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"Implementing wildlife-friendly measures in infrastructure planning and design in Mongolia"

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Photo credit: Kirk Olson

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1 Introduction[1]

Central Asia contains steppes and semi-deserts which constitute some of the largest expanses of unspoiled grasslands in the world and these support spectacular animal migrations. Many of the large mammal migrations remain and are essential for preserving the ecological integrity of the habitat. Interconnected steppe and desert ecosystems are critical for the long-distance movements and dispersal of Mongolian gazelle *Procapra gutturosa*, khulan *Equus hemionus*, argali sheep *Ovis ammon*, wild Bactrian camel *Camelus ferus*, black tailed gazelle *Gazella subgutturosa*. The conservation of migratory species and their habitats helps to safeguard the provision of essential ecosystem services, such as maintaining optimal foraging across a highly variable habitat resulting in increased carbon storage capacity of the grasslands, as well as cultural heritage values and economic benefits including sustainable tourism.

Roads, railways and other infrastructure pose a serious threat for migratory species, by blocking their access to important habitat. Movements of livestock and communities can also be significantly affected, which in turn have implications for the grassland ecology.

The negative effects of infrastructure on wildlife and ecological communities across Central Asia have become more apparent in the recent decade due to the rapid development of the mining and natural resource extraction sectors. Future plans are grand in scale and will traverse habitat which is currently the last refuge for many of Central Asia's greatest long distance migrants. The consequences of the presence of linear infrastructure for species such as the Mongolian gazelle are relatively well-known; due to the existence of long-standing obstacles to migration such as the Trans-Mongolian railway. There are a number of large-scale transcontinental infrastructure projects currently being planned and built, which have high potential to become barriers to the movements of wildlife and people. Without careful planning and mitigation these developments are likely to have negative consequences blocking the movement of wildlife and people, with wide-ranging impacts on species survival, habitat state and associated functions and values.

All the species of concern are listed on the appendices of the Convention on the Conservation of Migratory Species (CMS)[2] and covered by its Central Asian Mammals Initiative (CAMI). The CAMI is a platform aiming to enhance synergies in addressing common threats and facilitating coherent conservation efforts in this region. Furthermore, Resolutions 10.3 and 11.25 adopted by the CMS Parties recognize the need for maintaining and building trans-boundary ecological networks and removing obstacles hindering the migration of species. Building on and supporting existing mandates the 2014 CMS Conference of the Parties (COP) in Quito, Ecuador adopted Guidelines on Mitigating the Impact of Linear Infrastructure and Related Disturbance on Mammals in Central Asia. The Guidelines provide a review of existing national legal frameworks addressing the issue, as well as a set of recommendations for various infrastructure types, based on the best international practices.

The development and implementation of this set of international legal instruments benefited from a workshop addressing wildlife-friendly infrastructure in Central Asia, which was co-organised by the

[1] Technical workshop and official meeting presentations can be found here: http://www.cms.int/en/meeting/international-workshop-%E2%80%9Cimplementing-wildlife-friendly-measures-infrastructure-planning-and

[2] http://www.cms.int/

Mongolian Ministry for Green Development, the German Ministry for the Environment, the German Federal Agency for Nature Conservation and the CMS Secretariat (June 2013, Vilm, Germany). Solutions to solve past and actions required to avoid future problems created by linear infrastructure in Mongolia's Gobi-Steppe ecosystem were the focus of discussions. The participants adopted a Declaration of Intent with a list of recommended actions, which fed into several CMS decisions and capacity building activities.

Once again, backed by the support of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and the Ministry for Environment, Green Development, and Tourism of Mongolia and facilitated by the Secretariat for CMS with technical support from GIZ, WCS and the Mongolian Academy of Sciences a technical workshop and an official meeting representing international, local, and government interests on implementing wildlife-friendly measures in infrastructure planning and design in Mongolia were held in Ulaanbaatar, Mongolia between 25 and 28th August 2015. This document is a summary of the presentations and resulting discussions from these two important workshops. As a result of these workshops an Ulaanbaatar Action Plan was adopted (download via BfN and/or CMS websites:

http://www.cms.int/en/meeting/international-workshop-%E2%80%9Cimplementing-wildlife-friendly-measures-infrastructure-planning).

2 Understanding the problems and advancing solutions for maintaining habitat connectivity in Mongolia's Gobi-Steppe Ecosystem will have long term positive consequences for Mongolia

Change can be hard to accept and often resisted. However, with respect to development of roads and railroads in Mongolia change is inevitable and this will require adaptation by everyone in order to secure the future for the large migratory mammals which survive in the greatest diversity and numbers in the arid rangelands across temperate Asia. Discussions which advance knowledge of successful approaches and requirements for adaption to change, as well as the challenges arising from such changes are needed. The results of such discussions are likely to result in securing a more stable and positive outlook for migratory species in one of the world's largest grassland ecosystems.

Khulan, Mongolian gazelle, wild Bactrian camel, saiga antelope, black tailed gazelle are adapted to change. The change these species are best adapted to is the constant change in quality pasture they graze on due to the unpredictable snow and rainfall patterns which dictate the growth of and availability of these important vegetation resources. These long distance migrants are less adaptable to changes in the accessibility to these resources and past changes have had severe negative consequences in population distribution for some species. Correcting these past changes and using the lessons learned from them to avoid future conflict will be required so that Mongolia's wildlife (or natural) heritage will remain a part of its identity long into the future.

The timing for action is of essence as Mongolia's economy is fueled by the exploitation of a great wealth of mineral and carbon resources which exist throughout the country. In 2011 the governments of Germany and Mongolia entered into agreement on cooperation in the fields of raw materials, industry, and technology. Partly in response to the rapid and extensive construction of

roads and railroads facilitated by such resource exploitation, the government of Mongolia has recently approved policy standards which define general requirements for passage for wild animals along auto and railroads in steppe and Gobi regions. As a result of such measures, Mongolia is poised to be a global leader in how to effectively implement sustainable and green development strategies.

Photo credit: Thomas Mueller

3 Linear infrastructure will have impacts on wildlife movement in Mongolia but these can be minimized[3]

Good policy is driven by results derived from good science. The growing threat to biodiversity from linear infrastructure is increasingly well known around the world due to long-term monitoring, landscape scale research programs, and by studying the movements of populations and individuals. The recently adopted Central Asia Mammals Initiative[4], new CMS Infrastructure Guidelines[5], and recent adoption of the wildlife crossing standards by Mongolian government are examples of such policies derived from the results of good research.

3.1 Overview of the impact of barriers to Migration in Mongolia[6]

Many of the world's great land migrations have been lost. For example, bison *Bison bison* in the plains of North America once numbered in the tens of millions were reduced to near extinction by the end of the 19th century and today there are no free-ranging bison populations anywhere in the world. Additionally, saiga antelope from the steppes of Kazakhstan and surrounding regions, a Pleistocene era survivor, once counted several million strong and utilized as an important resource for local people and for use in traditional medicinal practices were reduced to as few as 30,000 individuals. Today the Mongolian gazelles are the most numerous gazelle species on earth, numbering approximately one million and nearly 97% surviving within Mongolia's borders. Khulan, once found all the way from the Middle East to NE Mongolia and Manchuria are now reduced to small relict groups contained by reserve boundaries, with the exception of the desert habitats of South and South West Mongolia which are now the species stronghold.

Already cleaved by the decades old Trans Mongolian railroad, development plans for the Gobi-Steppe Ecosystem threatens to fragment the remaining habitat into no less than 9 parcels. Without adequate planning and mitigation, this could result in the loss of long distance movement opportunities for khulan and Mongolian gazelle and potentially doom the species into ecological irrelevance. The use of GPS collars to study animal movements has been invaluable in shedding light on our understanding of how fragmenting the steppes will affect the movements of these two species. It is crucial that solutions are found before it is too late.

[3] The following summarizes presentations and discussions during the one day technical workshop.
[4] http://www.cms.int/en/document/central-asian-mammals-initiative
[5] http://www.cms.int/en/document/guidelines-mitigating-impact-linear-infrastructure-and-related-disturbance-mammals-centra-0
[6] Dr. B. Lhagvasuren: Institute of General and Experimental Biology, Mongolian Academy of Sciences

3.2 Understanding movement ecology: Implications for monitoring[7]

Movements of animals are the building blocks for biodiversity. Their movements results in the distribution of nutrients through their foraging behavior. They remove nutrients from one place through feeding and deposit them in others through defecation, urination, or their own death. They act as seed dispersants by consuming and dropping seeds in other regions, or through seeds hitching a ride on the bodies of mobile species. They trample and chisel the soil, allowing seeds to take hold and grow. Biodiversity cannot survive without such movements.

There are three general categories of animal movements, non-oriented, oriented, and spatial memory. Younger animals can learn from older animals and species which have been extinct in the wild and reintroduced can be taught to migrate again. Do Mongolian gazelles and khulan learn where to go? This is not clear yet from the data which is currently available. How animals navigate is an important question to answer. For example how a population responds to extreme weather events may depend on the spatial memory of older individuals in the groups. If mortality due to barrier effects of linear infrastructure and hunting mortality results in the loss of older individuals then migration routes may be lost.

Understanding of how resources which are important to the survival of individuals and populations are distributed helps us to understand how that species moves across the landscape and to better understand what solutions may be more effective in maintaining landscape permeability. Resources important to migrating ungulates exist along four gradients (amount, spatial configuration, temporal variation, availability). With respect to amount, they exist from many - few. How the resources are spatial configured may vary from close to spread out. The temporal variation of the resources may also vary between years. Finally resource availability may be seasonally predictable from abundant during a growing season to sparse during a non-growing season.

With the availability of fewer resources, animals are stimulated to move more frequently and greater distances. Population distribution and a populations movement patterns can be predicted based on the temporal and spatial predictability of resources important for survival. An animal's movement response to resource distribution also varies. Range residents survive in regions with predictable resource distribution. Migration occurs when populations migrate to and from known regions which resources may vary seasonally but are predictable in their distribution. Finally nomadism arises when resources are unpredictable both in spatial and temporal scales. The Gobi-Steppe Ecosystem is an example of an ecosystem with little resources compared to other temperate or tropical grassland systems. Khulan and gazelle move across considerable distances in response to the unpredictability of the resources distribute across their range. Barriers which impede such movements can have serious consequences for these populations if they are unable to reach suitable habitat and gain access to adequate nutrition. Improving our understanding of animal movements in response to resource distribution as well as our knowledge of planned developments will help to better advise how to proceed with conservation and management efforts. We still don't know what khulan and Mongolian gazelles long term reproductive response to barriers is. Improved

[7] Dr. T. Mueller, Senckenberg Biodiversity and Climate Research Centre, and Goethe University, Frankfurt, Germany.

animal movement forecasting will help us model how animals may respond to future development scenarios. How climate change will affect animal movements in the future is also an important component of study for the future.

3.3 Pre and post-construction monitoring of khulan movements in the Mongolian Gobi[8]

Pre-construction monitoring of species is critical for sound management of developments in order to minimize their effects on biodiversity. This helps to establish an accurate baseline for which to measure the effectiveness of development and biodiversity policies such as 'No Net Loss' and 'Net Positive Impact'[9]. Pre-construction monitoring also provides a clear benchmark which can trigger mitigation and offset activities. It is also important to be aware of when the monitoring was started to avoid a shifting baseline scenario which may prevent the revealing of the full impacts of a particular development.

In pre-construction monitoring for Mongolia's wild equids occurring in the Gobi desert it is important to understand the difference between the two species social organization. Khulan are a long distance nomadic species while Takhi are range residents. Khulan can go several days without water while Takhi must drink water on a daily basis.

We need to understand the system in which the two species are adapted to. What are the historical ranges and current ranges and can historical accounts provide adequate preconstruction baseline data? This helps to understand where impacts likely to occur? At what spatial scale will these impacts occur? What population comparisons can be made to better understand how development may be affecting biodiversity?

Knowledge of environmental stochasticity is necessary to avoid drawing conclusions to early, especially in habitats where extreme events are known to occur. Lastly, avoiding correlation traps is important- correlation does not mean causation and being able to find true cause of a change in monitoring conditions is critical for application of useful follow up mitigation and offset activities.

For the khulan which survive in Mongolia, the development of world class mineral and carbon deposits in the Gobi desert have high potential to affect the population in negative ways. Pre and post construction monitoring is being implemented in the region. Population surveys conducted during the mid-90's varied widely between 33,000 - 63,000 individuals. A 2013 air survey in the SE Gobi Oyu Tolgoi project area resulted in an estimate of approximately 33,000 khulan. Unfortunately the survey areas did not overlap and direct comparisons are difficult. This highlights the importance of suitable research design so that questions related to population trends can be answered with an accepted degree of certainty.

[8] Dr. P. Kaczensky, Research Institute of Wildlife Ecology, University of Veterinary Medicine, Vienna, Austria.
[9] http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/performance+standards/environmental+and+social+performance+standards+and+guidance+notes

Genetics and movements have been examined in the khulan population resulting in a better understanding of how the population may be affected by existing barriers. Monitoring of GPS collared individuals suggest that there may be 3 distinct regions (Dzungarian Gobi, Translaltai Gobi, and SE Gobi) which khulan range. Results from molecular analyses suggest that although the khulan populations are fragmented, this has yet to affect genetic differentiation which would result from a lack of exchange of breeding individuals between populations. Khulan movements have experienced a shift in their range, but often historical range accounts do not describe where survey teams did not go so that search effort can be taken into account in determining historic distributions. So far, khulan movements in and around the Oyu Tolgoi project area show little difference in movements between pre-and post construction monitoring, khulan remain a wide ranging animal.

There is still little known about reproduction and mortality of khulan in the project area. Currently there are many smaller development projects which do not receive the intense scrutiny of some large scale projects and the cumulative effects of multiple projects are also poorly understood. There is also little which can be done to understand these multiplier effects without more broad and encompassing monitoring efforts.

3.4 The movements of Mongolian gazelle in the eastern steppe, Mongolia[10]

Mongolian gazelles are affected by different environmental drivers than khulan. Khulan movements are highly correlated with the distribution of available water sources while Mongolian gazelles are tracking changes in vegetation productivity and largely released from water availability. Individual Mongolian gazelles are known to range up to 32,000 km's square each year. The structure of the landscape across an individuals and a populations range is an important topic of study to understand the nature and the importance of such wide ranging movements. A key question to answer is what is driving the Mongolian gazelle's nomadic movement patterns?

Precipitation events across the Gobi-Steppe Ecosystem occur either as rain or snowfall events. The spatial and temporal variation surround such events influence the quality and quantity of vegetation growth. This in turn affects habitat suitability and where Mongolian gazelles are or are not likely to occur. This vegetation growth can be tracked using satellite based sensors to map their distribution over large scales. This is an efficient way to understand the spatial temporal dynamics of this vegetation distribution.

Throughout the year Mongolian gazelles move widely, with the exception of a brief period of time centered on the timing of the breeding season and the timing of the calving, separated by 6 months. All other times, gazelles are in motion in search of quality forage.

What will be the barrier effects of long linear transportation corridor developments throughout the range of Mongolian gazelles? Long term monitoring of more than 50 Mongolian gazelles since 2007 has illuminated some of the patterns which can be explained by vegetation dynamics. Fencing along the Russian and Chinese borders has remained a solid barrier throughout the period of monitoring. A

[10] D. Nandintsetseg: Senckenberg Biodiversity and Climate Research Centre, and Goethe University, Frankfurt, Germany.

single gazelle has successfully managed to cross the Trans-Mongolian fence, doing so at an at-grade crossing maintained for vehicle traffic. Increasing intensity of an oil field in the South East region of Mongolian gazelle range may have reached a point where this activity has become a barrier for Mongolian gazelles attempting to access some of the far eastern regions of their range.

3.5 Assessment of population abundance and factors influencing distribution of ungulates in Southern Gobi[11]

Between 2012 and 2015, vehicle based surveys have been incorporated for monitoring of abundance and distribution of khulan and black-tailed gazelle in the South Gobi, specifically within the 98,000 square kilometer Oyu Tolgoi project area. The region has experienced rapid developments over the past few years and this has concerned some that portions of the khulan and black tailed gazelle populations which occur there are being negatively affected. Such monitoring can help to provide a baseline for future planning and assessment of various mitigation and offsetting opportunities.

Population estimates of khulan and black-tailed gazelle during spring 2015 were ~36,000 and ~33,000, but due the wide variation in confidence intervals surrounding the point estimate, estimates of short term trends in population dynamics cannot be assessed. However, assessing how habitat characteristics and human disturbance influence khulan and black tailed gazelle habitat use can still be carried out. Disturbance variables (roads, mine sites) had greater influence on habitat utilization than habitat characteristics (vegetation growth, habitat type, water etc.) did. This indicates that human disturbance across the Gobi region is displacing wild ungulates from utilizing better quality habitat which may be affecting survival and reproductive success and having a negative effect on these populations.

3.6 Modelling wildlife movement and barriers[12]

Ecosystem modeling is an important tool which ecologists and conservationists can use to rapidly understand how anthropogenic disturbance may affect natural systems. Without modeling, such information may either not be possible to acquire or may require lengthy and expensive studies which may not be feasible. Connectivity conservation is the protection of known migratory routes or the restoration or mitigation of known barriers. The use of movement data still remains the best way to understand animal movements and corridors. However connectivity models can still be utilized in absence of such data. Connectivity modeling scenarios for the Gobi Ecosystem are being tested by The Nature Conservancy to better inform landscape managers of what options can be incorporated into planning and decision making.

One tool frequently employed by ecosystem modelers to understand connectivity is the use of Least-Cost Path (LCP) analysis. This requires that all habitat patches are assigned a value based on an assigned 'cost' of traversing it. An LCP is calculated and mapped based on the lowest score of all

[11] B. Buuveibaatar: Wildlife Conservation Society, Mongolia Program, Ulaanbaatar Mongolia; Dept of Environmental Conservation, UMass Amherst, USA.
[12] M. Heiner: The Nature Conservancy, Boulder Colorado, USA.

potential movement options. LCP might be employed to determine the most optimal movement corridor for example. However, LCP is sensitive to differences in data and only a single route can be identified. LCP assumes an animal has perfect knowledge of the landscape it survives in.

Another and increasingly popular analysis is the use of circuit theory to identify areas where movement is most constrained an optimal location for mitigation or development avoidance. Circuit theory assumes a random walk behavior amongst individuals and animals have no prior knowledge of the ecosystem.

A hybrid analysis is the best option for modeling landscape connectivity and for conservation applications. This would allow for the identification of the best corridor as well as where movements may be constrained.

3.7 Understanding road ecology - Kazakhstan and Mongolia case studies[13]

Comparative examples from around the world can be useful in decision making, especially when the ecosystem under consideration is poorly understood. Many examples can be found in the literature. A newly published book titled 'A Handbook of Road Ecology'[14] contains numerous examples and guidelines intended for conservation practitioners, transport engineers, and those tasked with assessing environmental impacts of new transportation developments. Kazakhstan and Mongolia case studies are highlighted in this publication.

Central Asia is a major corridor linking population centers in Europe and Southeast Asia. The nation of Kazakhstan has the world's 9th largest landmass and contains 18 million people. Mongolia has the world's 19th largest territory and only 3 million inhabitants. The region is relatively sparsely inhabitated which is beneficial for a number of large highly mobile species. These include the Khulan, Mongolian gazelle, black-tailed gazelle, wild Bactrian camel, argali sheep, and other CAMI represented species. Many of these species have experienced alarming reductions in their range and are of high conservation priority. Fragmentation of habitat due to rail and road corridors built to facilitate the global marketplace is one such reason for this reduction in range.

Often, when it comes to large transportation projects, conservation concerns and identification of conservation actions are implemented last, have limited budget, and short in time. This prevents many conservation efforts from being effective and often results in wasted resources and frustration as well as a slip in conservation status of species being affected. Large development organizations and multinational cooperation agreements implemented to facilitate trade need to be better engaged for conservation efforts at regional scale to be effective. Multinational lending institutions all have environmental performance standards which must be adhered to. Unfortunately, there are many vagaries in such standards which can be exploited.

[13] Dr. K. Olson, Wildlife Conservation Society, Mongolia Program.
[14] http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118568184.html

With respect to road development across Central Asia, the United Nations Economic and Social Commission for Asia and the Pacific (UNSCAP)[15] has played an important role in bringing nations together to plan and implement the Asian Highway Network. In planning since the late 1950's, its implementation has increased in pace since the early 1990's. Another organization involved with facilitation trade between Asia and Europe is the Central Asia Regional Economic Corridor program (CAREC)[16] and includes landlocked countries in Central Asia and Russia and China. CAREC has identified 6 major corridors across these regions and brings respective governments together to plan new and improve existing corridors. Incorporating the conservation issues surrounding the barrier effects created by these corridors into CAREC's planning would be important for future conservation success.

Unintended consequences created through geopolitics can also affect the conservation status of migratory species. The creation of the Eurasian Customs Union was intended to be an economic answer to the European Union and provide economic opportunities for former Soviet Nations. However, not all nations eligible to participate in the customs union have equal sentiment about re-creating an economic version of the former Soviet Union and have declined to enter into the union. As a result, member states are taking steps to secure their borders to prevent smuggling and to demonstrate national strength. One such example is the fencing of the Kazakhstan-Uzbekistan border near the Aral sea. This has resulted in the creation of a new barrier for the Ustyurt saiga population already affected by the construction of the Trans-Kazakhstan railroad.

Solutions to these barrier effects exist and can easily be incorporated into planning if there is will to do so. If there is no desire to engage constructively and actions continue without input there is likely to be a negative consequence. However, such planning can have minimal effect, or in some cases, a positive effect if stakeholders are willing to come together and discussion the issues and search for solutions. Kazakhstan has more often than not chosen an approach which does not incorporate conservation concerns and have limited opportunities to move forward with. Mongolia has taken steps to be inclusive and search for solutions prior to the implementation of regional transportation development plans and is setting a global example for how to develop for the future and secure its wild natural heritage as part of that future.

3.8 Solutions to mitigate impacts of roads on wildlife movements[17]

Although much of the focus on linear infrastructure in Mongolia is focused on large mammals, it needs to be remembered that large birds of prey and bustards also fall victim to fencing and electric wires. Also when it comes to finding solutions for improving permeability across barriers, it needs to be remembered that different species have different mobility needs and multiple solutions to the same barrier might need to be implemented. Solutions will need to follow standards and the standards which the Mongolian government has recently adopted are robust and contain a variety of solutions which if implemented correctly, will work for wildlife and maintain safety conditions for humans and livestock.

[15] http://www.unescap.org/
[16] http://www.carecprogram.org/
[17] Ts. Dashzeveg, Wildlife Conservation Society, Mongolia Program.

The Wildlife Conservation Society (WCS) has initiated a number of efforts to assist in finding solutions to the problems created by roads, railroads, fences, and electric power lines. WCS has sponsored several study tours to parts of North America where mitigation efforts have improved connectivity for a number of species of large mammals which are affected by roads and fences. This provided direct experience for many Mongolian biologists and transportation professionals in Mongolia as to the potential range of solutions could exist for Mongolian wildlife. WCS has also produced a public awareness video to help bring the issues migratory species are facing with barriers in Mongolia into the general discussion about Mongolia's development and to help establish support for new measures which are likely to be initially more costly, but ultimately better for Mongolia. WCS has also been an integral source of expertise in developing the newly adopted national standards for wildlife crossing structures in Mongolia. Finally WCS has encouraged and supported a joint ministerial working group between the Ministry of Environment and Green Development and Tourism and the Ministry of Roads and Transportation. This joint ministerial working group has fostered important dialogue and collaboration between the two ministries which will be invaluable in development of a wildlife friendly transportation network across Mongolia.

WCS has also begun developing the early stages of a potential pilot program along the Trans Mongolian Railroad to test the efficiency of fence redesign to allow gazelles and other medium and small mammals less restricted passage across the railroad but also to test fence removal in some remote areas known to be approached by khulan to test their ability to cross the railroad in absence of a fence. It is important that such pilot programs be implemented correctly in order to determine how to proceed with mitigation along the entire railway. Herding households living in the range of gazelles and khulan along the railroad were 80% in favor of efforts to redesign and remove fences if it meant that it would improve the outlook for Mongolian gazelles and khulan while still managing to protect their livestock. This would also potentially be an enormous cost saving measure for railway fence maintenance as it is estimated to cost approximately 10,890,000 MNT[18] annually to maintain.

3.9 Managing traffic: Implications for wildlife connectivity[19]

Understanding how traffic corridors affect vegetation and wildlife is important to development of effective and safe transportation networks. With respect to wildlife it is generally accepted that in absence of fencing and in absence of traffic, most wildlife will cross roads (this may not be true of smaller less mobile species). The volume of traffic along roads and railways has an important influence on the crossability of them. In North America traffic volumes greater than around 2,000 vehicles/day on roads becomes a serious limitation for the ability of wildlife to cross. Traffic volumes greater than 10,000 vehicles/day makes roadways a permanent barrier for wildlife. Traffic on roads is typical not constant throughout the day and often late night and early mornings even on busy corridors there may be little to no traffic, allowing opportunities for animals to cross. In Mongolia, it is not yet fully understood how species such as Mongolian gazelles and khulan respond to changes in traffic volume. If vehicles are associated with harassment through chasing or hunting then the barrier threshold may be lower. Understanding what a traffic corridors impacts are beyond the road

[18] 1 USD = 1,994 MnT

[19] Dr. P. McGowen, Western Transportation Institute, Montana State University, USA.

and vehicle volume is important- factors such as dust generation, noise, and fear need to be better examined.

Many transportation organizations collect standardized data on wildlife-vehicle collisions so that hotspots can be identified and mitigated as well as understanding barrier trends which may trigger finding a solution to a problem before it becomes serious. This also helps transportation engineers understand if mitigation efforts which have been installed are effective. Carcass location data is one such data which can be readily collected. Drivers can also be involved in such studies on a volunteer basis- allowing for more observations using citizen science concepts. Standardized forms can be developed to allow for recording of observations in a clear way.

Traffic management is also an important mitigation concept. The heavily used coal road between a coal mine in the Gobi and the Chinese border can be used as an example. The road is believed to have become a serious barrier to migrating wildlife due to the number of large coal trucks and the amount of dust generated from driving on dirt tracks. By building a railway, a single train can replace 100 trucks, which greatly reduces traffic volume. Products can be 'value added' prior to their transport. If 30% of waste can be reduced through processing coal either by washing it or coking it, then the number of trains/day can also be reduced. Vehicle cueing is also a concept which may be incorporated by creating time gaps between convoys of trucks. Also public awareness and education campaigns can help drivers understand the risk of increasing cost of transport by driving off of paved roads to avoid tolls thereby increasing wear on the truck and greater maintenance costs and increasing transport times due to break downs and slower travel. Throughout the entire process of searching for solutions, it is important to remember that monitoring is critical to determine what is or isn't working.

4 Pathways for development of wildlife friendly infrastructure can be found within Mongolia's current legal framework, international agreements, and experiences from international community[20, 21]

Development of infrastructure is occurring all across Central Asia which is a globally important region for large migratory mammals. Mongolia is home for many of the species which there is increasing concern over. The fast pace of development associated with recently discovered deposits of natural resources is having an impact on the environment. Tackling these impacts will require joint efforts and collaborations amongst all parties concerned in order for the region to develop along a sustainable path. Policies and mechanisms available for implementing wildlife friendly infrastructure planning and design in Mongolia are topics of great importance. Minimizing the threats imposed on migratory species by the development of transportation infrastructure requires the development of standards and regulations for wildlife friendly infrastructure designs.

Mongolia can proudly boast that much of the landscape within her borders remains intact and home to many species which are globally admired. Mongolia has a responsibility to offer opportunities to improve people's lives and increase their livelihood options improving transportation infrastructure is critical towards meeting this responsibility. Mongolia's natural resource wealth is an important financial resource available which can be used to support development initiatives. Access to markets is also an important driver of transportation infrastructure development. Germany and Mongolia have signed an agreement to cooperate in the natural resources, industry, and technology sectors. Roads and railroads are essential to this cooperation. As a result of this agreement, Germany shoulders some of the responsibility in ensuring that Mongolia develops in a manner which does not result in a decline in its wild natural heritage. The challenge which exists is how to exploit Mongolia's vast resource wealth while preserving the unique open landscape and large migratory ungulate populations which is an important part of how Mongolia is defined.

Germany also hosts the CMS secretariat and takes on additional obligations to ensure the success of CMS. Germany supported and hosted an initial meeting on the impacts of linear infrastructure on large mammals in Mongolia on the Island of Vilm in 2013 which the current technical workshop and official meeting build upon. Mongolia has the opportunity to become global leaders in how to develop a national infrastructure plan while considering the integrity of its landscapes and the populations of migratory and nomadic species which survive there.

The CMS is one of the oldest international environmental treaties in existence. Around the world CMS has been instrumental in assisting nations with finding solutions to migratory species which cross international boundaries. Solutions to the challenges which transportation related infrastructure poses to migratory ungulates in Mongolia and the rest of Central Asia are needed. These solutions do exist. The CMS is international law and is in place to help implement these solutions. The Central Asian Mammals Initiative (CAMI) was adopted in Quito, Ecuador with

[20] The following summarizes presentations and discussions during the two day official workshop.

[21] A summary of opening remarks by Mr. Tsengel, State Secretary of the Mongolian Ministry of Environment and Green Development, and Tourism; Mr. C. Glass, Diplomat, Federal Republic of Germany; Mrs. E. Nickel, Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Federal Republic of Germany; Mr. B. Lenten, Deputy Executive Secretary, UNEP/CMS.

resolution 11.24 at the COP 11 meeting and represents a framework to work within to find and adopt the solutions necessary. Additionally, also adopted during the COP 11 meeting were "Guidelines on Mitigating the Impact of Linear Infrastructure and Related Disturbance on Mammals in Central Asia". Mongolia has also adopted its own national standards and policies which closely follow these international standards. Political will is now necessary to move forward towards implementation of these laws.

4.1 Current environmental legal and policy framework in Mongolia[22]

Mongolia already has a number of laws and policies in place which are designed to protect the environment and wildlife. There is an Environmental Protection Law, a Wildlife Protection Law, a Land Use Law, and an Environmental Impact Assessment Law. Mongolia has adopted a National policy to implement ecologically orientated development strategy between 2010-2020. A green development policy was adopted in 2014 and is intended to reduce waste, limit Mongolia's greenhouse gas emissions, improve air quality, and help to reduce poverty levels in Mongolia. Mongolia has laws designed to protect rare and endangered species from further decline. Some of Mongolia's laws are also specifically intended to protect the movements of wildlife, for example law 6.1.3: is Mongolia's law on protection of migratory species. As of 2014 Mongolia also has a National biodiversity conservation program (3.2.4) which is intended to protect the genetic and biodiversity resources which are found within Mongolia's borders. This law is also designed to extend to development of trans-boundary reserve opportunities. Mongolia expects that by 2018, all infrastructure development will comply with wildlife friendly policies intended to prevent the decline of biodiversity.

Not only does the Ministry of Environment, Green Development, and Tourism (MEGDT) play a role in protection of Mongolia's environment, but policies adopted by the Ministry of Roads and Transport can also have positive influence. Speed related amendments, traffic curfew policies, and convoying traffic are examples of such policies. Interministerial working groups are also important to building good policies for Mongolia's wildlife. Mongolia's national standards for wildlife friendly infrastructure were developed through the cooperation of the two ministries under the interministerial working group framework. Improvement on such working groups can be possible by requiring periodic performance evaluations of working groups. Funding for implementation of such policies will be required and it is acknowledged that Mongolia will struggle to do so but they must do this and it is possible that support from lending institutions could be extended to achieve this.

4.2 Experiences and lessons from Germany[23]

Germany has extensive experience with addressing habitat fragmentation issues due to infrastructure development. Germany and Mongolia present two very contrasting case studies but lessons can still crossover. Mongolia is in an excellent position to take successful examples from other countries and adopt them as their own as Mongolia still has a relatively clean slate to start

[22] Mr. A, Bayasaglan, Mongolian Ministry of Environment, Green Development, and Tourism.
[23] Mr. R. Grunewald, Federal Agency for Nature Conservation, Germany.

from. Germany develops its road network following a federal road plan which is developed based on current and future priorities and needs assessments. The approval procedure is lengthy and intended to avoid negative consequences of implementing plans in haste. Environmental assessments are first conducted at a large scale starting with strategic environmental assessments. Segments of development then are subjected to environmental impact assessments followed by issues specific assessment and mitigation of these issues. The effort is interdisciplinary and designed to address problems as early on in the project design as possible.

Complimenting Germany's road development plan is Germany's Federal Defragmentation Program[24] which is intended to develop ecological corridors to increase mobility of biodiversity in Germany and to reduce the effects of habitat fragmentation. Mitigation of existing roads to include wildlife over and underpasses which are tailored to the specific habitat and at times to specific species is an important activity under this program. The passageways are intended an designed for species as large as roe deer and wild boar and as small as reptiles, amphibians, and insects.

4.3 Incorporating Mongolia's new policies on wildlife friendly infrastructure poses challenges and will require greater communication between development and environmental interests[25]

Mongolia is implementing an ambitious plan to develop its national road and railroad network. Improvements to more than 12,000 km's of national road network continue to be made. This road network not only will connect Mongolian population centers but will also better connect Mongolia with trade networks across the region. Mongolia will also continue to expand its railroad network to include more than 4,000 km's of new rail routes connecting important mineral resources to ports which will allow access to markets around the world.

It is now known that roads and railroads can negatively impact the wildlife in the area by fragmenting habitat and through vehicle collisions. Standards for building wildlife crossing options at roads and railroads now exist and these need to be implemented in Mongolia. It will be very important for biologists to be involved in these plans as early as possible to avoid making mistakes. The wildlife crossing standards which were recently adopted by Mongolian government apply to desert and steppe ecosystems but not in forested and mountain ecosystems. It will be necessary to develop standards which are suitable for all of Mongolia's ecosystems and wild animals.

4.4 Case study: Implementing international standards for wildlife crossings on a mining road in the Gobi desert.[26]

CMS has been an important mechanism for protection migrating wildlife since 1983. Mongolia has joined the Bonn Convention in 1983. In Mongolia, some of the species of concern are: wild Bactrian camel, snow leopard, Mongolian gazelle, saiga antelope, khulan, black-tailed gazelle, and argali

[24] http://www.eea.europa.eu/soer/countries/de/nature-protection-and-biodiversity-national
[25] Mr. Gerelnyam, Ministry of Roads and Transport.
[26] Mr. Dorjsuren, EcoTrade.

sheep. There are a number of mining related transportation infrastructure developments being completed in Mongolia and the impact of these developments on wildlife need to be carefully considered especially for species which the Mongolian government considers to be rare and endangered. The road from Oyu Tolgoi to Gashuun Sukhait is a good example for how to build a road and ensure that minimal harm is done to wildlife. The road is a nearly 100km long and 8m wide road used by Oyu Tolgoi to haul copper and gold products to smelter factories across the border in China. There is also a 220KW power line linking OT project with power supply in China.

The road has been in use since 2002. Prior to it being paved the areas surrounding the roads were very dusty. The dust was affecting all flora and fauna, from plants and insects to large mammals. In the area where the road is constructed, there is concern that the movements of khulan and Mongolian gazelle may be blocked. The new paved road was built with low embankments in hopes that it would not be a barrier for khulan and gazelle. There are a number of bridges constructed along the road which it is hoped the many smaller species will use to cross the road. There is also a small portion of the road which passes through the B section of Small Gobi Strictly Protected Area.

A better understanding of animal movement and activity patterns is needed to fully understand how to include wildlife crossing structures or take measures such as implementing traffic curfews so that migrating animals are not blocked. Future road developments towards the east will raise concern for movements of Mongolian gazelles.

4.5 Case study: Construction of a railroad from Tavan Tolgoi to Gashuun Sukhait border crossing[27]

Construction of the first phase of Mongolia's new railroad plan is underway with a 225 kilometer long segment from Tavan Tolgoi coal complex to the Gashuun Sukhait border crossing to China. The Mongolian Railway Company is working closely with MEGDT to ensure that environmental issues are addressed in the best way possible. The region is habitat for khulan and gazelles and for that reason the railroad will not be fenced outside of the railroad stations and also the railroad is being raised at a number of points which will allow these animals to pass underneath. Also, there may be opportunities for building wildlife bridges in the future. Monitoring of animals with GPS collars is helping to understand this better. The railroad is planned to be completed by 2016. Currently in planning stage is the next segment which will connect Tavan Tolgoi with Sainshand and the TMR and continuing east towards Choibalsan. The prefeasibility study for a north south rail segment to Bichigt is also being undertaken.

The Ministry of Roads and Transport is responsible for planning these projects and the Ministry of Construction and Urban Development is responsible for implementation of construction. It is important that the Ministry of Construction and Urban Development be aware of the newly adopted wildlife standards so they can be incorporated into their works.

[27] Mr. Lkhagvasuren, Mongolian Ministry of Roads and Transport.

4.6 Case study: Mongolia's Western Regional Road Development project[28]

There are many internationally driven transport corridor development initiatives which are testing Mongolia's newly adopted and ever strengthening environmental protection laws. The Asian Development Bank (ADB) is providing the financial support for the development of a highway corridor in Western Mongolia as an extension of the 6,024 km long CAREC 4a corridor connecting Russia with Pakistan. This road passes through a number of environmentally and aesthetically sensitive regions. In order to comply with Mongolia's environmental laws, ADB is implementing a number of studies to assess suitable alignment locations and potential wildlife crossing structures. After conducting wildlife surveys, interviewing local people, assessing species range maps, and topographic considerations, a total of 17 locations were chosen for wildlife crossing points. The proposed crossing design consists of an at-grade crossing with reduced slope dirt embankments.

Efforts to maintain connectivity for wildlife did not begin until the project was at the halfway point to completion. There are many questions and concerns over the last minute conduction of wildlife surveys which did not incorporate the latest methodologies available for such work. Time and cost constraints prevented such efforts. Additionally the implementation of such measures as legitimate wildlife crossing structures is also in question. Over or underpasses were not selected due to cost considerations. The Asian Development Bank should be commended for attempting to ensure that environmental concerns are not ignored. However, increasing the priority for environmental issues will need to be made in order to have the desired affects.

4.7 Mongolian rail network: Past and present[29]

Railroads in Mongolia are a known barrier to movements of Mongolia's large mammals, specifically the Trans Mongolian Railroad. The Ulaanbaatar Railroad Company is responsible for operations along the Trans Mongolian Railroad and the Choibalsan to Erentsav railroad. Since 1955 trains have been travelling through Mongolia from Russia to Beijing. The TMR corridor remains an important link between Europe and China. Today, the TMR railway accounts for about 63% of the value of all freight entering Mongolia. The TMR is operating at near capacity running approximately 43-46 trains/day. There are plans to increase capacity of the TMR to a double track in 2020.

In order to accommodate increased traffic and speed capacity of the trains, a number of railway safety laws have been added and updated in the last decade. The largest risk to human safety areas are at loading and unloading stations and urban areas. The railroad corridor is fenced to prevent livestock collisions. Livestock owners are fined if train delays occur due to livestock on the railroad or in case of a collision. Ulaanbaatar Railway Company employs approximately 120 people for the purpose of fence maintenance. The fence is constructed to company standards, but there is no Mongolian law which requires this. During 2014, there were a total of 33 incidences of train delay or stoppage along the TMR due to livestock, 9 of these involved livestock collisions.

[28] Mr. E Khasar, Asian Development Bank, Mongolia Country Office.

[29] Presentations by Mr. J. Borkhuu, Deputy Head of Track Maintenance, Ulaanbaatar Railway Company; Mr. Davaanyam, Mongolia Railway Company.

Ulaanbaatar Railway Company places great emphasis on rail safety. Options which may be incorporated for facilitating wildlife crossing need to ensure safety considerations are respected. Collisions with animals can damage the train from direct force and also if the carcass is dragged under the carriage, many brake lines can be damaged especially with large animals such as cows, horses, camels.

Future railroad development plans are extensive and without effective mitigation measures in place, these new rail routes too will be problematic for Mongolia's large mammal species. In 2010, the Mongolian government has approved an ambitious national railway plan involving over 4,000 km's of new routes and has established a new railroad company to carry this plan out, the Mongolian Railway Company. These new rail routes will be designed to be wildlife friendly which will include overpasses and the corridor will not be fenced in uninhabited areas. The Mongolian Railway Company is willing to share details of their planned routes so that wildlife biologists and other stakeholders can provide data which may be useful in their feasibility studies.

4.8 Removing old barriers as part of a future vision for Mongolian ecosystems[30]

Examining Mongolia's past development and future initiatives offers an opportunity for Mongolia to develop along a sustainable pathway, but also to exam how to mitigate and correct mistakes of the past. The Trans-Mongolian railroad has been in existence for nearly seven decades. This has had devastating consequences to many of the large ungulate populations whose range overlaps the TMR, especially Mongolian gazelles and khulan. The TMR became an absolute barrier for khulan, the TMR route become the easternmost limits of their range. For Mongolian gazelle, each year thousands of gazelles are entangled and die in the corridor fencing, countless others are struck by trains if they manage to enter the corridor, while a vast majority of gazelles are unable to migrate through the TMR corridor.

Decades of monitoring and study have highlighted the barrier effect of this railroad. There is international consensus among scientists and conservationists that there are more wildlife friendly alternatives that can be incorporated along this fenced corridor. However despite a number of efforts to incorporate wildlife friendly measures, little has been done to incorporate these suggested changes along the railroad while at the same time a number of new passageways for vehicles and pedestrians have been identified and constructed.

As has been pointed out, there are a number of strong environmental laws which are in place to protect Mongolia's wildlife and their habitat. When it comes to existing infrastructure, it has been hard to translate these laws into tangible efforts. Examining recent changes to the Mongolian railway policy and Mongolia's constitution may offer suggestions for how to achieve changes along the TMR fence corridor to a more wildlife friendly design.

Mongolia adopted a new state policy on railroads in 2010 which included the need to update the technology and capacity of the railway infrastructure. The railroad fence corridor could be

[30] Dr. K. Olson, Science Adviser, Oyu Tolgoi Core Biodiversity Monitoring Project, WCS Mongolia.

considered part of the railway infrastructure which requires updating to a wildlife friendly design. Improving fence quality in urban areas and high livestock density areas would improve safety while installing cattle guards and modifying the fence to wildlife friendly design in low density areas would allow for gazelles to pass freely and keep large livestock off the tracks, and finally fence removal in areas where herder density is low or nonexistent and which lies within khulan range would allow khulan to access large areas of the former range in the east.

There are also many constitutional arguments which justify incorporating changes to the TMR fence corridor. Mongolian livestock are part of the nation's wealth and are to be protected so improving the fence in areas where livestock are abundant would serve to protect livestock. Fauna and flora of Mongolia belong to all Mongolians and are under state protection as well the state has the right to hold land owners responsible if they are not adequately managing the land in a environmentally sustainable way. Protecting movements of wild animals would improve the status of these populations and not addressing new technologies available for wildlife friendly designs is not responsible and therefore the government has the right to intervene if measures are not taken to improve permeability across the TMR corridor for wildlife. Mongolia is constitutionally responsible for adhering to international treaties it is party to, which includes CMS and newly adopted wildlife friendly infrastructure guidelines have recently been adopted. Likewise, Mongolia is not obligated to adhere to international treaties or agreements which are not agreeable to the constitution and therefore the agreement between Mongolia and Russia to co-manage the TMR should be revisited if is found the Russian management responsible for the TMR are not willing to approve fence design changes. Mongolian citizens have the right to be protected against environmental imbalance. The currently fragmented Gobi-Steppe Ecosystem is a form of ecological imbalance which is in need of balance by making the changes to a wildlife friendly TMR fence corridor. Finally all Mongolians are obligated to uphold the constitution, and to protect nature and the environment. Approving a wildlife friendly fence design and implementing a program to realize this change would be in compliance with the Mongolian constitution.

Development initiatives across Mongolia are planned and implemented on a grand scale. Equally, hope that Mongolia will follow a path which ensures that the landscape remains open and accessible and biodiversity resources remain at ecological meaningful levels. This will require a strong and unified future vision, but also a willingness to visit Mongolia's past and applies the necessary changes which will result in a realization of a future vision.

4.9 A framework for future action: Science and research, policy and implementation, and donor awareness[31]

Improved understanding of the environment where development projects exist or are being planned allow for better planning and avoidance of problems. Science and research prior, during, and post construction of projects is important as well as studies which add to general understanding of an ecosystem are important. Good understanding of species distribution and their status is important. Accurate population estimates allow monitors to follow trends and determine when actions are

[31] Outputs from a working group session during the official meeting tackling policy, Policy and implementation, role of donors, and Science and Research are attached as Appendix I.

required to address declines. What are the movement needs of species affected? All environmental impact assessments (EIA) must have good science incorporated into their development. It is not acceptable to pass a project simply due to lack of information or because an EIA did not include the latest science.

Monitoring of developments can include improved data collection of vehicle wildlife/livestock strikes along roadways and railways. Data on road traffic volumes will be helpful in determining whether or not to apply mitigation measures or to assess if traffic volumes are affecting crossing opportunities by wildlife. Trains can be fitted with cameras to record livestock and wildlife in the vicinity of the tracks. All of these measures are costly and funding sources are often elusive. Regional land use planning requires that all projects be examined, this is especially important in an ecosystem like the Gobi-Steppe where species are wide ranging and often encounter threats and obstacles from a number of independently planned developments. Each project may consider its own area as having adequately addressed environmental threats, but do not consider the multiplier effects such projects have. A green fund financed by industry which drives infrastructure projects as part of their responsibilities towards environmental compliance would serve to support development related ecosystem monitoring for all projects.

Development requires input and oversight by multiple ministries. Improved coordination amongst ministries and government agencies involved in development projects and environmental stewardship will serve the purpose of allowing projects with the potential to create conflict to be discussed early on in their conception so that the full mitigation hierarchy can be applied. Interministerial working groups provide the stage for such discussions and coordination and they should be supported. Mongolia's legal framework is still evolving and there are often topics which have conflicting laws applied towards them. This creates confusion and allows for loopholes to be exploited. Laws addressing environmental protection and development issues need to be assessed and harmonized to allow for a clear legal framework to be developed and followed. Better stakeholder involvement at the local and regional level will also result in better understanding of what people's needs and concerns are so that conflict can be avoided. As Mongolia's laws and standards are refined and strengthened it is important that capacity building and awareness are raised so that government, donor groups, environmental impact assessment companies, and conservation advocates are aware of and implementing the most up to date laws and standards. It also must be remembered that it is possible that the general public will view compliance to new standards to be costly and unnecessary and it will be important to address this in public awareness and education campaigns so that the benefits of such standards are appreciated.

Legislation must be respected if it is to be successful. This requires enforcement and compliance. Mongolia has a number guidelines and loopholes which are unclear and are often exploited at the expense of biodiversity. Implementation of legislation will require functioning working groups to ensure that legislation is clear and is being followed. Equally important is to ensure that participatory components of EIA's are given the respect they need and greater solicitation and respect from public comment is necessary for this.

Retro-mitigation of existing developments such as the Trans Mongolian Railroad are important activities in moving forward with sustainable and green development initiatives. It is well known that the corridor fencing along this railroad has had major negative influence on populations of khulan

and Mongolian gazelles for several decades. Solutions exist, but implementation remains elusive. Skepticism about changes to the corridor fencing needs to be addressed. A pilot study which examines how wildlife and livestock responds to corridor modifications such as strengthening the fence around settled areas, modifying to wildlife friendly fence in areas known to be problematic for gazelles and full fence removal where khulan range and are absent of herders.

5 Conclusions

Platforms which give professionals and experts from a diverse range of disciplines an opportunity to come together, discuss shared problems and challenges often result in actionable solutions. The fragmentation of habitat and barrier effects of linear infrastructure on highly mobile species such as Mongolian gazelle and khulan affect the Gobi-Steppe Ecosystem resulting in impoverished wild natural heritage within Mongolia and thus Central Asia of which biodiversity loss and declining ecosystem services are of global concern. The issue is not solely one for conservation biologists to take on, nor can responsibility be entirely shouldered by those involved in the construction of infrastructure. Complex challenges require equivalent responses. Industry professionals, policymakers, scientists, conservationists, and financiers of development all have a role to play in thinking through and implementing change to problems created in the past and avoiding creating new ones. Taken together the actions will likely result in a better future for both biodiversity, the ecosystems they are found in and society that depends on their good health.