# Key endangered species in Galba Gobi: status and provisional impact assessments of regional development scenarios


Nyambayar Batbayar, Bayarjargal Batsukh
Wildlife Science and Conservation Center of Mongolia
Jonathan Stacey, BirdLife International
and
Axel Bräunlich, consultant


February 2011

Wildlife Science and Conservation Center of Mongolia
BirdLife International

# Key endangered species in Galba Gobi: status and provisional impact assessments of regional development scenarios

Nyambayar Batbayar, Bayarjargal Batsukh, Wildlife Science and Conservation Center
Jonathan Stacey, BirdLife International
Axel Bräunlich Consultant

With the support of
The Ministry of Nature and Environment of Mongolia

Funded by
The World Bank (Netherlands-Mongolia Trust Fund for Environmental Reform)
and BirdLife International(the Rio Tinto - BirdLife Programme)

Additional support provided by
Environment Agency of Abu Dhabi, UAE

February 2011
Ulaanbaatar, Mongolia

**Contents**

**Acknowledgments** .......... **4**

**Executive Summary** .......... **5**

**Introduction** .......... **1**

**Surveying Biodiversity Issues in Mongolia's South Gobi Region** .......... **3**
Two Globally Threatened Species under Focus .......... 3
*Houbara Bustard* .......... 3
*Saker Falcon* .......... 5
Study Area .......... 6
Project Study Aim and Expected Outputs .......... 9
Methodology .......... 10
*Collating location data of Houbara Bustards* .......... 10
*Transect survey* .......... 11
*Raptor nest survey* .......... 12
*Satellite tracking for local movement of Saker Falcons* .......... 12
*Vegetation survey* .......... 13
*Observations of other wildlife species* .......... 13
*Modeling Houbara Bustard suitable habitat using GIS* .......... 14
*Data analysis* .......... 15

**Results of the Survey** .......... **17**
*Distribution and Population Density of Houbara Bustards* .......... *17*
*GIS Model for Houbara Bustard distribution* .......... *19*
*Nesting Success of Saker Falcons* .......... *22*
*Area use of Saker Falcons* .......... *23*
*Vegetation Survey* .......... *26*
*Other Wildlife* .......... *28*

**Further Discussion of Issues** .......... **30**
*Summary of Sensitivities to Endangered Bird Species* .......... *33*
*Summary of Sensitivities to Endangered Large Mammals* .......... *34*

**Recommendations** .......... **36**
*I. Recommendations for Saker Falcons and Houbara Bustards in the Galba Gobi IBA* .......... *36*
*II. Recommendations for Wildlife and Habitat Conservation within the wider South Gobi Region* .. *38*
*III. Recommendations for Biodiversity Impact Mitigation and Offsets* .......... *42*

**References** .......... **50**

**Appendixes** .......... **55**
*Appendix A. Comparisons of Plant Species Diversity, Density, and Coverage at Observation and Random Points* .......... *55*
*Appendix B. Average Cover and Frequency of Plant Species per Square Meter Area at Observation and Random Plots* .......... *56*
*Appendix C. Dominant Vegetation Types in the Galba Gobi IBA* .......... *57*
*Appendix D. GIS Layers Used in Observations* .......... *58*
*Appendix E. Movement of Satellite-Tracked Saker Falcons* .......... *59*
*Appendix F. Project-related Reports, Presentations, and Publications* .......... *62*
*Appendix G. Select Photo Documentary* .......... *63*

**List of Tables**

Table 1. Potential major mines in Southern Mongolia ..... 2
Table 2. Binary factors and associated criteria, category, and values to be used in the study ..... 15
Table 3. Sources of Houbara Bustard observations ..... 17
Table 4. Population density estimates, 95% confidence intervals, coefficients of variation from car transect survey for Houbara Bustards in the Galba Gobi IBA ..... 18
Table 5. Nesting success of Saker Falcons ..... 23
Table 6. Data on satellite-tracked birds and locations from mid-June 2009 to early October 2010 ..... 24
Table 7. 10 Principles on Biodiversity Offsets Supported by the BBOP Advisory Committee ..... 44
Table 8. Proposed activities for near future ..... 48

**List of Figures**

Figure 1. Overlap between state special protected areas, important bird areas, and exploration and mining licenses in Omnogobi aimag ..... 1
Figure 2. Houbara Bustard in the Galba Gobi IBA *(photo by B.Nyambayar/WSCC)* ..... 4
Figure 3. Saker Falcon on the nest *(photo by P.Gankhuyag/WSCC)* ..... 5
Figure 4. Overview map of the Galba Gobi IBA study area in Mongolia's South Gobi ..... 7
Figure 5. Average temperature and precipitation in the Galba Gobi region ..... 8
Figure 6. Shrubby desert steppe landscape in the Galba Gobi Important Bird Area *(photo by B.Nyambayar/WSCC)* ..... 9
Figure 7. Early morning search for Houbara Bustards with spotting scope *(photo by Axel Bräunlich /WSCC)* ..... 11
Figure 8. Saker Falcon fitted with GPS PTT satellite transmitter *(photo by B.Nyambayar/WSCC)* ..... 12
Figure 9. A small herd of Wild Ass is carefully approaching water *(photo by Axel Bräunlich /WSCC)* ..... 14
Figure 10. Houbara Bustard records in the Galba Gobi IBA ..... 18
Figure 11. Frequency of Houbara Bustard observations by elevation (2009 field data) ..... 19
Figure 12. Frequency of Houbara Bustard observations by slope (2009 field data) ..... 20
Figure 13. Scheme of GIS habitat model building ..... 20
Figure 14. Data layers used in the model building ..... 21
Figure 15. Potential Houbara Bustard habitats ..... 22
Figure 16. Locations of satellite-tracked Saker Falcons in southern Mongolia ..... 24
Figure 17. Movement of satellite-marked three Saker Falcons within Mongolia ..... 25
Figure 18. Area use of adult Saker Falcons near Tavan Tolgoi coal transport road ..... 26
Figure 19. Comparison of plant life forms at observation and random points ..... 27
Figure 20. Typical habitat for Houbara Bustards in Galba Gobi *(photo by B.Nyambayar/WSCC)* ..... 27
Figure 21. Fixed kernel foraging range of Wild Ass in spring ..... 29
Figure 22. Fixed kernel foraging range of Goitered Gazelle in spring ..... 29
Figure 23. Conceptual view of the biodiversity offsets and impact mitigation hierarchy ..... 43

**Acronyms and Abbreviations**

| | |
|---|---|
| BBOP | Business and Biodiversity Offsets Program |
| CBD | Convention on Biological Diversity |
| DTEM | Digital Terrain Elevation Model |
| GIS | Geographical information system |
| GPS | Global positioning system |
| EIA | Environmental Impact Assessment |
| IBA | Important Bird Area |
| IUCN | International Union for Conservation of Nature |
| MFA | Ministry of Food and Agriculture |
| MME | Ministry of Mines and Energy |
| MNET | Ministry of Nature, Environment, and Tourism |
| MNMA | Mongolian National Mining Association |
| MoH | Ministry of Health |
| MRPAM | Mineral Resource and Petroleum Authority of Mongolia |
| MRTCUD | Ministry of Roads, Transportation, Construction and Urban Development |
| NEMO | Netherlands-Mongolia Trust Fund for Environmental Reform |
| SPA | Special Protected Areas |
| SSIA | State Specialized Inspection Agency (recently changed to GASI – Government Agency for Special Inspection) |
| USGS | United States Geological Survey |
| UTM | Universal Transverse Mercator |
| WSCC | Wildlife Science and Conservation Center |
| WWF | World Wildlife Fund / World Wide Fund for Nature |

# Acknowledgments

The project study team is grateful for the support by the Ministry of Nature, Environment and Tourism (MNET) of Mongolia. The Protected Area Administration of MNET issued permission to work in the Small Gobi Strictly Protected Area. The State Border Defense Agency permitted the team to work in the border zone and borders points in Omnogobi aimag and provided helpful safety suggestions for the team during brutally hot summer field days.

The team is also grateful to Dr. Batsaikhan Nyamsuren, Dr. Tseveenmyadag Natsagdorj, Dr. Olivier Combreau, Mohamed Saleh Al Baidani, Mark Lawrence, Dr. Jacky Judas, Dr. Peter Pechacek, and Dr. Andrew Dixon for sharing their expertise on Houbara Bustard and Saker Falcon and providing much helpful advice.

Special thanks also go to the following field crew members and GIS specialists who generously provided support for this project: Badam Tomorbaatar, Enkh-Orshikh Bayarmagnai, Gankhuyag Purev-Ochir, Davaajargal, G. Ainsworth and S. Dorjderem of Ivanhoe Mines, Little Gobi SPA rangers Araashnyam and Lkhagvasuren, drivers B. Amarjargal, Bayaraa, and Sainjargal.

Wildlife Science and Conservation Center of Mongolia organized all the necessary logistics support in the country.

The project was co-funded by the World Bank (Netherlands-Mongolia Trust Fund for Environmental Reform - NEMO) and BirdLife (the Rio Tinto - BirdLife International Programme). Argos satellite tracking service was provided with the support of the Environment Agency-Abu Dhabi (EAD). National Avian Research Center of EAD kindly provided four satellite transmitters for tracking Houbara Bustards.

The work was managed by Tony Whitten, Senior Biodiversity Specialist, East Asia and Pacific Region, World Bank with assistance of Judith Schleicher, Biodiversity Specialist, East Asia and Pacific Region, World Bank.

# Executive Summary

The Gobi dominates much of southern Mongolia. By its very nature, the Gobi is one of the world's great deserts; it is covered with a fragile desert soil, an intriguing soil biofilm, and amazing plant diversity. Vegetation tends to be homogenous, dominated by drought-adapted shrubs and grasses across vast areas. Climate in the Gobi Desert is extreme with very low precipitation. However, despite its hostile climate and arid landscape, it is the only refuge for the last remaining herds of large ungulate populations in East Asia. There is no other significant open area in East Asia that supports large mammals such as Mongolian Wild Ass, Goitered Gazelle, Wild Camels, and Gobi Bear. Also there are many bird, reptile, and insect species that can only be seen in the Gobi.

World-class mineral resources, coupled with a strategic location between China and Russia, are driving rapid growth in Mongolia's mining sector. The mining industry in Mongolia is in a position to become a major supplier of mineral resources to some of the world's largest and fastest growing economies. Because of its proximity to a Chinese market and transportation infrastructure, the South Gobi Region in Mongolia is at a very important juncture to develop and export its natural resources and bring wealth and prosperity to the country and its people. Several large-scale mine sites are being developed, and more sites are under consideration for development in near future. In fact, most areas that lie outside protected areas in southern Mongolia are completely covered by exploration licenses. It is a potentially alarming situation that cannot be ignored and needs to be addressed strategically.

Some companies are proposing that railroads and highways will need to be constructed to transport their products to the Mongolia-China border to access Chinese and global markets. One of the consequences of developing such large infrastructure projects in this region is that such structures could have a significant impact on critical wildlife habitat in the Gobi, an environment that hitherto has not experienced such man-made influences. The likelihood of large ungulate movements being compromised or endangered birds' nesting habitats becoming degraded or fragmented is high. Also, the number of human and vehicle movements will be greatly increased, which will unquestionably have various negative impacts on Gobi biodiversity. Vehicles can disrupt fragile desert soils and associated biofilms exposing the soils underneath to wind erosion. Because the plants in the desert are slow growing, recovery is difficult and such damage can be long lasting. In general, the soil crust in the Gobi Desert takes millennia to form but only few moments to destroy.

The Galba Gobi Important Bird Area (IBA) is one of many critical natural wildlife habitats in the Mongolian Gobi that is threatened by rapidly expanding mining and infrastructure development. An Important Bird Area is a site providing essential habitat to one or more globally threatened or restricted range species or of significant populations of breeding, wintering, and/or migrating birds. The Galba Gobi IBA supports a significant number of globally threatened bird and mammal species in the Gobi region. The development of powerlines and transport infrastructure have been identified as particular threats to globally endangered Houbara Bustards and Saker Falcons in this area, both in terms of the disturbance they can cause to breeding birds and the potential to facilitate hunting and trapping in remote areas.

As part of the World Bank-supported Regional Development Plan for the South Gobi, a number of routing options are being considered for road and rail corridors (and potentially for powerlines) through the Galba Gobi IBA, linking the Tavan Tolgoi coal and Oyu Tolgoi mineral deposits to China. While these developments are potentially compatible with maintenance of the biodiversity values of this area, this is contingent on the availability of detailed data on the distribution of species and habitats of high conservation concern, and the application of such information through analysis and strategic action. In particular, there was a need for detailed data on the nesting distribution and seasonal movements of Saker Falcon and Houbara Bustard within the Galba Gobi IBA. Such data would enable a fuller assessment of the environmental impacts of different routing options for transport and power infrastructure, and facilitate the selection of alignment options that minimize impacts on nesting birds.

In spring and summer of 2009, a team of researchers from the Wildlife Science and Conservation Center (WSCC) and BirdLife International was dispatched to Galba Gobi IBA to survey Saker Falcons and Houbara Bustards. During the project study period, the researchers collected ecological data associated with these two species, while also gathering much useful information on rare wild ungulates in the area. The study findings have demonstrated that the Galba Gobi is well fitted to qualify as an Important Bird Area. The number of Houbara Bustards and Saker Falcons observed during the project study period was a clear indication of the importance of this area for these two globally threatened species. In fact, stricter conservation and management actions should be developed and implemented in this area to safeguard these species.

Unregulated vehicle movement, disturbance to nesting birds, increased traffic, unsustainable use of already scarce elm and saxaul trees, lack of suitable nesting sites, effects of noise and dust from the existing road, and hunting were major source of threats to Saker Falcons and Houbara Bustards in the Galba Gobi IBA. Furthermore, the overlap of grazing land with livestock, poaching, water points, and habitat fragmentation were major threats to the rare ungulates in this area.

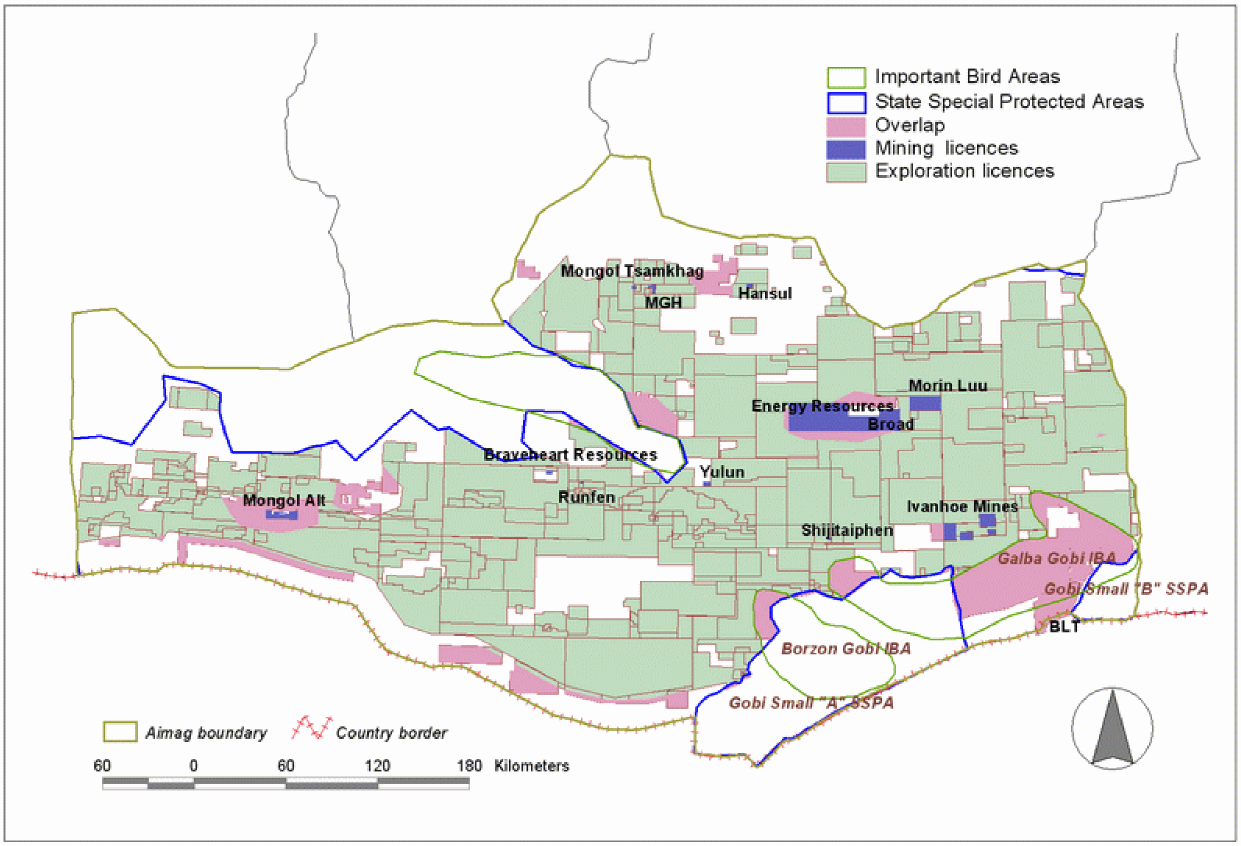
In southern Mongolia, erecting physical barriers to prevent wildlife collision with vehicles on planned highways and railways has become a key topic of discussion among stakeholders, developers, and wildlife specialists. Some strongly support the concept while others oppose it. Unarguably, minimizing the impacts of infrastructural development is likely to be one of the greatest challenges in wildlife conservation in such an environment as the southern Gobi. Any type of major linear structures such as railroads, highways, powerlines, and pipelines can have significant impacts on wildlife movement and survival and may result in significant habitat fragmentation or impact the distributions of some of these globally threatened species.

Regardless of investment, there will never be one perfect solution to meet all species' needs. Therefore, in view of the fact that building and developing regional infrastructure is inevitable, the first choice should be to not construct such railways or highways through identified core wildlife habitats. Any major infrastructure development should carefully consider and assess potential long-term impacts on both endangered and common species and exhaustively explore options for avoiding, mitigating, minimizing, and, if possible, offsetting such biodiversity impacts.

# Introduction

Mongolia is witnessing unprecedented levels of economic growth, driven in large part by the mining, oil, and gas industries. Especially, the southern frontier region of Mongolia is known worldwide for its rich mineral resources such as gold, copper, and coal and is becoming a particular focus for the extractive industries. Several world-class mining projects are already in place, and some are under development. Such examples include the Oyu Tolgoi copper-gold deposit, and the existing Tavan Tolgoi coal mining area (BirdLife Asia 2009; World Bank 2004, 2009). Most strikingly, the southern parts of Omnogobi and Dornogobi *aimags*[1] that lie outside of protected areas are almost completely covered by exploration licenses (Figure 1) because they contain rich deposits of mineral resources (BirdLife Asia 2009).

**Figure 1. Overlap between state special protected areas, important bird areas, and exploration and mining licenses in Omnogobi aimag**




*Source*: (BirdLife Asia 2009)

The South Gobi Region in Mongolia is at an important transition period to develop and export its natural resources to the world and to bring wealth and prosperity to the country and its people (Table 1). As Mongolia prepares to move toward this historical moment, it is clear that sustainable and effective use of

---

[1] An *aimag* is an administrative subdivision in Mongolia, sometimes referred as provinces.

these minerals in domestic and international markets will require large-scale economic and infrastructural development within the region (Walton 2010). At the same time there are increasing concerns on the ecological importance and conservation of wildlife resources of the region. Without effective environmental safeguard measures, these sectors have the potential to cause major negative impacts on Mongolia's natural habitats and wildlife populations - both direct (mine construction, tailings disposal, etc.) and indirect (road and rail development, construction of high voltage power lines, etc.) (BirdLife Asia 2009; Walton 2010).

**Table 1. Potential major mines in Southern Mongolia**

| *Mine* | *Mineral* | *Life (years)* | *Production (thousand tons/year)* | *Employment estimate* | *Estimated start year* |
|---|---|---|---|---|---|
| Nariin Sukhait | Coal | 40 | 12,000 | 150 | 2003 |
| Ovoot Tolgoi | Coal | 50 | 5,000 | 400 | 2008 |
| Uhaahudag | Coal | 40 | 10,000 | 1,000 | 2009 |
| Oyu Tolgoi* | Copper | 50 | 2,000 | 4,000 | 2012 |
| Tsagaan Suvraga* | Copper | 20 | 250 | 1,000 | 2012 |
| Tavan Tolgoi | Coal | 200+ | 15,000 | 1,500 | 2012 |
| Baruun Naran | Coal | 20 | 6,000 | 500 | 2012 |
| Tsagaan Tolgoi | Coal | 20 | 2,000 | 150 | 2015 |
| Sumber | Coal | 50 | 5,000 | 400 | 2015 |
| Shivee Ovoo | Coal | 200+ | 14,000 | 600 | 2015 |

*Note*: *Production figure is for copper concentration (30% copper).
*Source*: World Bank (2009)

.

Reliable and efficient transportation road and railway networks connecting mines in Mongolia with buyers and markets in China are in great demand in this infrastructure-deprived region. For this reason, construction of 329 kilometers of vehicle roads between Dalanzadgad and Gashuun Sukhait and 290 kilometers of railways from Tavan Tolgoi to Gashuun Sukhait have been proposed by the developers in different parts of the South Gobi Region and are encouraged by the Government of Mongolia. Major decisions to award licenses have been made to Energy Resources and Mongol Alt to develop railways from Tavan Tolgoi to Gashuun Sukhait and from Nariin Sukhair to Ceke, respectively. In addition, major construction of powerlines to facilitate regional development and export of surplus electricity are expected. These development projects will potentially cause secondary impacts associated with the increased human activity in the area and near the international (Mongolia–China) border. Consequently, there is a need to study the conservation needs of wildlife and their habitats in this area.

# Surveying Biodiversity Issues in Mongolia's South Gobi Region

During 2007 and 2008, the World Bank supported BirdLife International and the Wildlife Science and Conservation Center (WSCC) of Mongolia to identify and map important areas of critical natural habitat in Mongolia. Several important areas of natural habitat were identified in Omnogobi aimag (South Gobi Province), including the Galba Gobi Important Bird Area (IBA). This area, which stretches between and partly overlaps with the Small Gobi A and Small Gobi B Special Protected Areas, supports two globally threatened mammals, Asian Wild Ass or Wild Ass, *Equus hemionus* (Endangered) and Goitered Gazelle, *Gazella subgutturosa* (Vulnerable); and important breeding populations of three globally threatened bird species, Saker Falcon, *Falco cherrug* (Endangered); Houbara Bustard, *Chlamydotis undulata* (Vulnerable); and Lesser Kestrel, *Falco naumanni* (Vulnerable) (Kaczensky and others 2006; Nyambayar & Tseveenmyadag 2009).

The development of powerlines and transport infrastructure have been identified as particular threats to Houbara Bustard and Saker Falcons in this area, both in terms of the disturbance they can cause to breeding birds and of the potential to facilitate hunting and trapping in remote areas (Bevanger 1994; Janss & Ferrer 2000 ; Janss 2000; TRAFFIC 2008).

## *Two Globally Threatened Species under Focus*

As part of the World Bank-supported Regional Development Plan for the South Gobi, a number of routing options are being considered for road and rail corridors (and potentially for powerlines) through Galba Gobi IBA, linking the Tavan Tolgoi and Oyu Tolgoi deposits to China. While these developments are potentially compatible with maintenance of the biodiversity values of this area, this is contingent on the availability of detailed data on the distribution of species and habitats of high conservation concern and the application of such information through analysis and strategic action. In particular, there is need for detailed data on the nesting distribution and seasonal movements of Houbara Bustard and Saker Falcon within the IBA. Such data enable a fuller assessment of the environmental impacts of different routing options for transport and power infrastructure, and facilitate the selection of alignment options that minimize impacts on nesting birds.

### *Houbara Bustard*

There are three distinct subspecies of Houbara Bustards recognized across it breeding range; the Asian subspecies *Chlamydotis undulata macqueenii*, the North African subspecies *Chlamydotis undulata undulata*, and the Canary Island subspecies *Chlamydotis undulata fuertaventurae*. The subspecies that is distributed in Asia has been split into a different species, the Macqueen's Bustard, *Chlamydotis macqueenii* based on differences in male display behavior and genetic analysis (Gaucher and others 1996; Pitra and others 2002). This is the species that occur in Mongolia. But throughout this report, Houbara Bustard, *Chlamydotis undulata*, is used because this name has not been officially replaced in Mongolian avifauna nomenclature, and also International Union for Conservation of Nature (IUCN) and BirdLife

International have not recognized it as separate species due to lack of full evidence for specific separation (BirdLife International 2009).[2]

The plumage of Houbara Bustard is brown above and white below, with a black stripe down the sides of the neck. In flight, the long wings show large areas of black, white, and brown. Like other Bustards, it has a spectacular display, raising the white feathers of the head and throat and withdrawing the head (Figure 2). The range of *C. u. macqueenii* extends from the Arabian Peninsula across Central Asia to Mongolia (BirdLife International 2009; Gubin 2009). Houbara Bustards are polygynous and exhibit a lek mating system. A lek is a place where males gather to conduct a competitive mating display (Hingrat & Jalme 2005). The Houbara Bustard is considered globally threatened or Vulnerable according to the Red List category (BirdLife International 2009b).

Houbara Bustard is dependent on shrub-lands in desert and semi-desert area (Tourenq and others 2004). The Mongolian Gobi constitutes the easternmost part of its global breeding range. The Galba Gobi has especially vast unspoiled semi-desert habitats with shrubs and bushes that are preferable for Houbara Bustards. In this environment they inhabit sandy and stony semi-desert with shrubs. They feed on invertebrates, small vertebrates, and green shoots, and typically lay 2-4 eggs in a scrape on the ground. Although they have adapted to extreme arid environment, their eggs and young are vulnerable to ground predators (Gubin 2009).

Asian Houbara Bustards are migratory, and birds from Mongolia and China winter in India, Pakistan, Iran, and parts of the Middle East (Judas and others 2006; Launay and others 1999).

**Figure 2. Houbara Bustard in the Galba Gobi IBA** *(photo by B.Nyambayar/WSCC)*

[2] Readers who favor the name Macqueen's Bustard may assume the discussion in this study is about the same species.

Although habitat loss and degradation, collisions with power lines, and overgrazing are significant threats to Houbara Bustards (Heredia 1995), the main threat comes from hunting by Middle Eastern falconers and smugglers in China, Pakistan, and Iran. Houbara Bustards are especially heavily hunted and poached along all their migration routes and wintering grounds. The current levels of hunting and poaching are not sustainable. Without immediate agreement and implementation of international conservation measures, the Asian Houbara Bustard may face extinction in the wild (Bailey and others 1998; Combreau 2007; Tourenq and others 2004). Compared to other range countries, Mongolia has been the only country where Houbara Bustard is not hunted; however, this study found first evidence of illegal hunting activity in Galba Gobi in 2009.

The species has not been fully studied in Mongolia despite some irregular location records of biologists; little data have been made available. Batsaikhan and others(2005) summarized and published all available information on Houbara Bustard observation records in Mongolia. This is a useful summary giving a creditable overview about the distribution of the species in Mongolia. The Houbara Bustard is distributed along arid semi-desert and desert landscapes that stretch from southeast to northwestern Mongolia. Batsaikhan's summary considered habitat degradation by livestock and vehicle tracks to be the most likely of main threats to Houbara Bustards in semi-desert regions in Mongolia (Batsaikhan and others 2005).

***Saker Falcon***

The Saker Falcon, *Falco cherrug,* occurs across a wide area ranging from eastern Europe to north-eastern China. With a body weight of 840-1,100 grams, it is a large falcon with 115-centimeter wingspan (Figure 3). The species breeds throughout the whole of Mongolia in mountain, steppe, forest-steppe, and desert steppe zones (Fomin & Bold 1991; Gombobaatar 2006). It nests in trees, rock crevices, ledges, using nests of other birds such as Upland Buzzards *Buteo hemilasius*, Common Ravens *Corax corax* and others. Saker Falcon also uses nests located on artificial structures such as electric poles, buildings, bridges and towers (Ellis and others 1997; Fomin & Bold 1991; Gombobaatar 2006; Potapov and others 2001b).

**Figure 3. Saker Falcon on the nest** *(photo by P.Gankhuyag/WSCC)*

Although Saker Falcons occur in a wide range across the Palearctic region, the species is threatened by various natural and human-induced factors such as loss and degradation of steppe habitat through agricultural intensification. In some regions, threat comes from grazing abandonment; decline in prey species abundance and availability; electrocution on power lines; and trapping for falconry, most of which is uncontrolled and illegal (Dixon 2009; Gombobaatar 2006; Ming & Ying 2007). The off-take for falconry is a significant and major problem, which has caused sharp declines and local extinction in many range countries, including Mongolia. Mongolia officially exports up to 300 birds annually to Arab countries in the Middle East region (BirdLife International 2009). Recently, the Government of Mongolia temporarily banned the trade in Saker Falcons until population assessment is done.

Saker Falcons are migratory. Satellite tracking studies from central Mongolia show that adults are sedentary or nomadic around their breeding ground, whereas young Saker Falcons undertake long migration (Potapov and others 2001a).

Saker Falcon nests usually occur in areas where elm and poplar trees are found in the Galba Gobi. They also regularly nest in rocky hills outside the IBA boundary. Local threats to Saker Falcons are not clear. Some locals report that Middle East falcon trappers infrequently appear in this region in the fall season. Compared to Saker Falcons in the central part of Mongolia where nesting in human-made structure is common, falcons in the Galba Gobi mostly use natural nest sites such as trees and cliffs. Prior to this study, little information was available on Saker Falcons in the Southern Gobi Region of Mongolia.

## *Study Area*

The Galba Gobi IBA is located in southern part of Mongolia and extends to the China-Mongolia border. The study area covers three *sums*[3] in Omno Gobi aimag – Khan Bogd, Bayan-Ovoo, and Nomgon (Figure 4). In general, Omnogovi aimag is sparsely populated, and infrastructure is very limited. Forty-five thousand people occupy more than 165 square kilometers of land. Over 89 percent of the population live in traditional *ger*.[4] Current population size in the area affected by the mines at Tavan Tolgoi, Oyu Tolgi, and Tsagaan Suvraga, is about 10,500 people. Overall, a 10- to 14-fold population increase has been projected in this area by 2020 largely due to several mine site operations and subsequent infrastructure developments. The closest large settlement area to Galba Gobi IBA is the Khanbogd sum center. The sum is experiencing large number of people coming into this area due to the development of the Oyutolgoi project. By 2015, its population will reach 33,500. The next big town is the Bayan-Ovoo sum center, which will have a population of 4,100 people by 2015 (World Bank 2009).

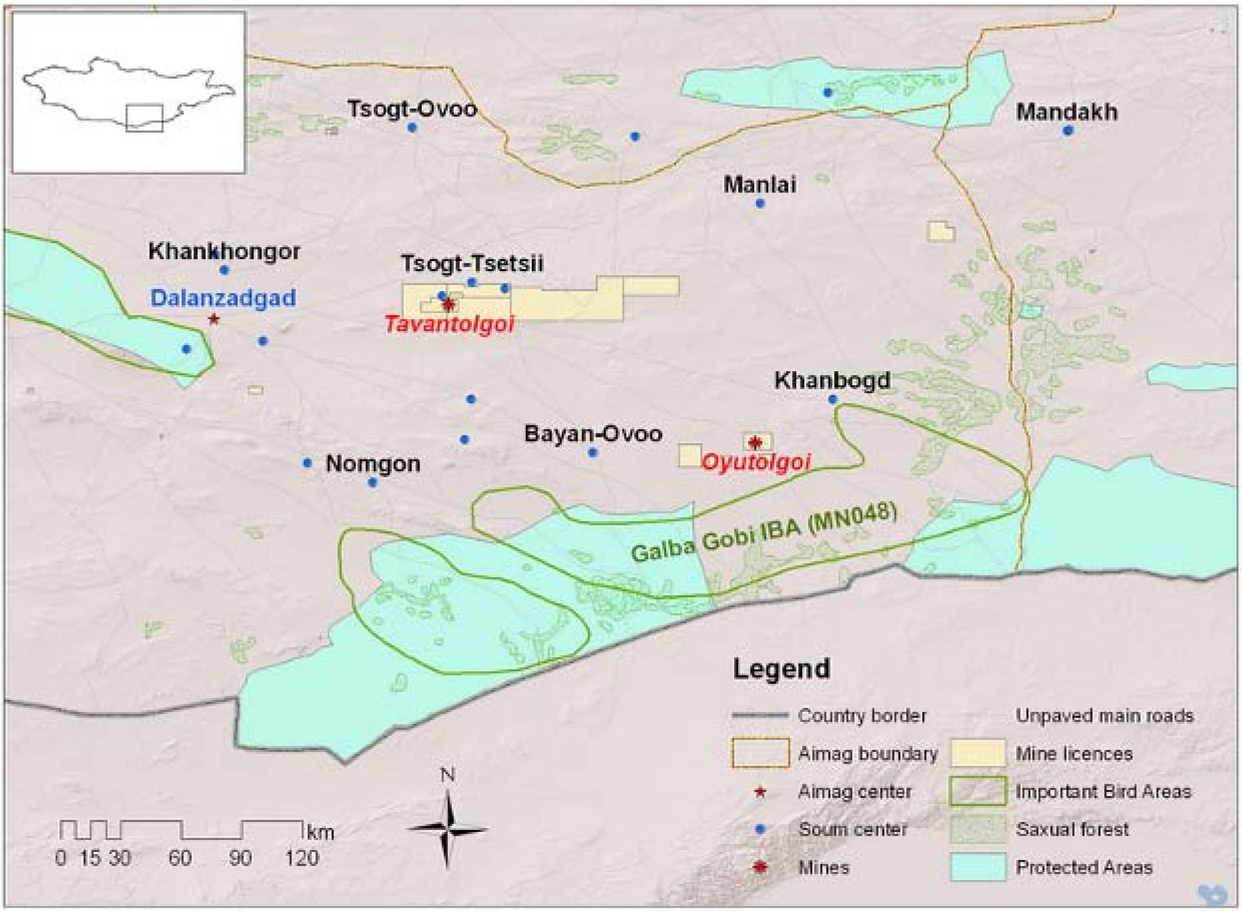
The Galba Gobi IBA is positioned between parts “A” and “B” of the Small Gobi Strictly Protected Area, and two ends of the IBA partially overlap with them. Two major global terrestrial ecosystem types, Alashan Plateau semi-desert and Eastern Gobi semi-desert, are found here (Olson and others 2001). The area has a short growing season, and growth of vegetation growth depends on rainfall.

The site is characterized by a long desert valley, with rolling hills, desert steppe, and dry riverbeds with patches of saxaul, elm, and poplar trees. These forest patches are important for the wildlife by providing

[3] Subdivision of *aimags.*
[4] Ger is the traditional dwelling of nomads in Mongolians and neighboring countries.

shade for wild mammals and livestock. They are also the preferable nesting location for many birds. Elevation of the area is below 1,300 meters, but much of the area is below 1,100 meters. Higher mountains are located in the southwest, north, and southeast of the IBA, but most of them are outside of the IBA boundary (Nyambayar and Tseveenmyadag 2009).

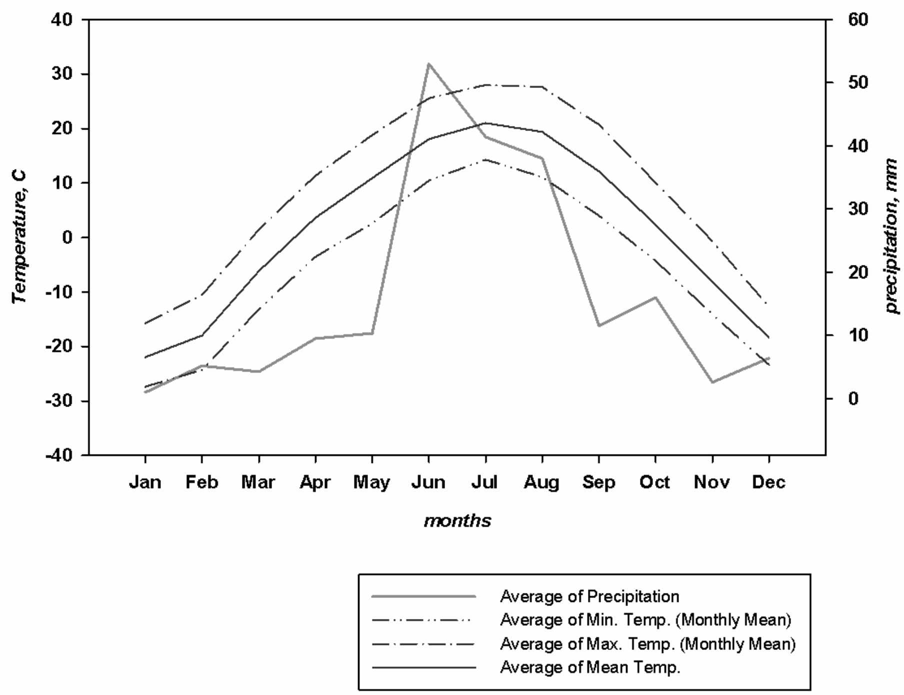
**Figure 4. Overview map of the Galba Gobi IBA study area in Mongolia's South Gobi**




*Note*: Insert shows location within Mongolia.

The region has a continental climate with extreme fluctuations of air temperature and very low precipitation. In general, this region has a long and dry cold winters; long, dry, and windy cold springs; long, dry, and hot summers; and cool and dry falls (Figure 5). The average mean temperature is 21.0°C in the warm months and -21.9° C in coldest months. The average maximum temperature in the warmest month of July is about 28°C, with the maximum temperature reaching 39°C. The average minimum temperature in the coldest month of January is about -27°C. Annual average precipitation ranges rarely exceed 120 millimeters per year, and it is both spatially and temporally variable. In some areas, several years may pass with no measurable precipitation, or sometimes rain may fall in one summer to create a green flush of vegetation and fill hundreds of dry riverbeds and ephemeral ponds with fresh water. Most of the precipitation falls between the beginning of May and the beginning of September, and it is the period when most vegetation can complete growth.

**Figure 5. Average temperature and precipitation in the Galba Gobi region**




Surface water is extremely scarce in this region. Lack of surface water is one of the most significant challenges for animals in arid semi-desert and desert environments. After rainfall, some springs and streams fill and become available for a short time period. However the groundwater table is relatively high, which means groundwater level is close to soil surface. Usually wild animals can reach drinkable water around 0.5 meter below the soil. Many hand-dug and government-provided deep wells are available throughout the area. Herders put solid covers over the waterholes to protect them from getting filled with dust, and to prevent insects and animals collecting in the wells; therefore, most wells are not accessible to wild animals. Many wells are now not operational and have closed recently due to cyanide and mercury pollution from illegal mining operations (Sheehy and others 2010).

Globally threatened bird species found throughout the Galba Gobi region are Saker Falcon, *Falco cherrug* (EN); Lesser Kestrel, *F. naumanni* (VU); and Houbara Bustard, *Chlamydotis undulata* (VU). In addition to these species, Cinereous Vulture, *Aegypius monachus* (NT); Short-toed Eagle, *Circaetus gallicus*; Booted Eagle, *Hieraaetus pennatus;* and Amur Falcon, *Falco amurensis*, breed in this region. Also the Great Bustard, *Otis tarda*, migrate through this area. The site supports species typical of the Eurasian steppe and desert biome, such as Mongolian Ground Jay, *Podoces hendersoni*; Saxaul Sparrow, *Passer ammodendri;* and Pallas's Sandgrouse, *Syrrhaptes paradoxus*. Several globally and nationally threatened and vulnerable mammal species occur at the site, including Asiatic Wild Ass, *Equus hemionus* (EN); Goitered Gazelle, *Gazella subgutturosa* (VU); and Mongolian Gazelle, *Procapra gutturosa* (LC) (IUCN 2010).[5]

[5] IUCN rates threatened species as LC (Least Concern), NT (Near Threatened), VU (Vulnerable), EN (endangered), CR (Critically Endangered), EW (Extinct in the Wild), and EX (Extinct).

## *Project Study Aim and Expected Outputs*

The project study aims to determine the population size, distribution pattern, and seasonal movements of Saker Falcon and Houbara Bustard populations in the Galba Gobi IBA and to formulate recommendations that enable the routing and design of infrastructure that avoids significant impacts on these two species. Following outputs were expected from this project:

1. ***GIS data layers*** showing environmentally sensitive areas within the Galba Gobi IBA with respect to critical nesting and feeding areas and migration routes of Saker Falcon and Houbara Bustard, and areas where development of transport and power infrastructure could occur with relatively low impact.
2. ***Technical report*** placing into a global context the significance of Galba Gobi IBA with the conservation of Saker Falcon and Houbara Bustard, and recommending mitigation measures with regard to the development of transport and power supply infrastructure.
3. ***Budgeted proposals*** for positive conservation actions that could be taken to maintain or increase the populations of the two species, to compensate for any losses due to infrastructure development (e.g., construction of artificial nests, establishment of local protected areas, etc.).

**Figure 6. Shrubby desert steppe landscape in the Galba Gobi Important Bird Area** *(photo by B.Nyambayar/WSCC)*

## *Methodology*

The study fieldwork was conducted from April to August 2009 within the boundary of Galba Gobi IBA. The project funders' request was to carry out field survey work for one spring and summer and produce timely recommendations before important decisions made on railway construction and infrastructure planning. This unique situation prevented the survey team from carrying out a more comprehensive study. Because of this limitation, the team employed methods that are less intense and easy to apply in the field but widely accepted, and that would provide opportunity to deliver the best possible project results in the shortest possible time. Limitations worthy of mention included the following:

1. Short field study period and extreme weather conditions that limited the best use of the short study period.
2. The two species investigated were never studied in this region, thus the team had to start from a zero baseline.
3. Large area with complicated terrain and lack of accessible road and supply points.
4. Lack of useful habitat information and vegetation maps.
5. Lack of digital data on infrastructure, water points, locations of livestock and herders, and their use of the study area.
6. None of the biologists working on this project had previous experience of surveying of such an elusive species as the Houbara Bustard.

### *Collating location data of Houbara Bustards*

One of the best ways to assess species spatial distribution is to use all available information from various sources. Especially, it is always difficult to obtain information on rare species in little-studied areas (Gregory and others 2004). The Houbara Bustard definitely falls in this rare species category and the Galba Gobi IBA is ornithological least studied region in Mongolia. Therefore, the team used several different approaches to increase the sample size.

First, we collected previously published and unpublished observation records of Houbara Bustards from various sources. In particular, Mongolian biologists and ornithologists provided invaluable source of information on this species.

Second, when we visited local herder families, border posts, and park rangers, we showed them photos and drawings of Houbara Bustards and asked them if the bird was seen in the area and if they have any additional information to share.

Third, we made observations from suitable vantage points using spotting scopes in the early morning and late afternoon. Houbara Bustards are predominantly active during these periods; therefore, this method was well suited for this study.

Fourth, we carried out vehicle based line transect survey across Galba Gobi IBA. When using the line transect methods the probability of detection is determined as a function of the perpendicular distance from the line of travel to the animal (Burnham and others 1980). In our case, we followed this general rule, and plus we made some adjustments in favor of increasing sample sizes. Below we detailed the method.

***Transect survey***

The line transect survey method was used to obtain data necessary for estimating Houbara Bustard population in the Galba Gobi. Also we recorded every large ungulates encountered during the transect survey.

The Galba Gobi IBA covers a very large area – over 8,000 square kilometers – and has numerous sandy dry river beds, and very little infrastructure (few dirt roads or tracks). This made it generally difficult for the team to survey it completely.

Because Houbara Bustard is very elusive and difficult to study, a thorough, comprehensive search was needed for the study (Launay & Bailey 1999). The team estimated at least four period surveys (covering post-migration, nesting and post-breeding, and pre-migration periods) would provide the data needed for making a baseline assessment. Thus car transect surveys were conducted each month from April to August. Usually early morning hours and hours just before sunset were used for transect surveys (Figure 7). The middle of the day was always avoided because Houbara Bustards usually stay in well-concealed places when sun is high at this time.

Transect directions were chosen randomly; but due to the rough terrain conditions, the routes followed mainly vehicle tracks. But we drove off roads whenever terrain permitted. We maintained the vehicle speed around 30 kilometers per hour with two observers recording animals within 250 meters on both sides of the car. Transect lines were usually less than 10 kilometers in length. When a Houbara Bustard was spotted the location was recorded together with information on behavior, sex, age, and group size. Binoculars (10x40 magnification) and telescopes (20x60 magnifications) were used for observation.

**Figure 7. Early morning search for Houbara Bustards with spotting scope** *(photo by Axel Bräunlich /WSCC)*

Stops were made every 4 to 6 kilometers during transects. At each stop point, researchers walked around the location for short periods in a zig-zag manner to search for "Houbara signs" – Houbara eggs, nests, chicks, feathers, droppings, and tracks. Minimum direct distance from car to the observer was usually around 250 meters.

We used handheld geographical positioning systems (GPS) (models Garmin GPS 60Csx and Garmin GPS 76Map) to record observations of Houbara Bustards and Saker Falcon nest locations during the field study. More than one feather or droppings or tracks within few meters radius at same location could also indicate a "display" activity occurrence. But a careful judgment is needed. A display site is an area where Houbara Bustards showed special mating rituals during breeding season. A nest point is a point where an actual nest was found during the spring survey. If fresh fragments of Houbara Bustard eggshell are found then it would also be considered a nest point.

With the gathered information, the team coordinated the locations on a topographic map. Such information is useful to delineate species spatial distribution and sometimes helpful to make inferences about population estimate.

***Raptor nest survey***

The study team searched for and monitored Saker Falcon nests from April until early June 2009. They checked elm, poplar, saxaul forests, single trees, and rocky hills for Saker Falcon nests. Other raptor nests found during this survey were recorded as well. Nest search started from the middle of April and ended after a second visit to the study area at the beginning of June. When a nest was found, the team climbed the tree to investigate the nest and determine the number of eggs and chicks. A previously prepared photo-aging guide for Saker Falcon nestlings was used to assess the growth and age of chicks. Basic morphological measurements were taken during nest visits. The team re-visited each nest 2-3 times during the nesting season. Nest locations were used to estimate density of the Saker Falcon in the Galba Gobi.

***Satellite tracking for local movement of Saker Falcons***

On June 6, June 9, and July 24, 2009, three Saker Falcons (two adults and one young) were fitted with satellite transmitters to track their local movements. The satellite transmitters were 30 g solar-powered GPS Platform Transmitter Terminals made by Microwave Telemetry, Inc., Columbia, MD, USA. They have a built-in sensor that functioned with Microwave's Satellite-in-View (SiV™) technology (Microwave Telemetry Inc. 2006). The transmitters were attached to the back of birds with Teflon harnesses (Figure 8). This harnessing technique is used in many similar birds of prey research programs worldwide. Birds were measured, weighed and released as close to capture locations as possible, typically within one hour of capture.

**Figure 8. Saker Falcon fitted with GPS PTT satellite transmitter** *(photo by B.Nyambayar/WSCC)*

The transmitters were programmed with two season cycles. First (or summer) season was programmed to locate one GPS fix at every one-hour interval between 8:00 AM to 6:00 PM from April 2$^{nd}$ to October 1$^{st}$ transmitting the signal every two days. The second (or winter) season was programmed to obtain GPS fixes at every one-hour interval between 9:00 AM and 5:00 PM from October 2 to April 1 and to transmit the signal every four days. Data were recovered from the Argos Data Collection and Location System (CLS America Inc., Largo, MD, USA), and then the team downloaded data directly from the Argos website. The Argos system provides 7 location class categories (1-7) that reflect the nominal accuracy of a given location as well. These data were useful when GPS was unavailable or unobtainable due to low battery voltage. With the location classes 3, 2, 1 (with accuracies estimated to be within 150, 350 and 1,000 meters, respectively), the team was able to track the bird movements when there was significant lack of location observed.

### *Vegetation survey*

Vegetation data was collected using the quadrat method and line-intercept method. These are widely used techniques to estimate plant cover and capture important plant diversity information (Godinez-Alvareza and others 2009; Mueller-Dombois & Ellenberg 2003).

Vegetation data was collected at 21 Houbara observation locations and 41 random locations in June and August 2009. The team generated 60 random points using the ArcView 3.2 GIS program, but poor field conditions only allowed the team only to reach the 41 locations. In each study location, the team established a 10-by-10 meters area plot and within each plot 3 sub-sample plots were randomly established and then 1x1 square meter wooden frames were laid out to record plant species. The team recorded the name, relative cover, density, and frequency of scrub, herbs, and grass species; and height of shrubs over 30 centimeters high. The line-intercept method was used to estimate shrub inter-distance, cover, and height within the study area. The team used the Mann-Whitney non-parametric test to find differences between vegetation variables at observation and random points. Data means and standard deviations were stated. The significance level was $p < 0.01$. Statistical calculations were done using JMP Version 8. The team also photographed the sample plots and collected sample specimens of plant species if not identified in the field.

Appendix A shows a comparison of plant species diversity, density, and coverage at observation and random points. Appendix B shows average cover and frequency of plant species per square meter area at observation and random plots. Appendix C lists the dominant vegetation types in the Galba Gobi IBA.

### *Observations of other wildlife species*

Incidental locations of other wildlife species such as Wild Ass, Goitered Gazelle, Long-eared Jerboa, and Lesser Kestrel were also recorded during the study period (Figure 9). Data were recorded on the same datasheet that was used for Houbara Bustard transect survey. It was not the intent of the team to record age and sex of animals because time was limited; therefore the team focused on only the location and number of wild ungulates in the Galba Gobi. For small mammals and birds, the team did not attempt to carry out systematic survey, thus observations are purely incidental and can be used only for general documentation purpose.

**Figure 9. A small herd of Wild Ass is carefully approaching water** *(photo by Axel Bräunlich /WSCC)*

***Modeling Houbara Bustard suitable habitat using GIS***

A land-use map and data was not available or very limited. Only unpaved roads, administration boundaries, sum and village centers, and mine site GIS data were available. The team obtained GIS shapefiles of existing and planned roads, dirt roads, IBA and protected area boundaries, and ecosystem maps from various sources. The data layer of major local dirt roads was obtained from National Geo-Information Centre and a layer of existing and planned roads from Ouy Tolgoi to the border was provided by Ivanhoe Mines. Boundary polygons for state special protected areas were provided by WWF Mongolia. A GIS data layer showing the exploration and mining licenses in Mongolia, current as of May 19, 2008, was obtained from the Department of Geological and Mining Cadastre of the Mineral Resources and Petroleum Authority of Mongolia. One-kilometer resolution temperature and precipitation data was downloaded from the Global Climate Data warehouse (Hijmans and others 2005). Base terrain data, Digital Terrain Elevation Data (DTEM), was downloaded from the USGS-Earth Explorer website. The DTEM global coverage has 3 arc seconds (~80 meters) spatial resolution. All original data were expressed in geographic coordinates, therefore they were transformed into Universal Transverse Mercator (UTM) coordinate systems before doing any processing occurred.

Based on the above data sources, the team developed a spatial distribution model that shows current habitats and areas to consider reducing negative effects of development on the Houbara Bustards. The team selected 6 factors in the model shown in Table 2 and assigned values to each pixel.

**Table 2. Binary factors and associated criteria, category, and values to be used in the study**

| Ranking Factor | Pixel Criteria | Pixel Value | |
|---|---|---|---|
| | | True | False |
| 1. Elevation | 80 meters pixels, derived from USGS DTEM, regionwide data available | 1 | 0 |
| 2. Slope | % slope, derived from DTEM | 1 | 0 |
| 3. Settlement | Locations of sum and bag centers and an area of 3-km radius | 1 | 0 |
| 4. Roads | All local roads including road to border | 1 | 0 |
| 5. Saxaul forest | Proportion of 80 meters pixels | 1 | 0 |
| 6. Core areas | Observed location and 5 km radius | 1 | 0 |

***Data analysis***

***Apparent nest success of Saker Falcons.*** Nesting success was calculated as the percentage of observed nesting attempts that were successful. This approach is referred to as *apparent nest success*. The formula for apparent nest success is:

$$P = \frac{Ns}{Ns + Nu}$$

In this formula, Ns and Nu are the observed numbers of successful and unsuccessful nests, respectively. The apparent nest success estimate method tends to overestimate true success for clutches found at a later date (Jehle and others 2004; Rotella and others 2000); therefore, a careful interpretation is needed.

***Population estimate of Houbara Bustards***. The team used Distance 5.2 Program for density estimation. It provides an analysis of distance sampling data to estimate density and abundance of a population. The Distance 5.2 Program uses the perpendicular distance of the object on transect line and the bearing angle from the transect line to the point at which individual Houbara are first detected. It assumes that the locations of objects directly on the line are never missed, the points are fixed at the initial sighting position, the distance and angles are measured accurately, and the sightings are independent events (Buckland and others 1993). However, a minimum of 30 objects are needed per transect survey to obtain data for meaningful estimates. In practical terms, this number of objects is difficult to obtain for species as elusive to detect as Houbara Bustards. But the team proceeded with the approach since it is a preferred method for Houbara Bustard population studies in other countries (Gubin 2009; Tourenq and others 2004).

***Movement and habitat use of Saker Falcon***. ArcView 3.2 and ArcGIS 9.2 (Environmental Systems Research Institute, Inc., Redlands, California, USA) and Google Earth 5.0 (Google, Mountain View, California, USA) were used to plot and analyze the telemetry locations. Locations corresponding to movements in which the birds covered unrealistically long distances in a very short period of time were excluded from analysis.

The team used a fixed kernel estimator with least-squares cross validation in the Animal Movement Analyst Extension version 2.0 for ArcView (Hooge & Eichenlaub 2000) to estimate the home range of Saker Falcons during the nesting period, and area use of Houbara Bustard, Wild Ass, and Black-tailed Gazelle in Galba Gobi. Kernel estimators are based on probability “kernels”, which are regions around each point location containing some likelihood of animal presence. It is considered one of the robust probability techniques (Powell 2000).

Before running the analysis the team assumed all wild ungulate locations are independent and come from one population. Four different levels (65, 75, 85, and 95 percent areas) were selected for Wild Ass and Goitered Gazelle because they usually give better information about the area used by wild animals when used by researchers for exploratory or descriptive purposes. The 50 percent area is considered the core area of activity and recommended for statistical comparisons (Hooge & Eichenlaub 2000).

Infrastructure, mine, and road distribution information were related with Saker Falcon and Houbara Bustard nesting and habitat use. The team used the Geographical Information System software, ArcView 3.2 and ArcGIS 9.3 versions (ESRI Inc.), to assess whether existing roads and mining-related activities have impacts on these species distribution and nesting success.

# Results of the Survey

## *Distribution and Population Density of Houbara Bustards*

During the project study period and field survey activities, the team collected a total of 85 records associated with Houbara Bustards in Galba Gobi. It includes direct observations of 32 live bird encounters (excluding 9 birds probably double-counted in short time period at same locations), dozens of feathers, droppings, and tracks (Table 3). Records also include communications from local people and notes from border guards or mine workers who happen to see Bustards in this area. Also the team was able to obtain 15 historical observations from researchers, with the majority from Professor N. Batsaikhan at the National University of Mongolia. This information was helpful to identify the spatial distribution of Houbara Bustards in Galba Gobi.

**Table 3. Sources of Houbara Bustard observations**

| Remarks | Total | % |
|---|---|---|
| Local people* | 7 | 8 |
| Historical record* | 15 | 18 |
| Found dropping | 17 | 20 |
| Found feathers | 14 | 16 |
| Live birds seen | 32 | 38 |
| ***Total*** | ***85*** | ***100*** |

**not included in density estimate*

The Houbara Bustard was found throughout the shrub-dominated, desertified steppe, semi-desert, and desert habitats of the Galba Gobi. They were seen near dry riverbeds and open areas with shrubs, but not in saxaul forests and places with tall trees and woods.

The team organized 4 line transect surveys by car during the study period. The number of Houbara Bustard sightings ranged from 6 to 30 during each survey period (Figure 10). Density estimates of Houbara Bustards sightings ranged from a minimum of 0.03 per square kilometers in April to a maximum of 0.22 per kilometers in June (Table 4). The density of Houbara Bustards in Asia ranges between 0.009 to 0.2 per square kilometers (Tourenq and others 2005). The survey results show that the density of Houbara Bustards in the Galba Gobi IBA is within this Asian range. But the team's density estimates are probably overestimated. Coefficient of variation of more than 40 percent is usually an indication of low precision estimates due to small sample size (Buckland and others 1993), though the April count has a coefficient of variation less than 40 percent. Also, a higher number of birds seen in June is most likely related to the species seasonal behavior since in June most chicks are out and females are more actively foraging. Also increasing observation experience of researchers may have slightly affected the data.

**Figure 10. Houbara Bustard records in the Galba Gobi IBA**

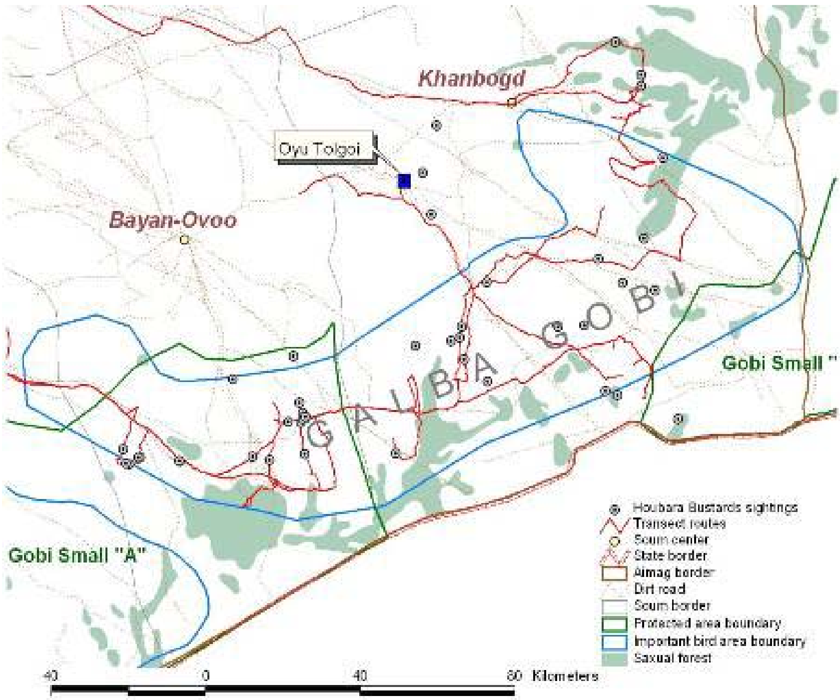



**Table 4. Population density estimates, 95% confidence intervals, coefficients of variation from car transect survey for Houbara Bustards in the Galba Gobi IBA**

| Months | Density estimate | AIC | Area surveyed (km2) | Sightings | Lower 95% CI | Upper 95% CI | Coefficient of Variation |
|---|---|---|---|---|---|---|---|
| April | 0.030 | 134.52 | 665.8 | 15 | 0.016 | 0.058 | 0.329 |
| May | 0.187 | 46.17 | 91 | 17 | 0.057 | 0.615 | 0.551 |
| June | 0.218 | 145.56 | 137.5 | 30 | 0.054 | 0.874 | 0.732 |
| Jul & Aug | 0.082 | 24.09 | 73.5 | 6 | 0.002 | 4.259 | 0.755 |

According to local people, the Houbara Bustards are sighted infrequently in the Gobi. It is extremely hard to see and identify them without previous experience. Also, locals reported to the team that hunters from Qatar began expeditions to this area in recent years. In fact, one of their campsites from 2008 was located during the survey. Herders were little informed about what game was being hunted although it is very likely that Houbara Bustard is one of their main target game species. Skeletal and feather remains of Houbara Bustards were found at the campsite.

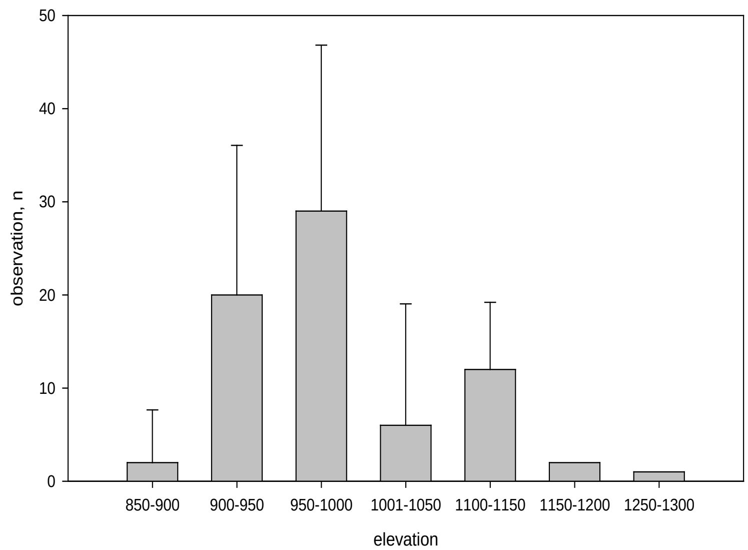
Although the survey resulted in a slight overestimate, the density estimate overall follows the seasonal change of the species. Houbara Bustards are very elusive, and it is more difficult to detect or see them when females are incubating eggs in April and May. But once eggs are hatched, chicks can walk with the mother and start to forage, or mothers can spend more time foraging; this increases their detection greatly (the team saw more birds in May and June). At the end of July, temperature in Gobi becomes very hot and bustards start preparing for long flights. They actively search for nutritious food to store more fat reserve and during this time they cover greatest foraging distances. Also this is the time when birds start disappearing from around the breeding area (Gubin 2009). It was impossible to know if they leave the breeding area or how far they fly from the nesting area without actually putting tracking devices on the birds.

## *GIS Model for Houbara Bustard distribution*

The team started the habitat model by building relationships between habitat variables and Houbara Bustard location information. The Houbara Bustards distribution range was determined using available occurrence information and field data collected in 2009. All 85 records including historical data were used for GIS analysis. Distribution range boundary was limited to the extent of the study area and additional areas visited. Modeled distribution range was the product of slope and elevation since the team did not have reliable vegetation- and habitat-coverage maps. Appendix D shows the GIS data layers utilized in this portion of the project.

Houbara Bustard sightings were in areas with elevation between 850 and 1,300 meters above sea level in 2009. Thus only areas where the elevation is less than 1,300 meters above sea level will be considered as suitable habitat locations in Galba Gobi (Figure 11).

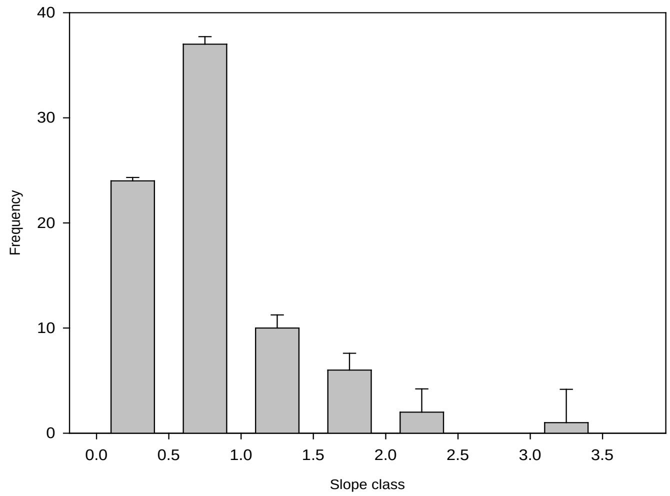
**Figure 11. Frequency of Houbara Bustard observations by elevation** (2009 field data)




The slope of the terrain is the most important habitat feature constraining the occurrence of the Houbara Bustard (Carrascal and others 2008). Houbara Bustards prefer to nest in areas where the slope of the terrain is minimal. Habitats on slopes that are steeper than 3.5 degree have low potential for nesting or regular occupation. Therefore, areas where the slope of the terrain is less than 3.5 degree were considered as suitable habitat locations (Figure 12).

Roads are one of the main influencing factors for Bustards (Hereda 1995). We predicted that the impact of roads on Houbara Bustard nesting habitat will increase proportionately with the road size and the frequency of usage as it was observed in other wildlife species (Rowland 2005; van der Zande and others 1980). We considered strip areas of 500 meters along two sides of roads have zero or low probability of nesting and are thus unsuitable. The 500-meter buffer is probably a conservative estimate, since the species normally occupy open habitat.

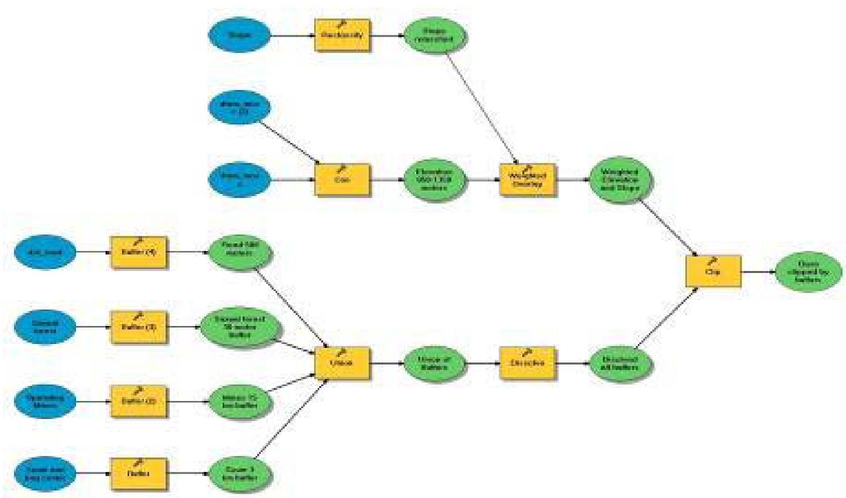
**Figure 12. Frequency of Houbara Bustard observations by slope** (2009 field data)




The team created 3-kilometer buffers around each human settlement assuming Houbara Bustards do not come close to towns. Also the team created a 30-kilometer buffer around the mine where most impacts will occur, and bustards will most likely not occupy this area for nesting.

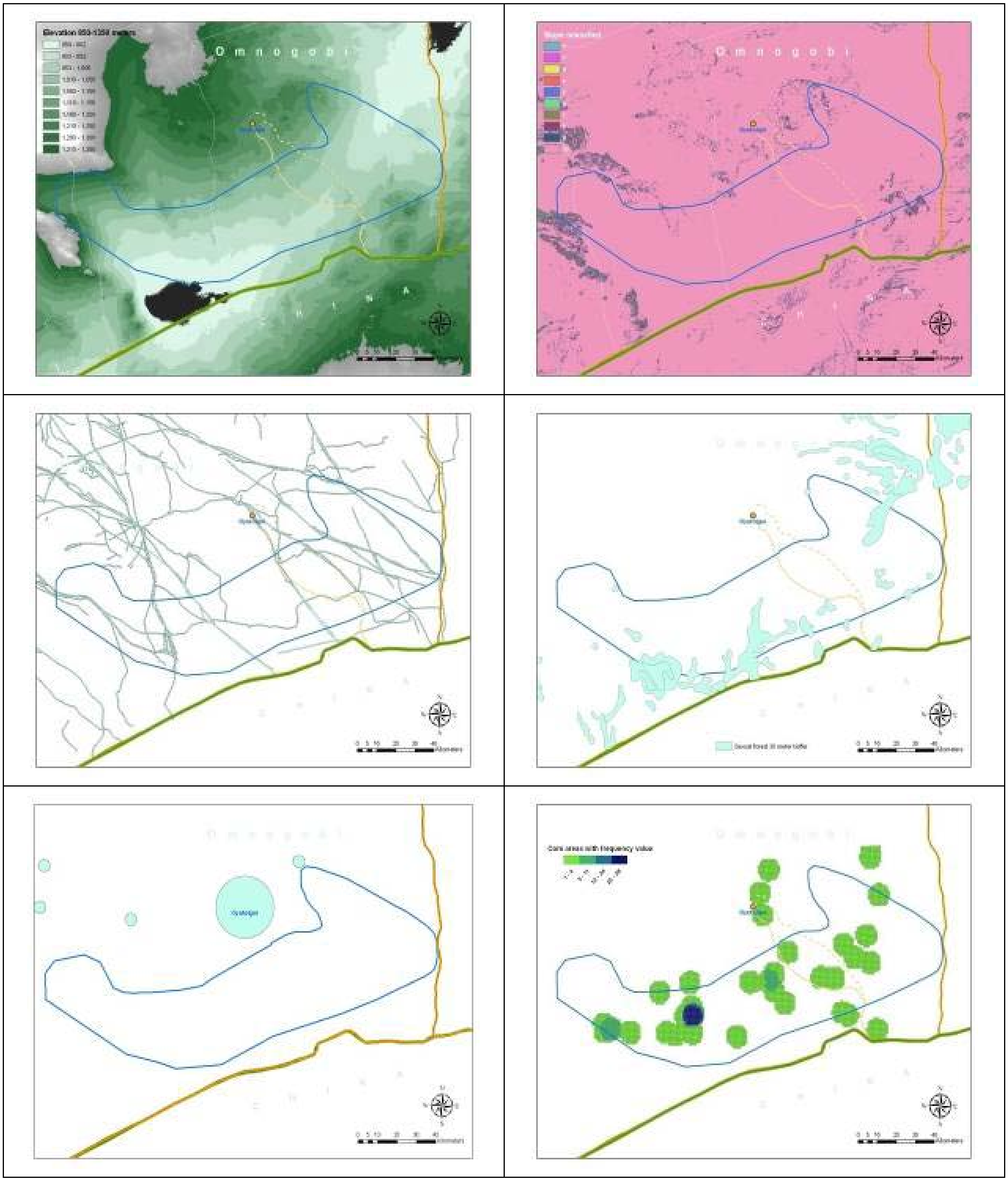
The team knows Houbara Bustards do not live close to saxaul forests because of potential predation by raptors. Therefore, the team created 30-meter buffers outside every saxaul forest patch. All these data processing was done during the initial steps of the model building as shown in Figure 13.

**Figure 13. Scheme of GIS habitat model building**



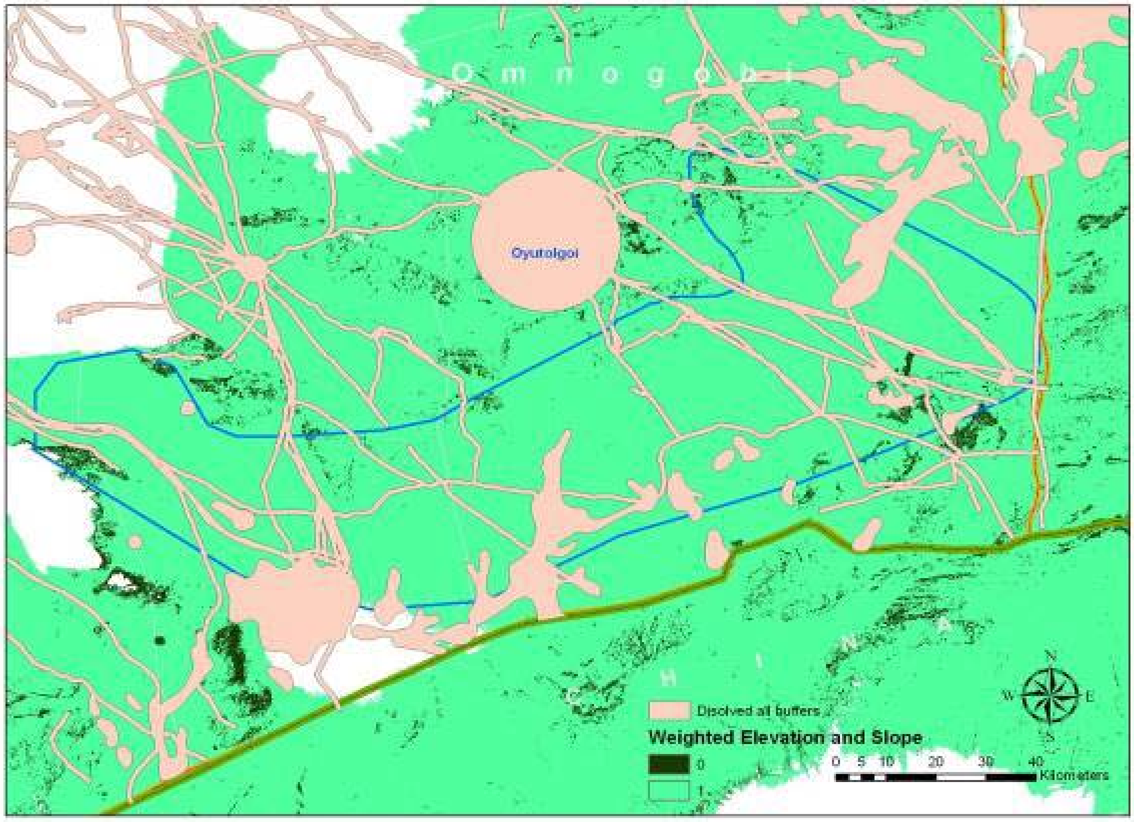
After data processing the team was able to join and overlay physical environment information with the Houbara Bustard distribution. Each data layer, as processed during this model building exercise, is shown in Figure 14.

**Figure 14. Data layers used in the model building**



The final model is shown in Figure 15. Based on this model output, it was apparent that the Houbara Bustards are under great pressure from local land use and potential future economic development. The species' breeding range is greatly intersected by roads and frequent disturbance seems to be a major issue.

**Figure 15. Potential Houbara Bustard habitats**




*Note:* Green areas are habitats remaining and potential habitats for nesting and summering. The dark green, pink, and white areas indicate the unsuitable habitat.

## *Nesting Success of Saker Falcons*

In total, 11 nests of Saker Falcons were located (Table 5). It gives a nesting density estimate of 0.13 breeding pair per area of 100 square kilometers. This indicates that the Galba Gobi is an important area for this species. More nests could be found in more rugged hilly and mountainous areas adjacent to the open area, but were not included in this study.

All nests found were in elm trees situated in valleys in the middle of desert or dry riverbeds near hilly areas. The number of eggs per nest ranged between 3 and 6 with an average of 4.2 eggs. The Saker Falcons normally lay 2-6 eggs with average of 4.3 eggs. Very rarely 7 eggs found (Dixon and others *unpublished data*). The team found 47 eggs in 11 nests. Almost all nests successfully produced at least one chick that reached fledgling age, but the outcome of one pair's nesting success was unknown. The apparent nest success of 10 nests was 33-100 percent in 2009. Their nesting was very much associated with woodland patches that are commonly found in the Galba Gobi. In fact, it was common for different species of birds of prey to be using the same woodland patches. It is an indication of the importance of those woodland patches and an indication of lack of suitable nesting sites. Breeding sites are a limiting factor for such raptor species.

**Table 5. Nesting success of Saker Falcons**

| *Nest ID* | *Number of eggs* | *Number of dead eggs* | *Number of dead chicks* | *Number of fledged young* | *% of egg loss* | *% of chick loss* | *% apparent nest success* |
|---|---|---|---|---|---|---|---|
| GGoo1 | 5 | 1 | 0 | 4 | 20 | 80 | 80 |
| GGoo2 | 6 | 0 | 4 | 2 | 0 | 33 | 33 |
| GGoo3 | 3 | 2 | 0 | 1 | 67 | 33 | 33 |
| GGoo4 | 4 | 0 | 0 | 4 | 0 | 100 | 100 |
| GGoo5 | 5 | 0 | 0 | 5 | 0 | 100 | 100 |
| GGoo6 | 3 | 0 | 0 | 3 | 0 | 100 | 100 |
| GGoo7 | 3 | | | NA | NA | NA | NA |
| GGoo8 | 5 | 0 | 0 | 5 | 0 | 100 | 100 |
| GGoo9 | 4 | 0 | 0 | 4 | 0 | 100 | 100 |
| GGo10 | 4 | 0 | 1 | 3 | 0 | 75 | 75 |
| GG011 | 5 | 0 | 0 | 5 | 0 | 100 | 100 |

The team did not see any apparent evidence of direct impact from road on nesting success of Saker Falcons. It might be better to study indirect effects of noise, dust, and vehicle light on rodents and spatial location of prey distribution.

There were 2 nests relatively close to the Tavan Tolgoi coal transportation road. Both nest ID GG001 and GG011 completed nesting attempts successfully, with 80 percent and 100 percent of nesting success, respectively. One egg in the nest GG001 did not hatch, while 4 nestlings reached fledgling age. Four chicks of the nest GG002 died due to what looked like malnutrition, despite the fact that the team did not see obvious prey shortage in that area. There were 6 young when the team visited on May 19, 2009, but only 2 had remained when visited again on June 9. However, these 2 chicks looked healthy. Raising 6 nestlings is above the average for Saker Falcons. But if food supply is not depressed, no intentional disturbance occurs; or no effect of contaminants is involved, then the raising of 6 nestlings is not a problem for Saker Falcons. In some other areas in Mongolia, it was observed that older nestlings accidently push younger or weaker nestlings out of the nest causing them to die naturally or be predated. Also strong winds can sometimes blow weakened nestlings out of nests (Dixon and others 2008; Gombobaatar 2006).

## *Area use of Saker Falcons*

One female, one male, and one juvenile Saker Falcon were satellite tagged in June and July 2009. It was not the team's intention to selectively catch different sexes and ages, but the capture ended up with a good combination.

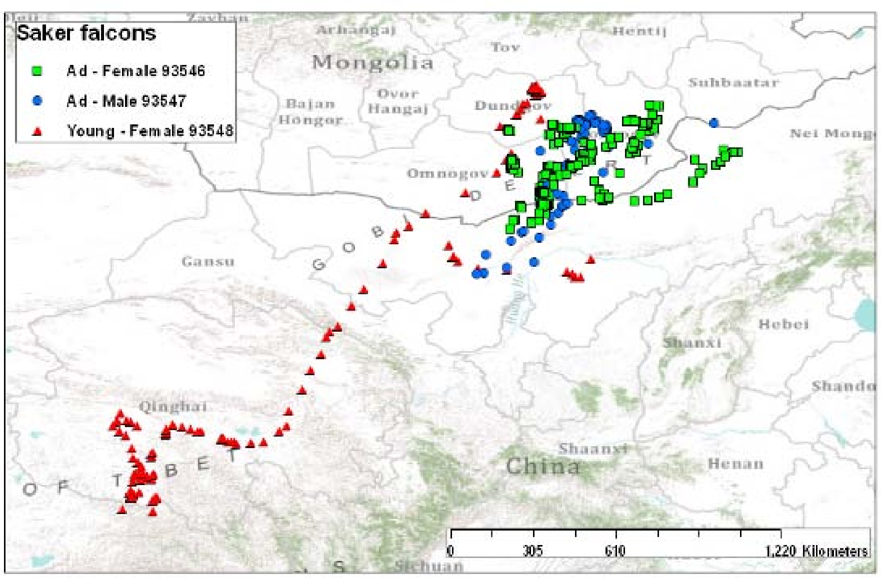
A total of 1,487 GPS locations were obtained for 261 days from June 6, 2009, through February 22, 2010, from 3 birds marked in the Galba Gobi IBA (1 female is still transmitting signals). Successful data transmission by individual birds ranged from 112 to 248 days. The GPS locations included an average of 508 fixes per bird ranging from 34 to 323 locations per month (Table 6).

**Table 6. Data on satellite-tracked birds and locations from mid-June 2009 to early October 2010**

| ***Bird ID*** | ***Sex*** | ***Age*** | ***Capture date*** | ***Number of GPS fixes obtained*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ***Jun 09*** | ***Jul 09*** | ***Aug 09*** | ***Sep 09*** | ***Oct 09*** | ***Nov 09*** | ***Dec 09*** | ***Jan 10*** | ***Feb 10*** | ***Total*** |
| Galba 93546 | F | Ad | 06/06/09 | 47 | 118 | 83 | 75 | 90 | 72 | 34 | 40 | 33 | 592 |
| Gobi 93547 | M | Ad | 06/09/09 | 43 | 144 | 110 | 123 | 24 | | | | | 444 |
| Zaluu 93548 | F | Juv | 07/24/09 | | 22 | 110 | 125 | 113 | 72 | 7 | 1 | 1 | 451 |
| ***Total*** | | | | ***90*** | ***284*** | ***303*** | ***323*** | ***227*** | ***144*** | ***41*** | ***41*** | ***34*** | ***1,487*** |

Overall, adult Saker Falcons that bred in Galba Gobi IBA showed highly mobile or nomadic behavior during post-breeding and wintering period. Satellite tracking data show that individual birds greatly varied in their hunting and migration behavior (Figure 16). The general movement and migration patterns of individuals were markedly different. Young falcon did migrate to western China in winter, whereas adults wandered around throughout winter covering large areas. But the adult Saker Falcons regularly came back to the breeding area during the non breeding season. It can be explained as defensive behavior towards nesting territory. A brief summary of each of the three birds movements are given in Appendix E.

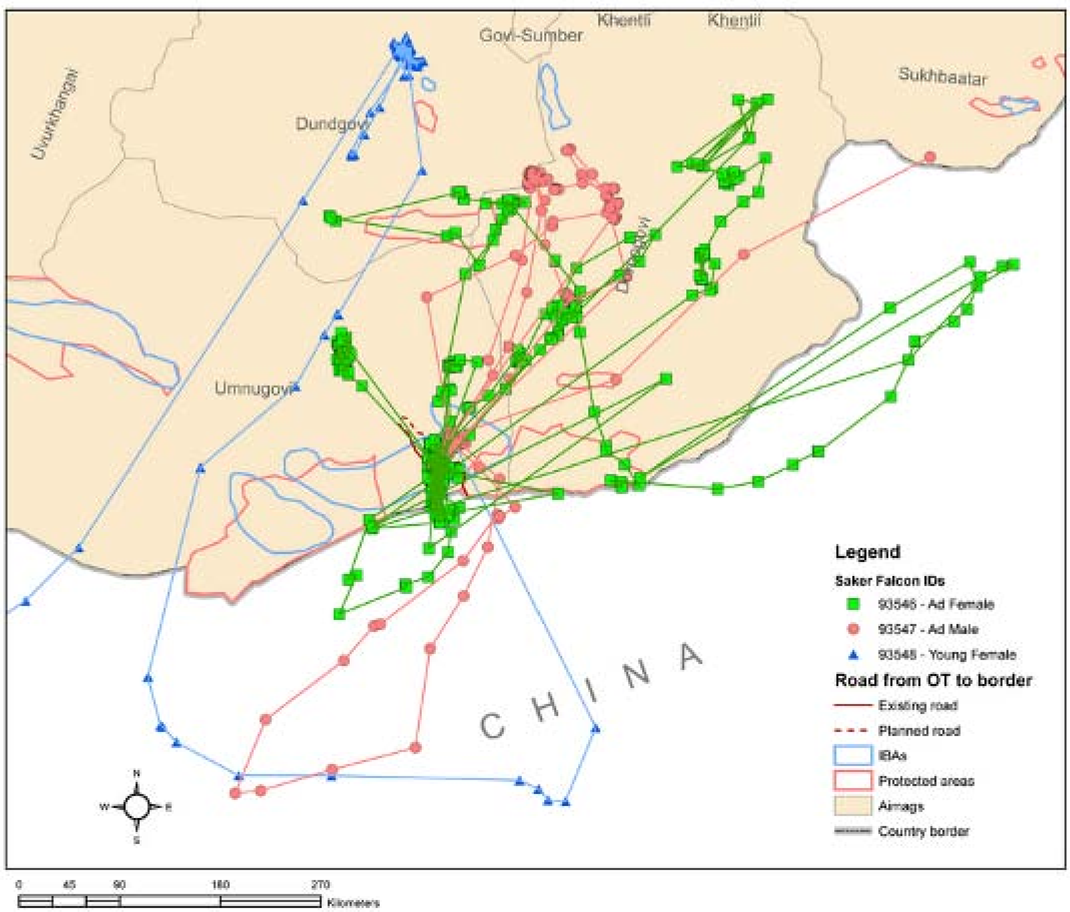
**Figure 16. Locations of satellite-tracked Saker Falcons in southern Mongolia**




*Note*: Green square is female, blue circle is male, red triangle is young female.

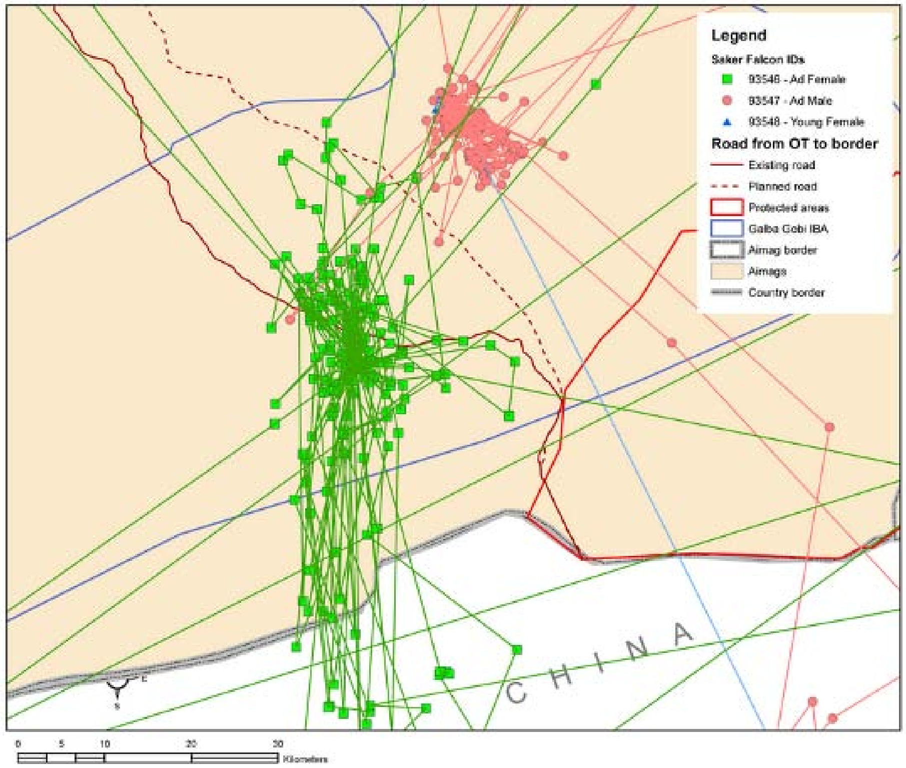
After nesting season, all birds moved north to varying distances (Figure 17). Southward migration started in September but only the young Saker Falcon migrated to wintering areas on the Qinghai–Tibetan Plateau. Adults were behaving like sedentary or nomadic birds. They were making short distance movements within Mongolia and some areas in northern China. During the post-breeding and wintering period, adults made several returns to the nesting areas. Both adults used different foraging areas, but both were coming back to their nesting area after spending some time away from the nest site. This individual variation is likely to be related to age and sex differences among birds and differing external environmental influences such as food supply and weather conditions. Such nomadic behavior with adults staying near breeding territory all winter was also observed in Saker Falcons from central Mongolia (Potapov and 2001a).

**Figure 17. Movement of satellite-marked three Saker Falcons within Mongolia**




Satellite tracking data shows that the hunting range of a female falcon that bred at Sukhain Toiruu overlaps with the existing road and planned road (Figure 18), but no obvious impact was observed. The satellite tracking data of the male that nested in Baga Modnii Khudag shows a smaller foraging range.

**Figure 18. Area use of adult Saker Falcons near Tavan Tolgoi coal transport road**



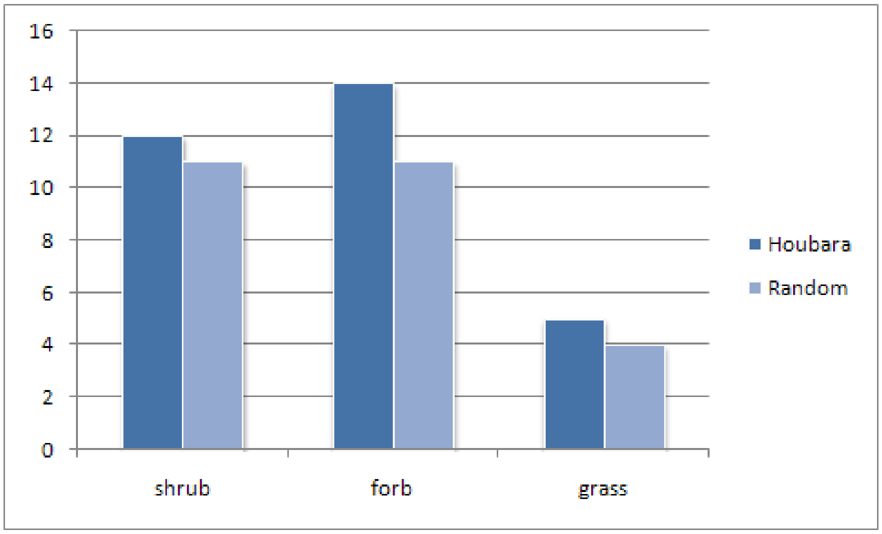

## *Vegetation Survey*

Vegetation data was collected from June 20-21 and from July 28 -August 3, 2009. Vegetation in the study area was characterized by a mixture of species that occur in semi-desert steppe, desert steppe, steppified desert, and true desert habitats. A total of 32 plant species that belong to 14 families and 29 genera were identified. Of them 39 percent were shrubs, 43 percent forbs, and 18 percent were grasses (Appendices A and B). The number of species recorded from sampling plots ranged between 1 and 11, which is typical of various desert habitats. A total of 39 plant communities were recorded in the Galba Gobi IBA.

The following plant species were recorded as dominant throughout the survey area (Appendix C): *Anabasis brevifolia*, *Artemisia scoparia*, *Ajania achilleoides*, *Peganum nigellastrum*, *Reaumuria soongorica*, *Salsola passerina*, *Stipa gobica "glariosa"*, and *Nitraria sibirica*. From them, *Ajania achilleoides* was more common at Houbara observation points, *Peganum nigellastrum* was common at random points, *Anabasis brevifolia* and *Salsola passerine* were most common at both points (Figure 19). These species formed the main plant associations at various locations.

The vegetation community types in the Galba Gobi IBA were dominated by shrubs. Most common shrub community types were *Anabasis brevifolia* and *Anabasis brevifolia+ Salsola passerina*. These types of shrubs were dominant at both observation and random plots. Subdominant vegetation community types were *Salsola passerina+Anabasis brevifolia*, *Anabasis brevifolia+Artemisia scoparia*, and *Salsola passerina+ Reaumuria soongorica*.

**Figure 19. Comparison of plant life forms at observation and random points**




Vegetation cover was relatively low throughout the study area at 2.9 percent on average per sample plot. Thirty-two plant species were recorded from Houbara observation points and 27 from random points. The team did not find significant differences in plant species richness ($z$= -1.714, $p$>0.086), vegetation cover ($z$= -0.74116, $p$>0.4586), density ($z$= -0,52923, $p$>0.5966), frequency ($z$= 1.72746, $p$>0.0841), shrub coverage ($z$= -1,44499, $p$>0.1485), maximum height of shrubs ($z$= -0.23214, $p$>0.8164**),** and coverage of shrubs with greater than 30-centimeters height ($z$= -0.2191, $p$>0.8261) at random and observation points. Average height of shrubs at both sampling plots was around 26 centimeters. In general, the team did not find strong differences between vegetation variables measured at observation and random points. It could be an indication that the Bustards have a broad range of habitat types in Galba Gobi IBA (Figure 20).

**Figure 20. Typical habitat for Houbara Bustards in Galba Gobi** *(photo by B.Nyambayar/WSCC)*

The team observed a tendency of vegetation cover degradation near water points and along vehicle roads in Galba Gobi. The team documented saxaul forest fire evidence at Daichingiin Zag (one of Saker Falcon nests was found at this location), and apparently it was caused by people passing through this area. Saxaul fire has not been reported previously in this country. In Mongolia, it should be a big concern because saxaul trees and forests provide extremely important cover and nesting places for many birds and mammal species. Most importantly, the saxaul forest contribution to the local ecosystem as habitat is matchless and crucial for biodiversity in the area.

## *Other Wildlife*

A total of 77 species of birds were recorded, including 4 globally threatened and 1 near-threatened species. The GPS coordinates for all observations were recorded by the team and are stored in the expedition's log. During the survey, the team discovered and photographed a male Rufous-faced Warbler Abroscopus albogularis at Ikh Bologijn Am near Khanbogd Sum on April 12, 2009. This observation constitutes a first record for Mongolia.

Recordings of 14 mammal species were made during the survey in Galba Gobi IBA. No Mongolian Gazelle were observed within the Galba Gobi IBA, but the team recorded them near the coal transportation road south of Tsogttsetsii sum. More research is needed to clarify the status of these species.

The team collected important data on the distribution and number of Wild Ass and Goitered Gazelles inhabiting the Galba Gobi. The 95 percent home range estimate using fixed kernel with least squares cross validation smoothing resulted in areas of 5737.0 square kilometers and 10,271.1 kilometers for Goitered Gazelles and Wild Ass, respectively. Goitered Gazelles were distributed throughout the Galba Gobi, whereas Wild Ass mostly occupied areas east of the Tavan Tolgoi coal road that cuts through the Galba Gobi IBA (Figures 21 and 22).

**Figure 21. Fixed kernel foraging range of Wild Ass in spring**

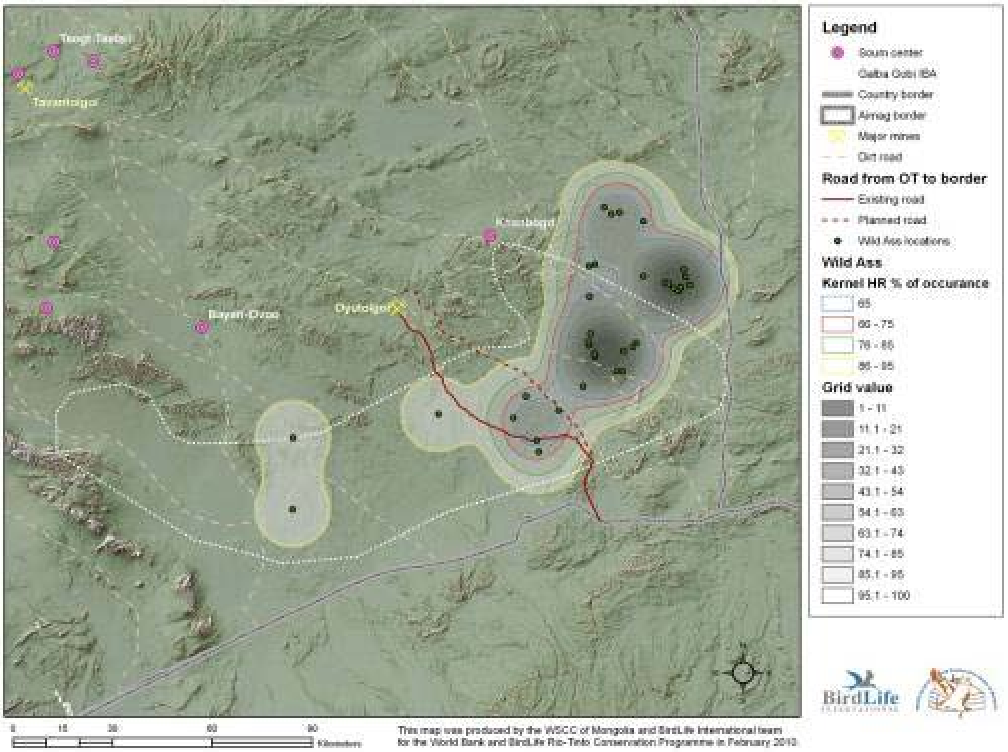
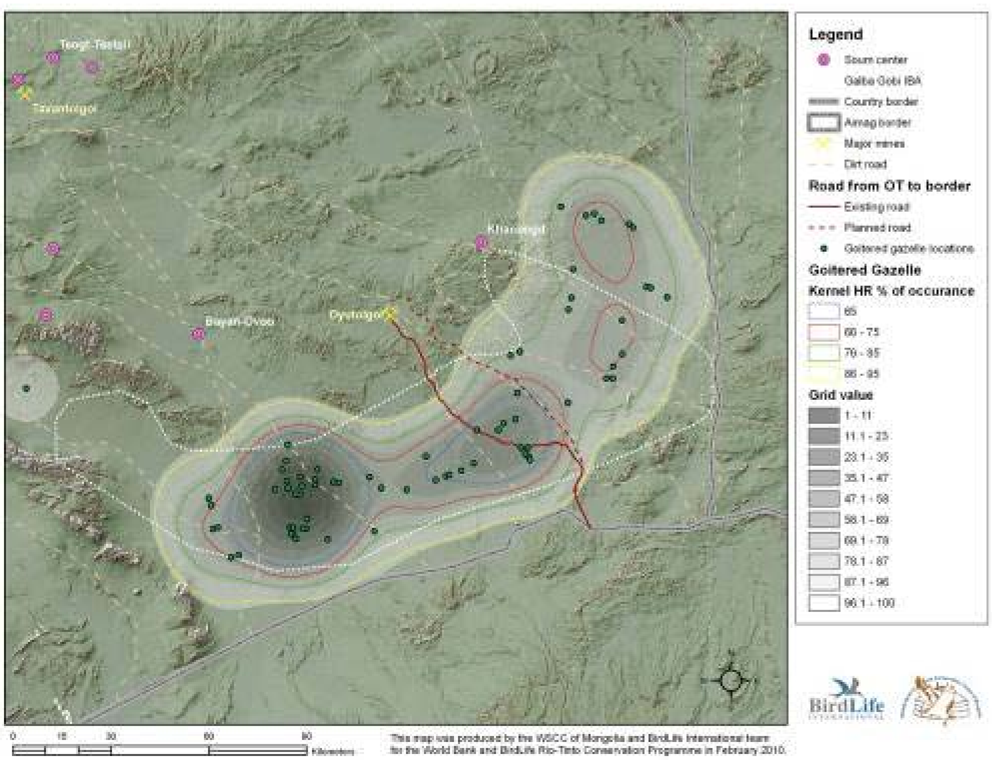



**Figure 22. Fixed kernel foraging range of Goitered Gazelle in spring**



# Further Discussion of Issues

The study demonstrated that the Galba Gobi was well fitted by the international criteria to qualify as an Important Bird Area (Nyambayar & Tseveenmyadag 2009). The number of Houbara Bustards and Saker Falcons observed by the team during the short study period was a clear indication of the importance of this area for these two globally threatened species. In fact, stricter conservation and management actions should be developed and implemented in this area to safeguard these species.

The Houbara Bustard occurs throughout flat and slightly undulating desert steppe with the altitude of between 850 and 1,300 meters above sea level in the Galba Gobi. In order to exist and maintain a population, they need healthy shrub cover and no disturbance.

One of the biggest threats to the Gobi landscape is the vehicle movement and is a significant source of disturbance on nesting Houbara Bustards. Vehicles leave long-lasting tracks on fragile sandy soil. The GIS model shows the Galba Gobi is significantly marked with vehicle tracks and nesting birds are most likely disturbed frequently. But the GIS data used in the analysis is somewhat limited because there was no attribute table related to the frequency of road use in different parts of the Gobi. Normally, different level of road usage should result in different disturbance levels on nesting Bustards. Since the team did not have sufficient information, it could not further explore the result. In any case, this species requires zero or minimum disturbance to successfully breed and raise their chicks (Gubin 2009).

Houbara Bustards choose sparsely vegetated areas with short shrubs. This allows them to spot an approaching predator at a reasonable distance (Combreau & Smith 1997; Yang and others 2003). The Houbara Bustard habitat in the Galba Gobi was similar to habitats described in China and Kazakhstan, which is also characterized by sparsely vegetated arid desert. The Galba Gobi habitat was similar to what was described as preferred habitat in the Mori Desert, Xinjiang region, in northern China. Plant species richness index in the study area was 4.2 at Houbara locations and 3.6 at random locations. The plant species richness index in the Mori Desert of China was 4.4 at Houbara locations and 6.49 at random locations (Yang and others 2003).

The display sites are the places where many males show their breeding rituals to attract females and eventually to mate. Male Houbara Bustards are more selective when choosing display sites because of safety. Houbara Bustards in China, preferred display sites in open areas with a low vegetation cover and close to well-vegetated patches for foraging or escaping from predators (Yang and others 2003). It has been well documented that human activities, such as agriculture, urban development, mine, and network of rural tracks and paved roads, significantly affect the distribution of Houbara Bustards (Carrascal and others 2008; Le Cuziat and others 2005). In Eastern Morocco, the Houbara Bustards showed significant avoidance of grazing in areas frequented by sheep and goats. Especially such sensitivity was significant when males start displaying. Therefore, increased number of livestock and human activity could cause disturbance to nesting birds and cause them permanently to abandon lek and nesting areas.

Large-size avian species in open country are often reported to collide with powerlines. Bustards are especially vulnerable. According to a specific study conducted in Spain, the highest bird mortality from powerline collision was recorded for the Great Bustard and Little Bustard, *Otis tarda* and *Otis tetrax*, respectively (Janss & Ferrer 1998) and similar significant observations were made in South Africa with Ludwig's Bustards *Neotis ludwigii* in the Karoo (Jenkins and others 2010).

Compared to other parts of Mongolia, Galba Gobi itself is hardly crossed with electric powerlines. Powerlines are well developed near sum and aimag centers, and between cities. There are no significant powerlines existing within the main Houbara Bustard habitats in the Galba Gobi. In general, the collision of Houbara Bustards with powerlines has never been documented in Mongolia, probably because the number and distribution of powerlines within the species range is not high in this country. However, on the other hand, such incidents are difficult to monitor and report. Carcasses resulting from collisions are frequently scavenged and removed from the site by predators.

Significant mortalities associated with poorly-designed power poles and wires have already caused deaths of many birds of prey, including Saker Falcons in Khentii and Sukhbaatar aimags (Boldbaatar 2006; Harness and others 2008; Tseveenmyadag 2007); as well as Pallas's Sandgrouses, *Syrrhaptes paradoxus*, and Demoiselle Cranes, *Grus virgo*, in Ovorkhangai aimag (Nyambayar 2008). The potential threats to the life of these birds must be considered as Mongolia continues its development of its powerline network throughout the nation.

Saker Falcon nesting density of 0.13 breeding pair per areas of 100 square kilometers is a clear indication showing importance of the Galba Gobi for the species. Although this study mainly concentrated on open area, the team has no doubt about the possibility of finding more nests in nearby rugged hilly and mountainous area. Areas south of the Oyu Tolgoi mine and Khanbogd sum are ideal places for nesting raptors. The team made shorts trips and found species such as Saker Falcon; Lesser Kestrel, *Falco naumanni*; Amur Falcon, *Falco amurensis*; Steppe Eagle, *Aquila nipalensis*; Short-toed Snake Eagle, *Circaetus gallicus*; Little Owl, *Athene noctua*; Long-eared owl, *Asio otus*; and Eurasian Eagle Owl, *Bubo bubo,* nesting in this area.

Saker Falcons are highly dependent on old mature trees and saxauls in the open landscape in Gobi. There are few man-made structures suitable for falcons to use in Galba Gobi. All nests found by the team were in mature elm trees located in dry riverbeds or on the edge of small wooded areas. They shared wooded patches with other raptors such as Black Kite, *Milvus migrans*; Amur Falcon; Common Kestrel; Lesser Kestrel; and Upland Buzzard. In addition, the team observed that there were few saxaul seedlings, and in some areas the saxaul forest was affected by burrowing rodents. In one instance the team documented a saxaul forest fire in one of the locations where we found a Saker Falcon nest. Fortunately, the nest survived because it was located upwind of the fire.

Satellite-tracking data showed that adult Saker Falcons that breed in the Galba Gobi are not migratory, but they are highly nomadic. Female falcons traveled extensively and covered greater distances than male falcons during the nesting season. Both adults made long nomadic travels outside the breeding season, and committed regular return visits to the nesting territory in order to maintain nesting territory. Nesting territory is the core area for Saker Falcons as indicated by satellite-tracked birds. It could be explained by the high cost of finding nest sites in such an open desert steppe region where suitable nesting area is limited by availability of mature trees and suitable rock formations.

Both Goitered Gazelle and Wild Ass are suffering from illegal hunting for meat and skins in southern Mongolia (Reading and others 2001, Clark and others 2006, Stubbe and others 2007). The team saw many Wild Ass carcasses during its survey period. Many of them were poached. Stubbe and others (2007) and Kaczensky and others (2006) have specifically described the poaching impacts on Wild Ass in the southern Gobi.

Furthermore, many nomad herders whom we met were complaining that their pasture land is overlapped with and degraded by the wild ungulates. Feh and others (2001) documented same complains ten years ago. Although horse, camel, goat, and sheep have some degree of overlap with wild ungulates in the Galba Gobi, they have probably lived that way historically for centuries and so overlapping on grazing habitats should not be a significant issue when interaction is minimal. But the recent increase in livestock numbers have brought unprecedented risks to compete for grazing land among livestock and rodents (Retzer 2007), Mongolian Gazelle (Campos-Arceiz and others 2004; Yoshihara and others 2008) , and Wild Ass (Reading and others 2001, Kaczensky and others 2006) in southern Mongolia. Examples from other countries show that grazing can also have direct consequences on the population of ground-nesting birds through clutch destruction by trampling or through direct disturbances of breeding or feeding behaviors (Pavel 2004); and it can also modify vegetation cover (McEvoy and others 2006), alter ground surface microtopography and soil penetration resistance (Stavi and others 2009), or affect ground-dwelling insects and rodent communities (Fehmi and others 2005; Garcia and others 2009; McEvoy and others 2006). Kaczensky and others (2006) noted that the herders stay too close to water sources causing serious disturbance to Wild Ass and other wild animals in Gobi.

The team's observations suggest that the number and frequency of vehicles operating on the existing road from Tavan Tolgoi to the border is already acting as a migration barrier for wild ungulates in southern Gobi. Its impact is, to some extent, similar to a "moving" fence, comprised of convoys of moving trucks. In spring 2009, main concentrating locations of the Wild Ass remained far in the east part of Galba Gobi, whereas the Gazelle were well spread across Gobi with a core spring concentration area in the west, again far away from Tavan Tolgoi – Gashuun Sukhait road. This might be the result of avoidance behavior exhibited by these ungulates. In other words, the areas with higher density of both species were clearly far from the existing road suggesting that traffic, noise, and dust might be causing disturbances to these species. But there is a need to conduct more detailed study to look at the degree on how noise, dust, or heavy traffic is affecting wildlife. More likely it would be a combination of these factors. Hunting pressure associated with such roads may also be a factor.

Wild Ass crossing the Tavan Tolgoi / Gashuun Sukhait road was observed and documented in Petra Kaczensky's report (Kaczensky and others 2006). In her report, most radio-collared Wild Ass did not go further west of the coal transport road, which is also a finding that supports the team's hypothesis of a "deterring fence made of moving trucks". If noise, traffic, and light are deterring animals (e.g, Wild Ass) at significant levels, they are unlikely to approach purpose-built passes designed specifically to allow wildlife movement. While they might habituate to these over time, it is perhaps impossible to predict without further study.

There is a need to further explore the behavior of Wild Ass and Goitered Gazelles. Based on limited observation of the team, the Goitered Gazelles were more mobile and effective in grazing at night compared to Wild Ass, and the Gazelles were able to cross the road at nighttime, which could partially explain its widespread distribution in the Galba Gobi. Also, because most larger animals tend to be more suspicious and sensitive to disturbance, the Wild Ass is more sensitive to noise and large moving objects compared to Gazelles, and they also are often frightened by vehicle lights at night (because poachers use high beam lights when hunting for these animals).

The “deterring fence” is already in effect in south Gobi even before developers begin consideration for creating long fences along rail and auto routes. The fence and transport infrastructure issue is a serious conservation question in southern Gobi. More observation, radio tracking, and further discussion among development, scientific, conservation, and local community groups is needed.

## *Summary of Sensitivities to Endangered Bird Species*

The future of Saker Falcon, Lesser Ketrel, and Houbara Bustard is directly impacted to human activity and the environment.

**Saker Falcon**

- Availability of suitable nesting sites is probably the most limiting environmental factor for Saker Falcons and other raptors inhabiting semi-desert and desert steppe in southern Mongolia.
- Cutting trees and saxaul forest will significantly impact the breeding population of Saker Falcons.
- Lack of young saplings and low growth of trees in the Galba Gobi and other areas in southern Gobi poses future conservation concerns because trees and saxaul forest support an important and complex biodiversity system in this region.
- Trees and forested areas should be taken under special protection by aimag and sum governments.
- Excessive land degradation due to increased off-road traffic, land surface destruction, and surface water reduction can cause population decline in rodent and other prey animals.
- Use of poisonous chemicals or heavy metals is known to have negative effects on reproduction of birds of prey through food chain or rodents and small birds in the case of Saker Falcons. Therefore, uncontrolled, improper, and illegal use of such materials could affect the species.
- Increasing vehicle access and use in the south Gobi could facilitate illegal take of Saker Falcons for falconry markets.

**Lesser Kestrel**

- In terms of breeding habitat requirements, same as Saker Falcons.

**Houbara Bustard**

- Houbara Bustards avoid human activities; any tall and unusual objects and structures in breeding habitat will result in the birds abandoning the area or deter them from using such areas.
- Lek sites are same as display sites and they are the best places where males show their breeding rituals. ”Male Houbara Bustards’ choice of lekking site is specific; they prefer open grassy areas

with a low density of shrubs. Leks are the best indicators of habitat quality and health, thus identification and monitoring of lek areas should be a special consideration.

- Because Houbara Bustards congregate in groups at display or lekking sites, any human activities near lek areas could significantly impact many birds at once, and thus impact breeding productivity for the species in that whole area.
- Overgrazing and frequent livestock activities disturb nesting birds and degrade habitat quality.
- The wintering ground of Houbara Bustards is in west Asia and Middle East, with fall and spring movements generally following east-west-east directions. Overhead powerline construction between Tavan Tolgoi and Oyu Tolgoi to the Chinese border will follow a predominantly north and south direction. Such an imposition across south Gobi flight paths could pose a significant threat to Houbara Bustard migration.
- Increasing road networks and use associated with both direct and incidental development within the south Gobi will increase access and disturbance to optimal Bustard habitat, as well as degrade such habitat, and thus contributing to a decline in quality and quantity of optimal, undisturbed habitat.

## *Summary of Sensitivities to Endangered Large Mammals*

The future of Wild Ass and Goitered Gazelle populations is of real concern.

**Wild Ass (Asian Wild Ass)**

- Wild Ass require large areas to graze and move seasonally, compared to Goitered Gazelle.
- In the arid landscape such as the Galba Gobi where lack of open water is common, the number and availability of water points are important for Wild Ass and other ungulates. Unfortunately, it is also common to see that herders or travelers frequenting the already limited water points and causing disturbance to wildlife (Sheehy and others 2010).
- Overlapping and competition for grazing land with livestock is increasing, and might disrupt wild ungulate’s traditional grazing behavior. This will exacerbate the effects of restrictions on Wild Ass traditional distribution/range in the south Gobi.
- Illegal hunting by artisanal (ninja) miners, travelers, and local people is a prominent problem.
- Wild Ass dig for surface/sub-surface water for survival, and many other animals benefit from such activity. But such surface/sub-surface water resources may well be potentially impacted by future mine-water abstraction or by increasing human occupations indirectly associated with mine development ( World Bank 2009, Walton 2010). Associated increases in livestock numbers may well compete for such surface water.

- Galba Gobi is a migratory corridor for Wild Ass and Goitered Gazelle but is highly disrupted by vehicle tracks and traffic and increased industrial development and associated incidental activity will further contribute to these impacts.
- Heavy railway and highway constructions will create a second major north-south bound migration barrier similar to Ulaanbaatar-Beijing railway and Wild Ass and Goitered Gazelle will likely be trapped between these barriers deepening the crisis of wild ungulate migration in southern Mongolia. Because of such confinement these species will not be able to sustain existing populations. Thus a decline is predicted as a result of such development (unless successful mitigation can be realized).
- Despite the species' formal protection status established since 1953, the Wild Ass has been categorized as endangered and is facing extremely high risk of extinction in the wild according to the recent Mongolian Red Data Book assessment, as it is elsewhere throughout the range of its isolated populations in Asia (Clark and others 2006).

**Goitered (Black-tailed) Gazelle**

Same as for Wild Ass.

# Recommendations

More than 80 percent of Mongolia has been identified as sensitive and vulnerable to climate-driven extremes. In particular, arid southern Mongolian Gobi lands are extremely fragile and any alteration in ecosystem quality may result in environmental degradation with wider and long-term implications for biodiversity.

One of the major conservation challenges is minimizing the impacts of infrastructure development on wildlife and their habitats. Many potential impacts to biodiversity can be identified prior to site selection and designing phases, so that developers can include measures to avoid or reduce these impacts. For example, the impacts of transportation infrastructure are often related to the type of transport vehicle as well as the forecast traffic volumes associated with a project. Therefore, the identification of wildlife corridors and key areas are crucial early steps in the design of road and railroad systems.

In the case of southern Mongolia, erecting physical barriers to prevent wildlife collision with vehicles on planned highway and railway routes has become a key topic of discussion among stakeholders, developers, and wildlife specialists, as some of these groups highly support the concept while others oppose it. Furthermore, such prevention and mitigation mechanisms have to be discussed at various governing levels in order for them to be effective and long lasting.

The Saker Falcon and Houbara Bustard studies conducted in the Galba Gobi IBA have revealed that there are major issues affecting these two species, as well as several endangered species of mammal. These species are currently threatened with habitat loss, disturbance, poaching, and potential pressures from development plans which impact the South Gobi Region. Therefore, targeted wildlife conservation, management, and habitat mitigation measures have to be considered at the species, site and regional level. Without improving the regional wildlife protection regulations and standards, and the capacity of environmental agencies and people, the conservation of globally threatened species cannot succeed.

## I. Recommendations for Saker Falcons and Houbara Bustards in the Galba Gobi IBA

The following recommendations are proposed for the next 1.5 – 3 years. There is a need for detailed information to be obtained in order to identify appropriate mitigation actions and their associated costs.

**Saker Falcons**

***Identify Saker Falcon nest location in unsurveyed areas of the Galba Gobi IBA and the South Gobi region.*** The team found that Saker Falcons exhibit high nest site fidelity and nesting locations were limited by nest substrate availability. Therefore, additional surveys to map all nesting sites should be conducted within the next two years. A complete census of nesting locations will provide crucial baseline data for future species management and habitat mitigation measures in the South Gobi.

***Avoid any activities that would result in the destruction of trees and saxaul forest.*** The protection of Saker falcon nesting sites should be achieved through the preservation of trees and saxaul forest, and rock formations where they nest.

Trees provide some of the most important services to the ecosystem, from providing habitats for nesting birds, to capturing carbon dioxide and filtering impurities from the air. The South Gobi Region has very limited tree resources, with trees found in a limited number of areas and the establishment of new trees being a rare occurrence. Thus the availability of suitable trees is the limiting factor to breeding raptor populations. As well as supporting the endangered Saker Falcon and other raptors, these trees provide crucial breeding habitat for many other species, including passerines, wild cats and bats. Trees also maintain the connectivity of resting places for many bird species during migration. Therefore, all activities that impact trees, whether directly or indirectly, must be avoided.

Currently, there is no monitoring scheme in place in southern Mongolia to investigate changes in saxaul forest and woody vegetation resources. With the current projection of population growth in southern Mongolia, and the environmental concerns this raises, it is vital that regulations are developed for the protection of saxaul forest and the use of other woody vegetation resources, whilst also developing alternatives to household firewood use. An example of such an alternative is the development of effective household scale machines that convert livestock dung into household fuel.

Mine operators should annually set aside a fund for tree planting that is accessible to local people and civil organizations. This fund can be used to establish and maintain tree plantations and habitat restoration projects at targeted sites recommended by experts. The amount of dedicated funds available, the number trees planted, and success rate of the project could be used to earn environmental protection credits for the mine operators.

**Houbara Bustards**

***Conduct a detailed study to identify lek sites and map important locations.*** Identification and protection of Houbara Bustard lek sites is the highest priority and requires urgent action in Galba Gobi IBA. Bustards show high fidelity to historical lek and nesting sites regardless of the availability of suitable habitat elsewhere (Hingrat and others 2007; Lane and others 2001 ). The team's limited study found that the Galba Gobi is an important area that regularly supports Houbara Bustards in Mongolia. Therefore, an additional detailed study to map all lek sites and nesting areas should be conducted in the near future in order to provide important baseline data for species management and habitat mitigation measures.

In addition, home range and post breeding areas need to be identified, since these areas are vital to the survival of the Houbara Bustard population. Knowledge of the location of these post breeding and pre-migration areas is vital to achieve successful conservation of the species. Therefore, an extended two year survey to identify Houbara Bustard lek sites, nest sites, and post breeding areas should be conducted from May to July.

***The number and frequency of informal tracks, vehicle use and unregulated movement throughout Houbara Bustard habitat should be strictly controlled and managed.*** Houbara Bustards readily abandon their nests when disturbed by humans and vehicles. Minimizing and regulating vehicle access will also address the associated threats of illegal poaching and hunting of Saker Falcons, Houbara Bustard, Wild Ass, and Goitered Gazelle, and will significantly reduce land degradation caused by vehicle tracks. Vehicle use and movement control regulations for southern Mongolia could also be developed and more strictly enforced. The impact of such regulations could prove crucial in preventing and minimizing soil degradation to the fragile land, as well as preventing disturbance to endangered species.

It is recommended that there be only one main east-to-west highway built along the existing road between Khanbogd, bayan-Ovoo and Nomgon sums, and only one north-south road (there is an existing road-A0203 - which is ideal) connecting to the border post. This has the possibility to significantly reduce the use of existing dirt roads that dissect main wild ungulate foraging areas and nesting habitat for Houbara Bustards in the Galba Gobi. If the traffic volume can be reduced to a minimum, the area south of this highway can potentially be used by wild ungulates to move and forage between west and east of South Gobi.

***Power transmission, road and railway planning, and construction processes must require joint planning by developers and wildlife biologists; and this amendment must be made to the relevant laws and regulations.*** Houbara Bustards are easily disturbed by tall objects and tall structures are perfect perches for large raptors that prey on bustards. Transmission lines should avoid bustard nesting habitat and power companies should consult with wildlife biologists in advance. Therefore, joint planning of power transmission between developers and wildlife biologists is needed, and all measures to avoid critical nesting and lek habitat should be taken. If development is unavoidable, an appropriate conservation offset program must be implemented to benefit the Houbara Bustard.

## II. Recommendations for Wildlife and Habitat Conservation within the wider South Gobi Region

***Develop a regional policy for wildlife and habitat conservation and establish a wildlife habitat mitigation fund.***

Aimag and sum governments must develop habitat safeguard policies with a strict strategy of implementation specific to the region, before major parts of the aimag land mass become the property of private sectors with different backgrounds, prospects and interests. Minimum disturbance and healthy shrub steppe habitat are essential for Houbara Bustards and for many other bird and mammal species. Presently there is no clear and strict policy at the aimag and sum level detailing what percentage of critical natural habitats have to be protected and monitored in order to sustain and support endangered species and a healthy ecosystem.

The Galba Gobi IBA and Part B of the Small Gobi SPA are currently two of the most impacted areas in the South Gobi Region, mainly due to the existing coal transportation road that connects Tavan Tolgoi mine with the Chinese border. The road has already impacted Houbara Bustard distribution and nesting habitats and the free movement of Wild Ass and Goitered Gazelles in the Galba Gobi IBA. This is likely to be the beginning of larger development impacts on regional wildlife habitat, as there are plans to build more roads and railways (to connect mines and transport mine products), a power plant to supply electricity, a copper smelter, an oil refinery, and chemical coking facilities, etc. Inevitably, this development will result in increased disturbance and fragmentation of habitat in the future. Consequently, the area will require more extensive wildlife habitat protection, restoration, and mitigation measures that Mongolia has never previously seen.

The wildlife and habitat monitoring, mitigation and restoration process may require a large amount of finance in this region and a significant part of this funding will need to come from developers. The Government of Mongolia needs to work collaboratively with investors and companies to develop a wildlife conservation and habitat mitigation fund. The Government of Mongolia should also develop and support a creative partnership that ensures adequate funds are devoted to repairing actual impacts to wildlife habitat and the environment.

Developing a mitigation fund and safeguard policies will be important financial and legal foundations to ensure that necessary wildlife and habitat conservation and restoration measures are carried out at the deserved areas and specific sites.

***Develop a Wildlife and Habitat Conservation Strategy for the South Gobi Region..***

The South Gobi Region needs a wildlife and habitat conservation strategy that will act as a flagship program for the unified regional effort to preserve biodiversity and ecosystem health. It could consist of longer and shorter term objectives. The overarching aim of the strategy is to maintain a healthy ecosystem, to halt biodiversity and habitat loss, and to restore habitats that have already been affected.

This strategy must include at least:

1. Clear strategic goals and objectives
2. Information on the distribution and abundance of species and populations
3. Descriptions of locations and relative condition of key habitats and community types essential to conservation of identified species and populations
4. Descriptions of issues that may adversely affect species and populations, or their habitats, and prioritized research and survey plans to identify factors that may assist in restoration and conservation
5. Descriptions of conservation actions for target species, populations, and habitats; priorities for implementing such actions; and plans for monitoring the implementation and effectiveness of conservation actions
6. Plans for monitoring species, populations, and critical habitats
7. Descriptions of procedures to review the strategy and set review intervals
8. Plans to engage public participation in development, implementation, and evaluation of the strategy
9. Plans to engage developers in the implementation of the strategy and actions for target species, populations, and habitats
10. Procedures for coordinating the development, implementation, review, and revision of the plan with aimag and sum administrations

This wildlife and habitat conservation strategy must be recognized and adopted by the Government of Mongolia, aimag and sum governors, and well publicized among public and private sectors. It may become an extremely useful contribution to the enforcement of environmental laws in southern Mongolia.

***Identify core wildlife areas and corridors within South Gobi Region.***

For any wildlife species, their survival depends on travelling and foraging across unobstructed landscapes. Long distance journeys are becoming increasingly difficult for wildlife in southern Mongolia. In order to maintain healthy wildlife populations in the South Gobi Region, the Mongolian Government needs to secure sufficient space that allows animals to move freely and contains sufficiently large areas of healthy habitat. With large scale economic development inevitable in this region, a top priority is to identify core areas and wildlife corridors. Wildlife corridors ensure connectivity between core habitats and maintain normal migratory behavior of animals.

The core area and wildlife corridor identification process should consider larger areas; it should not be based on individual state or local protected areas or IBAs. For example, the South Gobi Region should be considered as whole because there are several highly mobile endangered ungulates that roam through this region, as well as bird species that require large, unfragmented, healthy habitats. Therefore, within the next three years, research expeditions need to be conducted to identify core wildlife habitat and corridors in the Galba Gobi IBA and within the South Gobi Region. Highly accurate survey methods such as satellite or radio telemetry technologies should be used for Saker Falcons, Houbara Bustards, Wild Ass, Goitered Gazelles, and Mongolian Gazelles in the Gurvan Tes, Zagsuujiin Gobi, Borzon Gobi, Galba Gobi, Khatanbulag, Ooshiin Gobi, and Doloodoin Gobi. At least 10 individuals of each species should be radio or satellite marked and monitored for at least one year to determine their habitat use, migration and foraging patterns.

***Create a South Gobi Regional Biodiversity Database.***

Decision makers at all levels, environmental resource managers, developers, short and long term consultants, scientists, and the public require comprehensive, accurate, complete, and current data on the status of regional biodiversity. These data are needed to ***evaluate*** biodiversity and other natural resources in the areas under subject of development; ***determine*** potential development impacts and identify areas appropriate for conservation; ***pinpoint*** species of special concern in the development area; and ***identify*** necessary counter actions to prevent negative impacts.

Search for information may sound easy, but a large amount of valuable information is often ignored or unnoticed simply because it was unavailable or inaccessible. Therefore, we recommend establishing a biodiversity database for the South Gobi Region. In general, environmental and land management in the South Gobi Region requires creation of a database with collaborative public sharing of data among government, public, and private sectors. This database will collect and store various biodiversity-related research and management results and communications in one central, publically accessible database system. Its main purpose will be to make the information freely accessible to decision makers, the public, and researchers from various scientific, NGO, and corporate sectors.

***Monitoring of wildlife should be well resourced and strengthened***

Because the Galba Gobi and surrounding areas are critical habitat for many regionally and internationally rare species, long term ecological monitoring and data collection is vital to inform policies, determine environmental degradation, and assess habitat mitigation measures and management actions. It is unacceptable to make critical decisions on globally threatened and endangered species on inaccurate and incomplete data.

There is no suitable existing wildlife and habitat monitoring scheme in place in the South Gobi Region. Present sum and aimag environmental capacity, experience, and financial capability are far from adequate to enable reliable monitoring and policing.

Regional scientific capacity is very low and requires particular attention. Currently, in each sum, the meteorological stations are collecting weather data and only a limited amount of pasture condition data on a regular basis. The Oyutolgoi project has an excellent regular environmental monitoring program in place. Apart from these two examples, regular collection of baseline scientific data is very scarce. The majority of short term projects (conducted by researchers from Ulaanbaatar or abroad) focus on rare, endangered, or charismatic species, and tend to have a duration of 0.1-3 years. However, when investigating ecosystem changes, it is often more indicative to monitor common and 'unattractive' species rather than rare and charismatic species. Monitoring of common species ensures that data collection is relatively straightforward to organize and it is easier to secure long term data collection and broad coverage of the region. Thus, in addition to globally threatened and endangered species, several important ecological keystone plant and animal species need to be identified and further studied in to monitor ecosystem trends in the South Gobi Region, including the Galba Gobi IBA.

We also recommend establishing at least three wildlife and ecological monitoring sites in the following areas: Galba Gobi; Ovootkhural; and Khatanbulag. Among them, the Galba Gobi Long-Term Ecological Monitoring Site can cover the vast desert plain and mountains north of it. This site can be established in 2011 as a trial project because the development pressure is highest in this part of the South Gobi Region. This site can also serve as a research and monitoring facility for the A and B parts of the Small Gobi SPA. The remaining two sites can be established at a later date, based on experiments at the first site.

***Establish an enhanced network of nature and wildlife reserves***

The current network of state and local protected areas is not sufficient. The state protected areas are focused on protecting large areas of land primarily to preserve regionally or globally endangered wildlife. In addition to this network, wildlife movement corridors, important nesting and breeding locations of birds, regular wild ungulate calving sites, and migratory bird stopover sites must be protected. In the South Gobi region, it is common to see several species of ungulates and birds congregating in large numbers close to water abundant locations that lay outside the protected areas. Because water is a critical resource for many kinds of wildlife in this dry landscape, it is important to preserve water sources and ensure adequate access to water for wildlife.

***Extensive capacity building at the aimag and sum level should be undertaken in the immediate future.***

At the moment, the inspectors of the national park and environmental protection agencies do not have sufficient authority to impose penalties and fines when they encounter breaches of the law. Although the sum inspectors are regarded as the ears-and-eyes of the aimag and state inspectors, it is essential that their level of authority and skills meet the required standards.

Firstly, the sum inspectors need to be trained and equipped with necessary common tools and guidelines to inspect and monitor various activities within the context of environmental laws and best practice guidelines. Inspection and monitoring protocols specifically designed for the South Gobi Region are much needed in order to ensure coordinated monitoring and law enforcement. At present, there is little reliable data to identify trends in wildlife and habitat issues. Most wildlife related data were collected erratically, with much based on verbal information. An additional data collection issue is the lack of appreciation by locals of the importance of using robust and repeatable survey methods.

We recommend the establishment of annual sum environmental inspector meetings (ASEIM) for the South Gobi Region. During such meetings, the inspectors from three Gobi aimags can share their experiences, and discuss the status of environmental issues for that year, summarize environmental impact assessment reports, wildlife or other research results, report poaching incidents, water and land law breaches, and identify actions and objectives for the next year(s) and so on. At least three major subjects must be covered, such as wildlife and plant protection, land utilization, and mining operation. More focused subjects can be identified in addition to these. Once established, the ASEIMs will boost cooperation and information exchange between local government administrations, law enforcement, land agencies, national parks, environmental protection agencies, mining companies, and scientists; and could eventually improve coordinated planning and the environmental law enforcement activities in the region. These meetings will also be an excellent driver in establishing and maintaining a unified regional database for environmental issues, which will be an important tool in monitoring environmental degradation in the South Gobi. During such meetings, inspectors and participants should receive special training, and various workshops can also be organized to improve the knowledge and professional capacity of inspectors.

***Every school in the region should establish resources (rooms, exhibits and materials) for environmental education***.

Local schools are the key to educating future generation of citizens in the South Gobi Region. Ecology classrooms and exhibits can be established cheaply using local natural materials, drawings, and photographs. A sufficient quantity of handouts and booklets should be developed and disseminated at every school within the next year.

Local nature conservation clubs, bird watching clubs, or wildlife care groups can be established and could be adopted by mines or other businesses that are operating in the sum territory. Such "Adopt a school environmental program" can be developed and started sooner. Since the number of schools and students in the South Gobi Region is fairly low in comparison to densely populated countries, expenses should not be high. Companies can provide necessary support and resource mobilization in many areas, including infrastructure, facilities support, teaching and skill development, learning support, and provision of computer and science laboratory equipment, and food and nutrition. Companies could potentially earn credits through this program.

## III. Recommendations for Biodiversity Impact Mitigation and Offsets

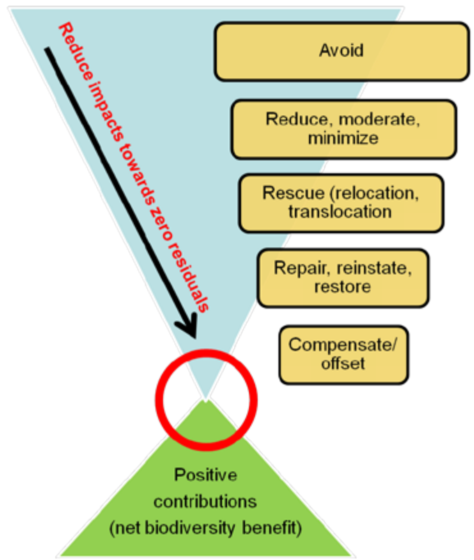
The Business and Biodiversity Offsets Program (BBOP), which is a collaboration of over 50 different companies, and government and conservations experts, is developing best practices on biodiversity offsets and conservation banking worldwide. The BBOP recommends that "the biodiversity offsets should be measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity" (BBOP 2009).

First of all, the systematic biodiversity planning is important, because there is a need to conserve representative sample of all biodiversity pattern and ecological processes both at the local and the landscape scale. Systematic biodiversity planning will provide clear and reliable information on where biodiversity priorities are present so that hierarchical biodiversity mitigation and offset measures can be planned accordingly (BirdLife Asia 2009, BBOP 2009).

The Environmental Impact Assessment (EIA) is an important base document for systematic biodiversity planning. After a thorough EIA, the stakeholders can identify hierarchical mitigation measures. According to the mitigation hierarchy, efforts should be made first to prevent or avoid impacts to biodiversity, then minimise and reduce, then rescue or relocate, and then repair or restore adverse effects.

After these steps, any significant residual effects should then be addressed via a biodiversity offset program (BBOP 2009).

**Figure 23. Conceptual view of the biodiversity offsets and impact mitigation hierarchy**




Although appropriate offset activities will vary from site to site, each offset activity must demonstrate measurable conservation outcomes otherwise any claims to zero harm, no net loss, or net positive impacts cannot be verified (BirdLife Asia 2009). Therefore, it is important to gather baseline data that can be used later to assess the efforts of companies and the practicality of the offset program. Today, the number of operating mines in the South Gobi Region is not very high and they all became operational relatively recently. Thus, it is not that late to collect baseline data from mining sites in the region.

Typical biodiversity offsets activities could include:

- Strengthening and supporting ineffective protected areas
- Safeguarding and supporting unprotected areas by entering into agreements with local communities as custodians of biodiversity
- Addressing some underlying causes of biodiversity loss such as having too many livestock that lead to habitat degradation
- Developing sustainable livelihoods that benefit both local communities and biodiversity
- Establishing wildlife corridors
- Removing invasive species
- Establishing buffer zones around a protected areas
- Securing migration paths: Establishing interventions to secure migration paths.
- Removing or reducing goats from a biologically sensitive site which is being overgrazed.

**Table 7. 10 Principles on Biodiversity Offsets Supported by the BBOP Advisory Committee**

| |
|---|
| 1. No net loss: A biodiversity offset should be designed and implemented to achieve in situ, measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity. |
| 2. Additional conservation outcomes: A biodiversity offset should achieve conservation outcomes above and beyond results that would have occurred if the offset had not taken place. Offset design and implementation should avoid displacing activities harmful to biodiversity to other locations. |
| 3. Adherence to the mitigation hierarchy: A biodiversity offset is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate avoidance, minimization and on-site rehabilitation measures have been taken according to the mitigation hierarchy. |
| 4. Limits to what can be offset: There are situations where residual impacts cannot be fully compensated for by a biodiversity offset because of the irreplaceability or vulnerability of the biodiversity affected. |
| 5. Landscape Context: A biodiversity offset should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes taking into account available information on the full range of biological, social and cultural values of biodiversity and supporting an ecosystem approach. |
| 6. Stakeholder participation: In areas affected by the project and by the biodiversity offset, the effective participation of stakeholders should be ensured in decision-making about biodiversity offsets, including their evaluation, selection, design, implementation and monitoring. |
| 7. Equity: A biodiversity offset should be designed and implemented in an equitable manner, which means the sharing among stakeholders of the rights and responsibilities, risks and rewards associated with a project and offset in a fair and balanced way, respecting legal and customary arrangements. Special consideration should be given to respecting both internationally and nationally recognised rights of indigenous peoples and local communities. |
| 8. Long-term outcomes: The design and implementation of a biodiversity offset should be based on an adaptive management approach, incorporating monitoring and evaluation, with the objective of securing outcomes that last at least as long as the project's impacts and preferably in perpetuity. |
| 9. Transparency: The design and implementation of a biodiversity offset, and communication of its results to the public, should be undertaken in a transparent and timely manner. |
| 10. Science and traditional knowledge: The design and implementation of a biodiversity offset should be a documented process informed by sound science, including an appropriate consideration of traditional knowledge. |

**Selected recommendations for road, railway, and powerline construction**

The use of wildlife mitigation structure by animals varies by species, time of day, season, and environmental events, such as drought or forest fire (Banff National Park of Canada 2010; Huijser and others 2007). Different types of wildlife pass or crosswalk have been designed for a variety of animals in many countries, for animals as small as the Japanese dormouse (*Glirulus japonicus*) and as large as the Grizzly Bear (*Ursus arctos horribilis*).

***Structures consisting of fencing are highly effective in reducing wildlife and vehicle collisions.*** Such mitigation measures can reduce overall wildlife road-kills by more than 80 percent and can reduce the number of ungulates killed on roads by more than 95 percent (Banff National Park of Canada 2010). However, from a conservation perspective, these mortality estimates may still not be acceptable when considering such endangered species as Wild Ass and Goitered Gazelle. Without additional mitigation actions, transport infrastructure impacts could be very significant.

Also any type of above-ground major linear structure such as railroads, highways, power lines, and pipelines can have significant impacts on wildlife movement and survival, and will result in habitat fragmentation. A relative example of the fencing and transport infrastructure issue comes from China. The construction of the Qinghai-Tibet railway and the Golmud-Lhasa highway across key migration corridors has disturbed the migration of the Tibetan antelope *chiru Pantholops hodgsonii.* The disturbance to Tibetan antelope migration resulted from railway and highway infrastructures, with subsequent increased human activities and road traffic. Although the railway has incorporated wildlife passes at several locations, wildlife use was still greatly affected by the structure of the passages: un-cleared construction material, equipment, and vehicles; dangerously short distances between highway and crossing structures; magnitude of land surface destroyed (and not restored) during the construction; presence of predators; and poor vegetation cover and vegetation type changes following railway construction (Xia and others 2007).

In Mongolia, the existing transport line (with a road and fenced railway) between Ulaanbaatar and Beijing has had significant and permanent impacts on Mongolian Gazelles (Ito and others 2005; Ito and others 2008) and Wild Ass (Kaczensky and others 2006). In addition to road-kill mortality, the north-south bound international railway in Mongolia has divided the population of Mongolian Gazelles and kept them isolated from one another since its construction, and also has removed the eastern part of the south Gobi from the traditional range of the Wild Ass (Kaczensky and others 2006, (Ito and others 2006). There are no current records of Wild Ass occurring east of the railway. The railway appears to be the major obstacle preventing Wild Ass movement to eastern grazing lands which is part of their historical range and essential in maintaining populations in such a harsh and fluctuating arid environment.

Any major development plan should consider preserving a wide range of sufficient breeding habitats for Houbara Bustards and large ungulate species. For example, the foraging range of Wild Ass varies greatly. They do not show clear preferences for any plant community types, needing access to large tracts of land to cope with the unpredictable resource distribution within the Gobi (Kaczensky and others 2008). According to limited telemetry study (Kaczensky and others 2008) and direct observation studies (Stubbe et al 2007, Reading and others 2001), the distribution range of wild ungulates in South Gobi Region is largely related to areas where subsurface water is accessible to animals within valley bottoms and plains. Therefore, such areas should be avoided first.

***A crosswalk system could be used in southern Mongolia, but an initial detailed survey needs to be carried out to find the most likely wildlife-crossing locations.*** Crosswalk systems are fenced structures intended to restrict the location of mammal crossings to specific, well-marked, unfenced areas along the highways, where motorists can expect them (Lehnert & Bissonette 1997). It is especially feasible for Wild Ass, which does not demonstrate the habit or physical fitness for jumping over or going under fences. However, the crosswalk system and design should be tested in multiple locations in order to identify successful settings and applicability for widespread use. Although Wild Ass and Goitered Gazelle are wild ungulates that roam freely in this vast open landscape, a well-designed crosswalk system could be an option worth exploring further in case the decision to fence transport routes becomes imminent. One serious concern is that road-crossing points could potentially be targeted by poachers. Therefore, strong wildlife law enforcement activities must be put in place, along with warning signs informing of harsh fines for poachers placed in visible locations along roads, town exits, and border posts.

***Raised sections of road discourage animals from crossing roads.*** Road and railway systems should be constructed following the natural grade of the surrounding terrain and as low as possible. In particular, east-west bound roads should be not elevated since wild ungulates have greater foraging and moving space along the longitudinal line in the South Gobi Region. Characteristic semi-desert and desert landscapes in the southern Gobi can stretch 800-1200 km longitudinally, whereas they span between 50 - 180 km in north-south direction. In addition, there is the border fence in the south and a different steppe zone in the north.

***Wildlife underpasses and overpasses.*** Both wildlife underpasses and overpasses would be a challenge in terms of engineering and effective conservation perspectives. Wildlife overpasses are among the most effective structures for allowing wildlife of many types to move relatively unconstrained across roads or railways. They have been successfully used in Europe and North America (Banff National Park of Canada 2010). In contrast, underpasses are typically bridges or culverts that allow wildlife to pass underneath the road or railway. Various types of underpass are used in many countries. They can be categorized on the basis of size, type of structure, and function. Any underpass structure must be well designed to provide safe passage for ungulates and other species that need visibility, maneuverability, light, possible vegetative cover, and moderated noise from traffic. Using underpasses pose more challenges to open-country wildlife than any other types of pass, since most species are not habituated to passing through a completely confined structure.

Also overpasses create a large arched mound, whereas the construction of underpasses will require higher grounds at either end of the pass with a tunneled depression or basin in the middle, a feature uncommon in the Galba Gobi, which it is mostly open landscape. Such tunneled depressions can become flooded and impassable during wet periods.

***Another option, which could prove effective (albeit costly) in the south Gobi, is the construction of a series of vehicle underpasses (rail or road).*** Although it would pose some engineering challenges (e.g., flood prevention system), a vehicle underpass effectively allows long sections of open steppe habitat to be used by free-moving mammals. The location and length of such vehicle underpasses would need to be determined by understanding likely mammal behavior and movement.

***Improve highway surface and vehicle standards.*** Consideration of improved highway surface and vehicle standards could potentially reduce noise and debris while facilitating increased speed of traffic flow and frequency. Slow traffic will result in (as currently experienced) a longer, slower “moving fence”. If vehicle speed and convoy frequency are well regulated, it may be possible to ensure sufficient gaps between convoys to enable adequate and regular mammal movements across the highway/transport corridor.

***Another consideration is to build the railway and highway without fences allowing animals to cross freely.*** This technique has been practiced in many countries. In such circumstances, trains must be equipped with ‘cow-catchers’. A cow-catcher or pilot is typically a shallow, V-shaped sheet metal and steel frame mounted at the front of locomotives. It is designed to deflect objects from the track at a fairly high speed without disrupting the smooth movement of the train. The shape of the cow catcher works to lift any object on the track and push it aside, out of the way of the locomotive behind it. Such appliances are required by law in most European countries and North America (Wikipedia 2010).

***Safe transmission line and pole structure***. Wherever there are power transmission lines, there will be risk of bird collision with overhead wires and electrocution. It is important to understand the species involved, location, type and frequency of collision or electrocution, and overall effects on the wildlife population. Collision with overhead wires and electrocution can cause significant impacts on endangered species (Sundar and Choudhury 2005, Silvia and others 2010). Although most birds tend to avoid visible transmission lines, the distance to these structures generally determines the breeding density of species, and also they can lead to displacement of populations and habitat fragmentation (Silvia and others 2010). Therefore, proposals for power transmission infrastructure should consult with bird collision and electrocution experts to assess the conformity of bird-friendly design and obtain written evaluation consent prior to any investment. Currently, there is no regulation exist to promote bird-friendly power line and pole design in Mongolia. The recent bird electrocution examples documented in Khentii, Sukhbaatar, and Ovorkhangai aimags, indicate that there is an urgent need to develop a national level regulation, otherwise individual project-based initiatives or protests against wrong designs will not yield the needed results to reduce bird powerline collision and electrocution risks.

Potential options for the South Gobi region should consider, but not be limited to, these recommendations. As new, more detailed data on wildlife habitat use and nesting locations becomes available, making choices on mitigation and management measures will be more precise.

**Table 8. Proposed activities for near future**

| Activity | Time | Leading responsible body |
|---|---|---|
| **I. Species level** | | |
| 1. Survey to identify Saker Falcon nest locations in unsurveyed areas of the Galba Gobi IBA and the South Gobi region. | Within 1.5-2 years | MNET |
| 2. Protect Saker Falcon nest sites through developing policy to protect regional forest and tree resources | Within 1.5 years | MNET, Aimag Governors |
| 3. Conduct detailed study to identify Houbara Bustard lek sites and map important locations in the Galba Gobi IBA and unsurveyed areas in the South Gobi region. | Within 1.5-2 years | MNET |
| 4. Study sensitivity of Houbara Bustards in land cover change and habitat fragmentation in the Galba Gobi IBA | Within 2 years | MNET |
| 5. Conduct radio or satellite tracking study to identify core and corridor areas of Saker falcon, Houbara Bustard, Wild Ass, Goitered Gazelle, and Mongolian Gazelle within South Gobi Region | Within 2-4 years | MNET |
| 6. Develop single species conservation action plans for endangered species including Saker falcon, Houbara Bustard, Wild Ass, Goitered Gazelle, and Mongolian Gazelle in the South Gobi Region | Within 2-4 years | MNET |
| | | |
| **II. Regional/Landscape level** | | |
| 1. Develop a consolidated GIS map of sensitive and critical habitats of the Saker falcon, Houbara Bustard, Wild Ass, Goitered Gazelle, and Mongolian Gazelle, and other critical species in the South Gobi Region | Within 2 years | MRTCUD, MNET, MME, and Aimag Governors |
| 2. Develop a regional policy for wildlife and habitat conservation and establish wildlife habitat mitigation fund | Within 2-3 years | MNET, MF, Aimag Governors, SSIA |
| 3. Develop regulation for reviewing and permitting wildlife and habitat mitigation proposals | Within 1-3 years | MNET, MF, MME, Aimag Governors, MRPAM, SSIA |
| 4. Develop a Wildlife and Habitat Conservation Strategy for the South Gobi Region | Within 1.5 years | MNET |
| 5. Develop and create the South Gobi Regional | Within 2 years | MNET, Aimag |

| | | |
|---|---|---|
| Biodiversity Database | | Governors |
| 6. Strengthen wildlife monitoring and law enforcement through increasing the professional and technical capacity of environmental inspectors in the sums | Within 2 years | MNET, Aimag Governors |
| 7. Establish enhanced network of nature and wildlife reserves through unified planning and coordinated approach | Within 2-5 years | MNET, Aimag Governors, SPAA |
| 8. Increase capacity building at the aimag and sum level | Within 1-2 years | MNET, SSIA, Aimag Governors |
| 9. Develop a national level regulation or make amendments to relevant existing laws about bird-friendly powerline and pole structures to reduce bird collision and electrocution risks. | Within 1-3 years | MNET, MRTCUD, and MME |
| 10. Establish environmental education rooms at every school in the region | Within 1-3 years | ME, Aimag Governors |
| | | |

At this stage these are recommended actions, which will need to be costed within the context of an agreed south Gobi regional management plan, progressed through appropriate stakeholder consultation.

# References

Bailey, T. A., J. H. Samour, and T. C. Bailey. 1998. Hunted by falcons, protected by falconry: Can the houbara bustard (*Chlamydotis undulata macqueenii*) fly into the 21st century? Journal of Avian Medicine and Surgery 12:190-201.

Banff National Park of Canada 2010. Highway Fencing and Wildlife Crossings. Trans-Canada Highway Twinning Project, downloaded from http://www.pc.gc.ca/eng/pn-np/bc/yoho/natcul/natcul29.aspx on March 02, 2010.

Batsaikhan, N., A. Bold, and S. Dorjderem. 2005. Distribution of Houbara Bustard (*Chlamydotis undulata macqueenii)* in Mongolia in A. Bold, S. Boldbaatar, and K. Munkhbayar, editors. Avian and reptile fauna in Mongolia. Top Design, Ulaanbaatar.

Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigation measures. Ibis 136:412-425.

BirdLife Asia 2009. Safeguarding Important Areas of Natural Habitat alongside Economic Development. Mongolia Discussion Papers. . East Asia and Pacific Region Sustainable Development Department, World Bank, Washington, DC.

BirdLife International. 2009. Species factsheet: Houbara Bustard *Chlamydotis undulata*. Downloaded from http://www.birdlife.org on 30/10/2009.

Boldbaatar, S. 2006. Problems in bird conservation in Mongolia and adjacent countries. Pages 22-27 in T. Z. Dorzhiev, editor. Current Problems of Ornitology in Siberia and Central Asia. Proceedings of 3rd International Ornitology Congress. Part 1, Buriyat State Univeristy.

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake 1993. Distance sampling: estimating abundance of biological populations. Chapman and Hall, London.

Burnham, K. P., D. R. Anderson, and J. L. Laake. 1980. Estimation of density from line transect sampling of biological populations. Wildl. Monogr 72:1-202. .

Business and Biodiversity Offsets Programme (BBOP). 2009. Business, Biodiversity Offsets and BBOP: An Overview. BBOP, Washington, D.C. Available from www.forest-trends.org/biodiversityoffsetprogram/guidelines/overview.pdf.

Campos-Arceiz, A., S. Takatsuki, and B. Lhagvasuren. 2004. Food overlap between Mongolian gazelles and livestock in Omnogobi, southern Mongolia. Ecological Research 19:455-460.

Carrascal, L. M., D. Palomino, J. Seoane, and C. L. Alonso. 2008. Habitat use and population density of the houbara bustard *Chlamydotis undulata* in Fuerteventura (Canary Islands). African Journal of Ecology 46:291-302.

Clark, E. L., J. Munkhbat, S. Dulamtseren, J. E. M. Baillie, N. Batsaikhan, S. R. B. King, R. Samiya, and M. Stubbe, editors. 2006. Summary Conservation Action Plans for Mongolian Mammals. Regional Red List Series Vol. 2. Zoological Society of London, London.

Combreau, O. 2007. Arabic Falconry and the Illegal Houbara Trade in Arabia. Falco:16-17.

Combreau, O., and T. R. Smith. 1997. Summer habitat selection by houbara bustards introduced in central Saudi Arabia. J. Arid Environ. 36:149-160.

Dixon, A. 2009. Saker falcon breeding population estimates. Part 2: Asia. Falco 33:4-10.

Dixon, A., M. Etheridge, G. Purev-Ochir, and N. Batbayar. 2008. Saker falcons rearing an upland buzzard chick. Falco 31:7-8.

Ellis, D. H., M. H. Ellis, and P. Tsengeg. 1997. Remarkable Saker falcon (*Falco cherrug*) breeding records for Mongolia. Journal of Raptor Research 31:234-240.

Feh, C., B. Munkhtuya, S. Enkhbold, and T. Sukhbaatar. 2001. Ecology and social structure of the Gobi khulan Equus hemionus subsp. in the Gobi B National Park, Mongolia. Biological Conservation 101:51-61.

Fehmi, J. S., S. E. Russo, and J. W. Bartolome. 2005. The effects of livestock on California ground squirrels (*Spermophilus beecheyii*). Rangeland Ecology & Management 58:352-359.

Fomin, V. E., and A. Bold 1991. Katalogue of the birds of the Mongolian People's Republic. Nauka, Moscow.

Garcia, R. R., B. M. Jauregui, U. Garcia, K. Osoro, and R. Celaya. 2009. Effects of livestock breed and grazing pressure on ground-dwelling arthropods in Cantabrian heathlands. Ecological Entomology 34:466-475.

Gaucher, P., P. Paillat, C. Chappius, M. S. Jalme, F. Lotfikhah, and M. Wink. 1996. Taxonomy of the Houbara Bustard *Chlamydotis undulata* subspecies considered on the basis of sexual display and genetic divergence. Ibis 138:273-282.

Godinez-Alvareza, H., J. E. Herrick, M. Mattocks, D. Toledo, and J. Van Zee. 2009. Comparison of three vegetation monitoring methods: Their relative utility for ecological assessment and monitoring. Ecological indicators 9:1001-1008.

Gombobaatar, S. 2006. Biology, ecology and conservation of Saker Falcon *Falco cherrug* in Central Mongolia. Faculty of Biology. National University of Mongolia, Ulaanbaatar.

Gregory, R. D., D. W. Gibbons, and P. F. Donald. 2004. Bird census and survey techniques. Pages 17-56 in W. J. Sutherland, I. Newton, and R. E. Green, editors. Bird Ecology and Conservation; a Handbook of Techniques. Oxford University Press, Oxford.

Gubin, B. 2009. A Natural History of the Houbara Bustard. Environment Agency - Abu Dhabi (EAD).

Harness, R., S. Gombobaatar, and R. Yosef. 2008. Mongolian distribution of power lines and raptor electrocution. IEEE 52:1-6.

Heredia, B. 1995. Action plan for the houbara bustard in the canary islands (*Chlamydotis undulata fuertaventurae*). BirdLife International.

Hijmans, R. J., S. E. Cameron, J. L. Parra, P. G. Jones, and A. Jarvis. 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology:1965-1978.

Hingrat, Y., and M. S. Jalme. 2005. Mating System of the Houbara Bustard *Chlamydotis undulata undulata* in Eastern Morocco. *Ardeola* 52(1):91-102.

Hingrat, Y., M. S. Jalme, F. Ysnel, E. L. Nuz, and F. Lacroix. 2007. Habitat use and mating system of th houbara bustard *Chlamydotis undulata undulata* in a semi-desertic area of North africa: implications for conservation. Journal of Ornithology 148:39-52.

Hooge, P. N., and B. Eichenlaub 2000. Animal movement extension to Arcview. ver. 2.0. Alaska Science Center - Biological Science Office, U.S. Geological Survey, Anchorage, AK, USA.

Huijser, M. P., A. Kociolek, P. McGowen, A. Hardy, A. P. Clevenger, and R. Ament 2007. Wildlife-Vehicle Collision and Crossing Mitigation Measures: a Toolbox for the Montana Department of Transportation. Western Transportation Institute, College of Engineering, Montana State University.

Ito, T. Y., N. Miura, B. Lhagvasuren, D. Enkhbileg, S. Takatsuki, A. Tsunekawa, and Z. Jiang. 2005. Preliminary Evidence of a Barrier Effect of a Railroad on the Migration of Mongolian Gazelles. Conservation Biology 19:945-948.

Ito, T. Y., N. Miura, B. Lhagvasuren, D. Enkhbileg, S. Takatsuki, A. Tsunekawa, and Z. Jiang. 2006. Satellite tracking of Mongolian gazelles (Procapra gutturosa) and habitat shifts in their seasonal ranges. Journal of Zoology 269:291-298.

Ito, T. Y., A. Okada, B. Buuveibaatar, B. Lhagvasuren, S. Takatsuki, and A. Tsunekawa. 2008. One-Sided Barrier Impact of an International Railroad on Mongolian Gazelles. Journal of Wildlife Management 72:940-943.

IUCN. 2010. IUCN Red List of Threatened Species. Version 2010.1. http://www.iucnredlist.org/. Downloaded on 23 March 2010.

Janss, G., and M. Ferrer. 2000. Common crane and great bustard collision with power lines: collision rate and risk exposure. Wildlife Society Bulletin 28:3.

Janss, G. F. E. 2000. Avian mortality from power lines: a morphologic approach of a species-specific mortality. Biological Conservation 95:353-359.

Janss, G. F. E., and M. Ferrer. 1998. Rate of bird collision with power lines: Effects of conductor-marking and static wire-marking. Journal of Field Ornithology 69:8-17.

Jehle, G., A. A. Yackel Adams, J. A. Savidge, and S. K. Skagen. 2004. Nest survival estimation: a review of alternatives to the Mayfield estimator. The Condor 106:472-484.

Jenkins, A. R., J. J. Smallie, and M. Diamond. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 263-278.

Judas, J., O. Combreau, M. Lawrence, M. Saleh, F. Launay, and G. Xingyi. 2006. Migration and range use of Asian Houbara Bustard *Chlamydotis macqueenii* breeding in the Gobi Desert, China, revealed by satellite tracking. *Ibis* 148:343-351.

Kaczensky, P., O. Ganbaatar, H. v. Wehrden, and C. Walzer. 2008. Resource selection by sympatric wild equids in the Mongolian Gobi. Journal of Applied Ecology 45:1762-1769.

Kaczensky, P., D. P. Sheehy, C. Walzer, D. E. Johnson, D. Lhkagvasuren, and C. M. Sheehy 2006. Room to Roam? The threat to Khulan (Wild Ass) from human intrusion. Mongolia Discussion Papers. East Asia and Pacific Environment and Social Development Department. Washington, D.C.: World Bank.

Lane, S. J., J. C. Alonso, and C. A. Martín. 2001 Habitat preferences of great bustard Otis tarda flocks in the arable steppes of central Spain: are potentially suitable areas unoccupied? Journal of Applied Ecology 38:193–203.

Launay, F., and T. Bailey, editors. 1999. Counting Houbara Bustard. IUCN/SSC/BirdLife Working Group on the Houbara Bustard. NARC, IUCN/SSC/BirdLife International, Cambridge.

Launay, F., O. Combreau, and M. A. Bowardi. 1999. Annual migration of Houbara Bustard *Chlamydotis undulata macqueenii* from the United Arab Emirates. Bird Conservation International 9:155-161.

Le Cuziat, J., E. Vidal, P. Roche, and F. Lacroix. 2005. Human activities affect the potential distribution of the Houbara Bustard Chlamydotis undulata undulata. Ardeola 52:21-30.

Lehnert, M. E., and J. A. Bissonette. 1997. Effectiveness of Highway Crosswalk Structures at Reducing Deer-Vehicle Collisions. Wildlife Society Bulletin 25:809-818.

McEvoy, P. M., M. Flexen, and J. H. McAdam. 2006. The effects of livestock grazing on ground flora in broadleaf woodlands in Northern Ireland. Forest Ecology and Management 225:39-50.

Microwave Telemetry Inc. 2006. Argos/GPS PTT-100 Field Manual. Columbia, MD.

Ming, M., and C. Ying. 2007. Saker falcon trade and smuggling in China. Falco (Carmarthen) 30:11-14.

Mueller-Dombois, D., and H. Ellenberg. 2003. Aims and methods of vegetation ecology. The Blackburn Press

Nyambayar, B. 2008. Report on mass mortality of Pallas's Sandgrouse in Ovorkhangai aimag. Internal Report of the Ornithology Laboratory. The Institute of Biology, Mongolian Academy of Scienes, Ulaanbaatar.

Nyambayar, B., and N. Tseveenmyadag 2009. Directory of Important Bird Areas in Mongolia: Key Sites for Conservation Wildlife Science and Conservation Center of Mongolia, Ulaanbaatar.

Olson, D. M., E. Dinerstein, E. D. Wikramanayake, N. D. Burgess, G. V. N. Powell, E. C. Underwood, J. A. D'Amico, I. Itoua, H. E. Strand, J. C. Morrison, C. J. Loucks, T. F. Allnutt, T. H. Ricketts, Y. Kura, J. F. Lamoreux, W. W. Wettengel, P. Hedao, and K. R. Kassem. 2001. Terrestrial ecoregions of the worlds: A new map of life on Earth. Bioscience 51:933-938.

Pavel, V. 2004. The impact of grazing animals on nesting success of grassland passerines in farmland and natural habitats: a field experiment. Folia Zoologica 53:171-178.

Pitra, C., D. Lieckfeldt, S. Frahnert, and J. Fickel. 2002. Phylogenetic Relationships and Ancestral Areas of the Bustards (Gruiformes: Otididae), Inferred from Mitochondrial DNA and Nuclear Intron Sequences. Molecular Phylogenetics and Evolution 23:63-74.

Potapov, E., N. Fox, D. Sumya, S. Gombobaatar, F. Launay, O. Combreau, and C. Eastham. 2001a. The Mongolian Saker Falcon: migratory, nomadic or sedentary? Argos Newsletter 58:10-11.

Potapov, E. R., N. C. Fox, D. Sumya, S. Gombobaatar, and O. Shagdarsuren. 2001b. Nest site selection in Mongolian sakers. Pages 132-137 in E. Potapov, S. Banzragch, N. Fox, and N. Barton, editors. Saker falcon in Mongolia. Research and conservation. Proceedings of II International Conference on Saker Falcon and Houbara Bustard, Ulaanbaatar, Mongolia 1-4 July 2000. Ministry of the Nature and Environment, Ulaanbaatar.

Powell, R. A. 2000. Animal home ranges and territories and home range estimators. Pages 65-110, in L. Boitani, and T. K. Fuller, editors. Research Techniques in Animal Ecology. Columbia University Press.

Reading, R. P., H. M. Mix, B. Lhagvasuren, C. Feh, D. P. Kane, S. Dulamtseren, and S. Enkhbold. 2001. Status and distribution of khulan (*Equus hemionus*) in Mongolia. Journal of Zoology 254:381-389.

Retzer, V. 2007. Forage competition between livestock and Mongolian Pika (Ochotona pallasi) in Southern Mongolian mountain steppes. Basic and Applied Ecology 8:147-157.

Rotella, J. J., M. L. Taper, and A. J. Hansen. 2000. Correcting nesting-success estimates for observer effects: maximum-likelihood estimates of daily survival rates with reduced bias. The Auk 117:92-109.

Rowland, M. M., M. J. Wisdom, B. K. Johnson, and M. A. Penninger. 2005. Effects of Roads on Elk: Implications for Management in Forested Ecosystems. Pages 42-52 in Wisdom, M. J., technical editor, The Starkey Project: a synthesis of long-term studies of elk and mule deer. Reprinted from the 2004 Transactions of the North American Wildlife and Natural Resources Conference, Alliance Communications Group, Lawrence, Kansas, USA.

Sheehy, D. P., C. Sheehy, D. E. Johnson, D. Damiran, and M. Fiamengo. 2010. Livestock and wildlife in the Southern Gobi Region, with Special Attnetion to Wild Ass. Mongolia Discussion Papers. East Asia and Pacific Region Sustainable Development Department, World Bank, Washington, DC.

Silva, J. P., M. Santos, L. Queirós, D. Leitão, F. Moreira, M. Pinto, M. Leqoc, and J. A. Cabral. 2010. Estimating the influence of overhead transmission power lines and landscape context on the density of little bustard Tetrax tetrax breeding populations. Ecological Modelling 221:1954-1963.

Stavi, I., E. D. Ungar, H. Lavee, and P. Sarah. 2009. Livestock Modify Ground Surface Microtopography and Penetration Resistance in a Semi-Arid Shrubland. Arid Land Research and Management 23:237-247.

Stubbe, A., M. Stubbe, and N. Batsajchan. 2007. Morphology, reproduction and mortality of *Equus hemionus hemionus* in Mongolia. Erforschung Biologischer Ressourcen der Mongolei Vol 10, pages 117-132, Halle/Saale.

Sundar, K. S. G. and B. C. Choudhury (2005). "Mortality of sarus cranes (Grus antigone) due to electricity wires in Uttar Pradesh, India." Environmental Conservation 32(03): 260-269.

Tourenq, C., O. Combreau, M. Lawrence, S. B. Pole, A. Spalton, G. Xinji, M. A. Baidani, and F. Launay. 2004. Alarming houbara bustard population trends in Asia. Biological Conservation 121:1-8.

TRAFFIC. 2008. “What’s Driving the Wildlife Trade? A Review of Expert Opinion on Economic and Social Drivers of the Wildlife Trade and Trade Control Efforts in Cambodia, Indonesia, Lao PDR and Vietnam”. East Asia and Pacific Region Sustainable Development Discussion Papers. East Asia and Pacific Region Sustainable Development Department, World Bank, Washington, DC.

Tseveenmyadag, N. 2007. A preliminary survey report on biology, ecology, and populatioin status of Saker Falcons (*Falco cherrug* Gr.) in Khentii, Dornod, and Sukhbaatar aimags by the team 2. Internal Report of the Ornithology Laboratory. The Institute of Biology, Mongolian Academy of Scienes, Ulaanbaatar.

van der Zande, A. N., W. J. ter Keurs, and W. J. van der Weijden. 1980. The impact of roads on the densities of four bird species in an open field habitat--evidence of a long-distance effect. Biological Conservation 18:299-321.

Wikipedia. 2010. Pilot (locomotive) - Wikipedia, http://en.wikipedia.org, The Free Encyclopedia.

World Bank. 2004. Mongolia Mining Sector, Managing the Future. The World Bank, Washington, DC

World Bank. 2009. Southern Mongolia Infrastructure Strategy. The World Bank, Washington, DC. Available online at http://www.associm.com/newsletters/pdf/Southern_Mongolia_Infrastructure_Strategy.pdf

Walton, T. 2010. Southern Gobi Regional Environmental Assessment. Mongolia Discussion Papers, East Asia and Pacific Sustainable Development Department. Washington, D.C., World Bank.

Xia, L., Q. Yang, Z. Li, Y. Wu, and Z. Feng. 2007. The effect of the Qinghai-Tibet railway on the migration of Tibetan antelope Pantholops hodgsonii in Hoh-xil National Nature Reserve, China. Oryx 41:352-357.

Yang, W.K., J.F. Qiao, O. Combreau, X. Gao, and W.Q. Zhong. 2003. Breeding Habitat Selection by the Houbara Bustard *Chlamydotis (undulata) macqueenii* in Mori, Xingjiang, China. Zoological Studies 42:470-475.

Yoshihara, Y., T. Y. Ito, B. Lhagvasuren, and S. Takatsuki. 2008. A comparison of food resources used by Mongolian gazelles and sympatric livestock in three areas in Mongolia. Journal of Arid Environments 72:48-55.

# Appendixes

## *Appendix A. Comparisons of Plant Species Diversity, Density, and Coverage at Observation and Random Points*

| *Variables* | *Observation points, N=21* | | *Random points, N=41* | | *Z test* | *P value* |
|---|---|---|---|---|---|---|
| | *Mean* | *SD* | *Mean* | *SD* | | |
| Species diversity | 4.75 | 2.314 | 3.80 | 1.824 | 1.714 | 0.086 |
| - Forbs | 1.763 | 0.792 | 1.654 | 0.623 | 06.00 | 0.548 |
| - Grasses | 2.36 | 1.319 | 2.075 | 1.206 | 0.897 | 0.369 |
| Plant density (/м$^2$) | 3.128 | 5.907 | 2.428 | 2.635 | -0,53 | 0.597 |
| Frequency (/м$^2$) | 5.666 | 6.409 | 6.069 | 6.044 | -1.727 | 0.084 |
| Vegetation cover (/м$^2$) | 3.534 | 4.067 | 3.694 | 4.474 | -0.741 | 0.459 |
| Density of species (/м$^2$) | | | | | | |
| - *Anabasis brevifolia* | 2.366 | 1.637 | 2.346 | 1.598 | -0.03 | 0.975 |
| - *Salsola passerina* | 1.481 | 1.051 | 2.140 | 2.021 | -2.061 | 0.038* |
| - *Ajania achilleoides* | 5.666 | 6.386 | 3.250 | 3.194 | -0.077 | 0.439 |
| - *Peganum nigellastrum* | 3.760 | 3.369 | 5.275 | 3.526 | -2.188 | 0.028* |
| Cover of species (/м$^2$) | | | | | | |
| - *Anabasis brevifolia* | 4.113 | 2.943 | 4.881 | 4.119 | -0.857 | 0.391 |
| - *Salsola passerina* | 4.074 | 3.384 | 3.894 | 3.222 | -0.00 | 1.0 |
| - *Ajania achilleoides* | 6.416 | 4.944 | 3.0 | 2.256 | -1.877 | 0.060 |
| - *Peganum nigellastrum* | 1.960 | 1.485 | 3.014 | 3.631 | -1.234 | 0.217 |
| Shrub cover | 2.94 | 2.162 | 2.152 | 1.999 | 1,45 | 0.15 |
| Shrub height | 26.859 | 15.72 | 28.139 | 26.051 | -0.232 | 0.816 |
| Shrub with height of ≥30см | 41.148 | 13.03 | 43.865 | 34.789 | -0.219 | 0.826 |

*significance indication

## *Appendix B. Average Cover and Frequency of Plant Species per Square Meter Area at Observation and Random Plots*

| ***Plant species*** | ***Observation points*** | | | ***Random points*** | | |
|---|---|---|---|---|---|---|
| | ***Number of plots*** | ***Average cover (%)*** | ***Average frequency*** | ***Number of plots*** | ***Average cover (%)*** | ***Average frequency*** |
| *Allium mongolicum* | 2 | 1.0 | 1.0 | - | - | - |
| *Anabasis brevifolia* | 86 | 4.2 | 6.1 | 195 | 4.9 | 7.4 |
| *Arnebia fimbricata* | 4 | 1.3 | 2.8 | 2 | 3.0 | 4.5 |
| *Arnebia gutatta* | 4 | 1.3 | 5.0 | 5 | 1.0 | 1.8 |
| *Artemisia intricata* | 20 | 1.6 | 5.3 | 47 | 2.0 | 4.1 |
| *Artemisia scoparia* | 11 | 6.1 | 10.1 | 12 | 3.0 | 4.5 |
| *Astragalus variabilis* | 3 | 2.0 | 4.0 | 1 | 2.0 | 5.0 |
| *Brachanthemum gobicum* | 5 | 4.4 | 6.2 | - | - | - |
| *Cleistogenes soongorica* | 9 | 3.0 | 5.7 | 7 | 1.7 | 4.3 |
| *Convolvulvus fruticosa* | 12 | 7.3 | 8.3 | 5 | 5.6 | 6.2 |
| *Cynachum pubescenes* | - | - | - | 2 | 5.0 | 9.0 |
| *Echinops gmelinii* | - | - | - | 1 | 1.0 | 1.0 |
| *Ephedra equistena* | - | - | - | 6 | 15.3 | 20.0 |
| *Erodium tibetanium* | 2 | 2.5 | 2.0 | 1 | 1.0 | 2.0 |
| *Halogeton glomeratus* | - | - | - | 2 | 3.0 | 7.5 |
| *Haloxylon ammodendron* | 1 | 2.0 | 2.0 | - | - | - |
| *Heteropappus centrali-asiaticus* | 1 | 1.0 | 2.0 | 5 | 2.4 | 5.4 |
| *Iris bungei* | 3 | 3.0 | 3.7 | - | - | - |
| *Kaliduim sp.* | - | - | - | 1 | 8.0 | 12.0 |
| *Nitraria sibirica* | 5 | 18.6 | 21.0 | 5 | 13.6 | 19.8 |
| *Oxytropis aciphylla* | 8 | 1.1 | 2.3 | 13 | 2.3 | 3.0 |
| *Peganum nigelastrum* | 29 | 1.9 | 4.3 | 64 | 3.1 | 8.2 |
| *Poaceae sp.* | - | - | - | 6 | 1.5 | 3.0 |
| *Potaninia mongolica* | - | - | - | 2 | 6.0 | 11.5 |
| *Reamuria soongorica* | 16 | 5.5 | 7.0 | 22 | 4.8 | 7.1 |
| *Salsola passerina* | 32 | 4.7 | 5.4 | 52 | 3.5 | 5.7 |
| *Scorzonera divaricata* | - | - | - | 1 | 2.0 | 2.0 |
| *Stipa glareosa* | 5 | 2.2 | 4.0 | 3 | 1.0 | 2.0 |
| *Stipa gobica* | 6 | 2.2 | 4.5 | 10 | 2.0 | 4.1 |
| *Zygophyllum xantoxylon* | 1 | 1.0 | 2.0 | - | - | - |
| *Unidentified species* | 6 | 6.7 | 21.2 | - | - | - |
| *Unidentified species* | - | - | - | 1 | 2.0 | 2.0 |

## *Appendix C. Dominant Vegetation Types in the Galba Gobi IBA*

| ***No.*** | ***Dominant vegetation types*** | ***Observation points*** | ***Random points*** |
|---|---|---|---|
| 1 | *Anabasis brevifolia* | 4 | 9 |
| 2 | *Anabasis brevifolia+Salsola passerina* | 2 | 5 |
| 3 | *Anabasis brevifolia+Artemisia scoparia* | 1 | 2 |
| 4 | *Anabasis brevifolia+Convolvulvus gortschakovii* | 1 | 2 |
| 5 | *Salsola passerina+Anabasis brevifolia* | 1 | 2 |
| 6 | *Salsola passerina+Reaumuria soongorica* | 1 | 2 |
| 7 | *Ajania achilleoides+Anabasis brevifolia* | 1 | 1 |
| 8 | *Ajania achilleoides+Reaumuria soongorica+Anabasis brevifolia* | 1 | 1 |
| 9 | *Anabasis brevifolia+Ajania achilleoides* | 1 | 1 |
| 10 | *Anabasis brevifolia+Ajania achilleoides+Salsola passerina* | 1 | 1 |
| 11 | *Anabasis brevifolia+Oxytropis aciphylla* | 1 | 1 |
| 12 | *Anabasis brevifolia+Peganum nigellastrum* | 1 | 1 |
| 13 | *Anabasis brevifolia+Peganum nigellastrum+Convolvulvus gortschakovii* | 1 | 1 |
| 14 | *Anabasis brevifolia+Reaumuria soongorica* | 1 | 1 |
| 15 | *Anabasis brevifolia+Salsola passerina+Sympegma regelli* | 1 | 1 |
| 16 | *Anabasis brevifolia+Stipa gobica* | 1 | 1 |
| 17 | *Brachanthemum gobicum+Cleistogenes songorica+arnebia* | 1 | 1 |
| 18 | *Convolvulvus gortschakovii* | 1 | 1 |
| 19 | *Convolvulvus gortschakovii+Salsola passerina* | 1 | 1 |
| 20 | *Ephedra przewalskii* | 1 | 1 |
| 21 | *Haloxylon ammodendron+Anabasis brevifolia* | 1 | 1 |
| 22 | *Nitraria sibirica+Kalidium gracile* | 1 | 1 |
| 23 | *Nitraria sibirica+Peganum nigellastrum* | 1 | 1 |
| 24 | *Nitraria sibirica+Peganum nigellastrum+Reaumuria soongorica* | 1 | 1 |
| 25 | *Nitraria sibirica+Reaumuria soongorica+Convolvulvus gortschakovii* | 1 | 1 |
| 26 | *Nitraria sibirica+Salsola passerina+Peganum nigellastrum* | 1 | 1 |
| 27 | *Peganum nigellastrum* | 1 | 1 |
| 28 | *Peganum nigellastrum+Ajania achilleoides* | 1 | 1 |
| 29 | *Peganum nigellastrum+Anabasis brevifolia* | 1 | 1 |
| 30 | *Peganum nigellastrum+Artemisia scoparia* | 1 | 1 |
| 31 | *Reaumuria soongorica* | 1 | 1 |
| 32 | *Reaumuria soongorica+Kallidum gracile+Peganum nigellastrum* | 1 | 1 |
| 33 | *Reaumuria soongorica+Salsola passerina* | 1 | 1 |
| 34 | *Salsola passerina+Peganum nigellastrum+Artemisia scoparia* | 1 | 1 |
| 35 | *Salsola passerina+Reaumuria soongorica+Anabasis brevifolia* | 1 | 1 |
| 36 | *Stipa gobica+Reaumuria soongorica+Salsola passerina* | 1 | 1 |
| 37 | *Sympegma regelli+Anabasis brevifolia* | 1 | 1 |
| 38 | *Zygophyllum xantoxylon+Anabasis brevifolia* | 1 | 1 |
| 39 | *Zygophyllum xantoxylon+Anabasis brevifolia+Peganum nigellastrum* | 1 | 1 |

## *Appendix D. GIS Layers Used in Observations*

| **Name** | **Type** | **Source** |
|---|---|---|
| Road from Oyutolgoi to Gashuun Sukhait, (planned and existing) | Line | Ivanhoe Mines Inc |
| Point location of Lesser Kestrel, Khulan and Goitered Gazelle | Points, polygons | WSCC, 2009 Galba Gobi field survey |
| Distribution map of Houbara Bustards | Polygon | WSCC, 2009 Galba Gobi field survey |
| Nest sites of Saker Falcons | Polygon | WSCC, 2009 Galba Gobi field survey |
| Unpaved roads in the South Gobi | Line | NGIC |
| Sensitive areas | Grids & polygons | WSCC |

# *Appendix E. Movement of Satellite-Tracked Saker Falcons*

Brief information of the movement of three satellite-tracked Saker Falcons from mid-June 2009 to early October 2010.

***Name "Galba", PTT ID 93546:*** An adult female was captured in Sukhain Toirom on June 6, 2009. Her nest was in elm tree and there were four chicks.

**June 9-30, 2009.** During the last half of June, Galba ranged over an area of 155 square kilometers around her nest site.

**July 1-31, 2009.** During July, Galba continued to range around her breeding site but also made numerous forays to the south, traveling up to 50 kilometers and crossing the border into China.

**August 1-31, 2009.** In early August, Galba dispersed from her breeding area moving ca. 125 kilometers northwest to an area in the Ih Shanhyn Mountains where she remained until the end of August. On August 27 she returned back to her breeding territory and remained there until the end of the month.

**October 1-31, 2009.** Galba did not move far until October 5, then started flying to south for 70 kilometers crossing China border and made a loop to west and returned to the breeding area on October 7 but did not stay there for long. She continued her flight to northeast and arrived near Ondor Shil Mountain in Dornogobi aimag. She remained there at border area between three aimags until middle of October, then returned to Shar Khadnii Bulag mountain.

**November 1-30, 2009.** Galba went to the Mandalt town in Inner Mongolia in China early of the month. On the way she spent a night in mountains after crossing the Beijing-Erlian railway line about 55 kilometers southeast from Erlian (Ereen) city. She did not stay long in Inner Mongolia, and constantly moved and changed her position. By November 12, she went back and approached border south from the nest and stayed few days there and returned to the nesting area on November 17. Next day, she was on the move again to northeast to reach in an area just south of Orgon sum in Dornogobi aimag.

**December 1-31, 2009.** On December 2, Galba continued her movement to northeast. She arrived few days later near Delgerekh sum, making one short stop near at Sainshand sum on the way, on December 16. Then she started heading back to the nesting area again. There was a silent period which we did not hear anything from her until January 12.

**January 1-30, 2010.** Galba appeared again at the nesting area and remained there until January 22. Then she moved to Shar Khadnii Bulag Mountain and kept flying until she approached Zuunbayan sum. Soon she flew back to the nest area direction. She took her time and wandered a little, but used nearly the same route on her return. She arrived at nest site on February 10.

**February 10-31, 2010.** Galba stayed within the nesting until February 22.

Galba transmitted a total of 619 GPS location data by February 22, 2010. She was very active and highly mobile. However, she kept returning to her nesting area once or twice each month, which could be an intention to defend her nesting territory. During her journey from July 2009 to February 2010, she covered an area of 147,575.8 square kilometers (100% minimum convex polygon) over 3 aimags, and also with significant amount of time spent in northern part of China.

***Name "Gobi", PTT ID 93547:*** An adult male was captured at the nest in Baga Modnii Khudag on June 9, 2009. Nested in elm tree, with two live and four dead chicks.

**June 1-30, 2009.** In June, Gobi ranged over an area of 35 square kilometers around his nest site.

**July 1-31, 2009.** Up to the July 19 Gobi ranged over an area of 135 square kilometers around his nest site. On July 19 he moved 160 kilometers northeast where he stayed until July 21 before moving a further 110 kilometers north to settle near Ondershil, Dundgobi aimag until the end of the month.

**August 1-31, 2009.** Gobi remained in the Ondershil area until August 22 and then made the 250 kilometers journey southeast back to his breeding area where he remained until the end of the month.

**September 1-30, 2009.** Gobi remained in the breeding area until middle of September, then moved northeast and arrived at Khavtsgain Khondii, Dornogobi aimag. He made two trips to this area until end of September.

**October 1-9, 2009.** Gobi made a southwest loop between October 1 and October 6. Then he flew east some 500 kilometers and arrived near Bayan Ondor Mountain in Sukhbaatar aimag, not far from Mongolia-China border. Soon after the transmitter stopped sending data.

Gobi transmitted a total of 449 location data until last time signals on October 9, 2009.

***Name "Zaluu", PTT ID 93548:*** One of two juveniles at the nest in Baga Modnii Khudag. She was trapped and satellite tagged on July 24, 2009. She was a healthy female.

**July 26-31, 2009.** Zaluu stayed close to her nest site until the end of the month.

**August 1-31, 2009.** Zaluu stayed in her natal area until August 9 when she embarked on a looping dispersal movement first heading southeast into China then west and north back into Mongolia eventually to reach a point ca. 345 kilometers north of her natal area by August 12. Zaluu remained in this area near Deren sum of Dundgovi aimag until the end of the month.

**September 1-30, 2009.** Zaluu did not move until September 26. Then started moving back and forth a little to the southwest. On September 29 she started migrating to the southwest. By the end of month she was right at the border.

**October 1-16, 2009.** Zaluu continues her migration. She passes by the Qinghai Lake on the Tibetan Plateau on October 2. Her migration stopped when she almost reached the northern foothills of the Himalayas.

Zaluu transmitted a total of 456 location data, with the last good signals received on December 4, 2009. Engineering data and Argos nominal data suggests that the transmitter was moving around from this last location until the end of February 2010. It is thought that either Zaluu is still alive with the transmitter malfunctioning or the transmitter has fallen off and local people have found it and are moving with it. Another possibility is the bird has died and people found the transmitter and are moving with it. Normally, if the bird died in early December, the transmitter should be completely silenced by now.

# *Appendix F. Project-related Reports, Presentations, and Publications*

Nyambayar Batbayar, and Bayarjargal Batsukh. ***Preliminary Report to the Ministry of Nature, Environment and Tourism, on the Results and Findings from Saker Falcon and Houbara Bustard Survey Conducted in Galba Gobi IBA, Southern Mongolia***. In Mongolian, document file submitted to the vice minister of MNET; D.Enkhee, MNET, NEMO project; and Ms.Enkhtsetseg, World Bank, NEMO project.

Badam Tomorbaatar, Bayarjargal Batsukh, Nyambayar Batbayar. ***Report on Vegetation Survey and Houbara Bustard Habitat Assessment in Galba Gobi IBA in Southern Mongolia***. Wildlife Science and Conservation Center of Mongolia. In Mongolian, document file.

Axel Bräunlich. ***Trip Report: Technical Support to Surveys of the Distribution and Movements of Saker Falcon and Houbara Bustard within Galba Gobi Important Bird Area, Omnogobi aimag, Mongolia, May 2009***. WSCC and BirdLife International; in English, document file.

Nyambayar Batbayar. ***Saker Falcon and Houbara Bustard Survey in Galba Gobi, Southern Mongolia.*** In English, Powerpoint presentation file, presented at the National Avian Research Center, Abu Dhabi, United Arab Emirates, April 8, 2009.

Nyambayar Batbayar and Bayarjargal Batsukh. ***Preliminary Results and FIndings from Saker Falcon and Houbara Bustard Surveys in Galba Gobi, Southern Mongolia***. In Mongolian, Powerpoint presentation file presented to the MNET vice minister D. Idevkhten; D.Enkhee, MNET, NEMO project; and Ms.Enkhtsetseg, World Bank, NEMO project.

***Brochure*** that introduces importance of Galba Gobi IBA, the two focus species, and the project in Mongolian and English.

***Television interview*** with Bayarjargal Batsukh on ecology and conservation needs of Houbara Bustards, which was aired on September, 31, 2009 by National Central Television.

***Project description and output*** on WSCC web site, www.wscc.org.mn.

***GIS data layers*** resulting from this project will be placed on the web, wscc.org.mn/resources/gis_data.html.

# *Appendix G. Select Photo Documentary*

Houbara feathers and tracks on sand *(photo by B. Nyambayar/WSCC)*

Preparing noose to capture Houbara Bustards *(photo by B. Nyambayar/WSCC)*


Tavantolgoi coal transport road and travel of dust over Galba Gobi *(photo by B. Nyambayar/WSCC)*


A heard of Mongolian Gazelles trying to cross the road and beyond are coal transporting tracks *(photo by B. Nyambayar/WSCC)*

Cinereous Vulture and Himalayan Griffon at a poached Wild Ass carcass *(photo by B. Nyambayar/WSCC)*

Researchers speaking with a herder and his camels drinking water from hand dug well in Galba Gobi *(photo by B. Nyambayar/WSCC)*

A patch of saxaul tree patch after a swift moving fire *(photo by B. Nyambayar/WSCC)*

Elm tree in the Galba Gobi *(photo by B. Nyambayar/WSCC)*

*A feather of houbara bustard on the steppe*