is also one of the last remaining places on earth where large terrestrial migrations are still intact and their needs must be considered in the region's development.

86 Engagement with industry and government agencies outside of the traditional environmental sector in positive and informative discussions will help with inclusion of the topic of impacts on biodiversity conservation and measures that can be taken into future discussions. Many of the development initiatives in this report are already underway and the opportunity to implement proposed alternatives is severely limited. At this point in time, someone with broad vision for the development of Kazakhstan will be required to step up and exhibit the political will necessary to carry out responsible development.

87 Major transport corridors will likely be in use for centuries. Wildlife agencies, NGO's and individuals concerned with the long term existence of saiga are also working hard to ensure saiga can survive as long as and longer than the functional life of these developments. It is not only up to those charged with the responsible management and conservation of saiga but also the responsibility of those involved with the development of Kazakhstan to ensure this. There have been a number of discussions and institutions created to help achieve this for Kazakhstan and around the world (UNEP Green Economy, Green Bridge in Central Asia, CMS, The Convention on Biodiversity). These efforts must rise to the occasion and demand participation in the development discussion and not be satisfied to remain at the fringes.

88 Forward progress can only be achieved when it is no longer acceptable to develop using a zero sum model and accept that development projects must only proceed if there can be a guarantee that wildlife and wild landscapes will remain healthy and intact. The future of the saiga as an iconic symbol of endless and intact steppe will

be decided in the coming decade. Will they be included in Kazakhstan's future or will they be left behind?

Appendices

Appendix A: Literature cited

Amos P. 2009. Freight transport for development toolkit: rail freight. Transport Research Support, The World Bank.

Arizona Game and Fish Department. 2011. Wildlife Compatible Fencing. Arizona Game and Fish Department. Phoenix Arizona. http://www.azgfd.gov/w_c/documents/110125_AGFD_fencing_guidelines.pdf Accessed on 8 January 2013.

Association of American Railroads. 2007. National rail freight infrastructure capacity and investment study. Cambridge Systematics Inc. Cambridge MA, USA.http://www.camsys.com/index.htm

Bekenov AB, Grachev IUA., Milner-Gulland EJ. 1998. The ecology and management of saiga antelope in Kazakhstan. Mammal Review, 28:1-52.

Ben-Shahar R. 1993. Does fencing reduce the carrying capacity for populations of large herbivores? Journal of Tropical Ecology, 9:249-253.

Berger J. 2004. The last mile: how to sustain long-distance migration in mammals. Conservation Biology, 18:320–331.

Bhattacharya M, Primack RB, &Gerwein J. 2003. Restoring habitat permeability to roaded landscapes with isometrically-scaled wildlife crossings. Biological Conservation, 141:482-488.

Bissonette, J.A., & Adair, W. 2008. Restoring habitat permeability to roaded landscapes with isometrically-scaled wildlife crossings. Biological Conservation, 141:482-488.

Boone RB, & Hobbs NT. 2004. Lines around fragments: effects of fencing on large herbivores. African Journal of Range and Forest Science, 21:147-158.

Boone RB, Lackett JM, Galvin KA, Ojima DS, and Tucker CJ. 2007. Links and broken chains: evidence of human-caused changes in land cover in remotely sensed images. Environmental Science & Policy 10:135-149.

Economic Commission for Europe, Economic and Social Commission for Asia and the Pacific. 2008. Joint Study on developing Euro-Asia transport linkages. Prepared under the United Nations Development Account Project on "Capacity Building Through Cooperation in Developing Land and Land-Sea Interregional Transport Linkages". United Nations New York& Geneva, 218 pp.

Dorsey BP. 2011. Factors affecting bear and ungulate mortalities along the Canadian Pacific Railroad through Banff and Yoho national parks.Master'sThesis.Montana State University, Bozeman Mt.

Ee Khong Kie M. and Akhmet S. 2009. Kazakhstan: Trade facilitation and logistics development strategy report. Asian Development Bank, Mandaluyang City, Phillipines.

Forman RTT, and Alexander LE. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics, 29:207-231.

Fox JL, Dondhup K, &Dorji T. 2009. Tibetan antelope Pantholopshodgsonii conservation and new rangeland management policies in the western Chang Tang Nature Reserve, Tibet: is fencing creating an impasse? Oryx, 43:183-190.

Frank DA,McNaughton SJ, Tracy BF. 1998. The ecology of the Earth's grazing ecosystems. BioScience, 48:513-521.

Grachev YA. 2012. The results of the 2012 saiga aerial surveys in Kazakhstan. Saiga News, 15:3.

Greenberg I. 2006. "Kazakhstan: Fence For Part Of Uzbek Border". New York Times, October 20. <http://query.nytimes.com/gst/fullpage.html?res=9C05E3DD163FF933A15753C1A9609C8B63 > accessed: on 8 January 2013.

Harris G, Thirgood S, Hopcraft JGC, Cromsigt, JPGM, and Berger J. 2009. Global decline in aggregated migrations of large terrestrial mammals. Endangered Species Research, 7:55-76.

Harrington JL, and Connover MR. 2006. Characteristics of ungulate behavior and mortality associated with fencing. Wildlife Society Bulletin, 34:1295-1305.

Hart JV, Van Riper C, Mattson DJ, and Arundel TR. 2008. Effects of fenced transportation corridors on pronghorn movements at Petrified Forest National Park, Arizona.Pg 161-185. In: C. van Riper III and M. K. Sogge (eds). The Colorado Plateau III: Integrating research and resources management for effective conservation. University of Arizona Press, Tucson, Arizona. 393 pp. [Book Chapter]

Hayward MW, Kerley GIH. 2008. Fencing for conservation: Restriction of evolutionary potential or a riposte to threatening processes? Biological Conservation, 142:1-13.

Hobbs NT, Galvin KA, Stokes CJ, Lackett JM., Ash AJ., Boone RB, Reid RS, Thornton PK. 2008. Fragmentation of rangelands: Implication for humans, animals and landscapes. Global Environment Change, 18:776-785.

Ito TY, Miura N, Lhagvasuren B, Enkhbileg D, Takatsuki S, Tsunekawa A, and Jiang Z. 2005. Preliminary evidence of barrier effect of a railroad on the migration of Mongolian gazelles. Conservation Biology, 19:945–948.

Ito TY, Okada A, Buuveibaatar B, Lhagvasuren B, Takatsuki S, Tsunekawa A. 2008. A one-sided barrier effect of an international railroad on Mongolian gazelles. Journal of Wildlife Management, 72:940-943.

Ito TY, Lhagvasuren B, Tsunekawa A, Shinoda M, Takatsuki S, Buuveibaatar B, and ChimeddorjB. 2013. Fragmentation of the habitat of wild ungulates by anthropogenic barriers in Mongolia. PLoSONE 8(2): e56995. doi:10.1371/journal.pone.0056995

Jamestown Foundation. 2012. Borders hardening throughout Central Asia in anticipation of NATO Pullout. Eurasia Daily Monitor, Vol 9 Issue 96. http://www.unhcr.org/refworld/country,,THE_JF,,KAZ,,4fbdfdd62,0.html> accessed on 8 January 2013.

Kaczensky P, Kuehn R, Lhagvasuren B, Pietsch S, Yang W, and Walzer C. 2011. Connectivity of the Asiatic wild ass population in the Mongolian Gobi. Biological Conservation, 144:920-929.

Lea international ND. 2002. Report on wild ass crossing on Viramgam – Halvad corridor. Gujarat State Highways Project Phase IIb. A report prepared for: The Government of Gujarat, India. The World Bank. 68 pp.

MacDougall AS, McCann KS, Gellner G, Turkington R. 2013. Diversity loss with persistent human disturbance increases vulnerability to ecosystem collapse. Nature, 494:86-89.

Mallon DP. 2008. Saiga tatarica. In: IUCN 2012. IUCN Red List of Threatened Species.Version 2012.2.<www.iucnredlist.org>. Accessed on 08 January 2013.

Milner-Gulland EJ, Kholodova M, Bekenov A, Bukreeva O, Grachev Y, Amgalan L, and Lushchekina A. 2001. Dramatic declines in saiga antelope populations. Oryx, 35: 340–345.

Morrison JC, Sechrest W, Dinerstein E, Wilcove DS, Lamoreux JF. 2007. Persistence of large mammal faunas as indicators of global human impacts. Journal ofMammalogy 88:1363–1380.

Newmark WD. 2008. Isolation of Africa's protected areas. Frontiers in Ecology and Environment, 6:321-328.

Olson KA. 2012. Wildlife crossing options along existing and planned Mongolian railway corridors. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department, Washington, DC: World Bank.

Olsson M. Augustsson, E., Seiler, A., Widen, P., &Helldin, J-O. 2010. The barrier effect of twin tracked, non-fenced railroads in Sweden. Intra Eco Network Conference Abstract.

Ostlind E. 2011. The perilous journey of Wyoming's migrating pronghorn. High Country News, Dec 26 2011 issue.

Paige C. 2008. A landowner's guide to wildlife friendly fences. Landowner/Wildlife Resource Program, Montana Fish, Wildlife and Parks, Helena, MT. 44pp.

Pissot J. 2007. Trains, Grains, and Grizzly Bears: Reducing Wildlife Mortality on Railway Tracks in Banff National Park. In Proceedings of the 2007 International Conference on Ecology and Transportation, edited by C. Leroy Irwin, Debra Nelson, and K.P. McDermott. Raleigh, NC: Center for Transportation and the Environment, North Carolina State University, 2007. pp. 64-67.

Rea R, Childs KN, and Aitken DA. 2010. YouTube insights into moose-train interactions. Alces, 46:183-187.

Rodriguez A, Crema G, and Delibes M. 1996. Use of non-wildlife passages across a high speed railway by terrestrial vertebrates. Journal of Applied Ecology, 33:1527-1540.

Sawyer H, Kauffman MJ, Middleton AD, Morrison TA, Nielson RM, and Wyckoff TB. 2013. A framework for understanding semi-permeable barrier effects on migratory ungulates. Journal of Applied Ecology, 50:68-78.

Singh NJ, Grachev IA, Bekenov AB, Milner-Gulland EJ. 2010a. Saiga antelope calving site selection is increasingly driven by human disturbance. Biological Conservation, 143:1770-1779.

Singh NJ, Grachev IA, Bekenov AB, Milner-Gulland EJ. 2010b. Tracking greenery across a latitudinal gradient in central Asia: the migration of the saiga antelope. Biodiversity Research, 16:663-675.

Sokolov VE. 1974. Saiga tatarica. Mammalian Species, 38:1-4.

TemirbekovS, and Gintzburger G. 2012. Ustyurt Rangelands Kazakhstan. Mission Report to Fauna and Flora International. Cambridge, UK.

The World Factbook 2012. Washington, DC: Central Intelligence Agency, 2012. https://www.cia.gov/library/publications/the-world-factbook/index.html

Van Der Grift EA. 2001. The impact of railroads on wildlife. The Road RIPorter, 6:8-10.

Wells P, Woods JG, Bridgewater G, and Morrison H. 1999. Wildlife mortalities on railways: monitoring methods and mitigation strategies. Unpublished Report. Parks Canada, P.O. Box 350, Revelstoke, British Columbia, Canada.

Yang Q, and Xia L. 2008. Tibetan wildlife is getting used to the railway. Nature, 452:810-811.

Appendix B. List of individuals and organizations consulted.

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