Appendices

Appendix 1 Plant community composition in the SE Gobi (Source: UNEP Vegetation Type Maps compiled by the Russian-Mongolian Complex Ecological Study1995).

ID	Description
Semidesert steppe	
25	Artemisia-bunchgrass, bunchgrass (Stipa, Cleistogenes, Agropyron) steppes with Caragana on light chestnut soils
26	Petrophytic forbs-Artimisia-bunchgrass (Agropyron, Stipa) steppes on the light chestnut and mountain chestnut soils.
27	Psammophytic and hemipsammophitic bunchgrass (Agropyron, Stipa glareosa and Stipa gobica, Cleistogenes) steppes with shrubson light chestnut sandy loamy and sandy soils
28	Hemihalophytic Nanophyton-Artemisia-bunchgrass, Allium-Stipa glareosa steppes on light chestnut solonetz soils and solonetzes
DESERT	
North Desert (Semi-Desert)	
29	Bunchgrass (Stipa gobica, Sipa glareosa) with Anabasis, Allium, Ajania, Artemisia Nanophyton on brown desert-steppe, locally calcareous soils
30	Petrophytic bunchgrass (Stipa gobica, Stipa glareousa) with Ajania, Salsola laricifolia, Ceratoides papposa, Caragana on brown soils, locally in combination with perennial soltworts on solonetz brown soils
31	Psammophytic bunchgrass (Stipa gobica, Stipa glareosa) with Caragana, Ceratoides papposa, and Stipa-Cleistogenes communities on brown loose-sandy soils and sands
32	Halophytic bunchgrass (Stipa gobica, Stipa glareousa) with perennial saltworts, Salsola passerina with Stipa and Allium; Reaumuria songarica with Stipa and Allium communities on solonetz brown soils and their complexes with solonetzes
Middle-Desert(Steppificated Desert)	
33	Anabasis brevifolia with Stipa gobica, Stipa glareosa, Allium; Nanophyton erinaceum with Stipa, Artemisia, Ajania with Stipa deserts on pale-brown locally weakly solonetz soils
34	Petrophytic Anabasis brevifolia, Sympegma, Ajania, Salsola laricifolia with Stipa glareosa deserts on pale-brown soils.
35	Psammophytic Artemisia with grasses, Ceratoides papposa, Caragana, Potaninia deserts on pale-brown sandy soils
36	Halophytic perennial saltworts with Stipa glareosa in combination with Kaldium deserts on solonchaks and Haloxylon stands on pale solonetz-solonchak
South-Desert (True)	
37	Anabasis, Nanophyton, Sympegma, Ephedra, low Haloxylon stands on grey-brown desert, locally solonetz soils, often in combination with Sympegma-Potaninia or Artemisia terrae-abbae-Ceratoides papposa communities on sands

38	Petrophytic Anabasis, Salsola laricifolia, Sympegma, Amygdalus, perennial saltwort deserts on grey-brown skeleton and grey brown raw soils
39	Psammophytic Psammochloa, Artemisia, Caragana, Potaninia, Zygophyllum deserts, high Haloxylon stands on grey-brown, locally gypsic, sandy, weakly differentiated soils and sands
40	Halophytic, Reamuria, Salsola passerina, Anabasis brevifolia, Brachanthemum deserts on grey-brown solonetz soils and solonchak soils
41	Gypsum-halophytic Nitraria, Haloxylon with Nitraria on perennial saltworts deserts on grey-brown solonchak strongly gypsic soils

Desert

56	Sedge halophytic grass (Puccinellia, Hordeum) meadows on saline meadow soils, Iris-Carex duriuscula meadows on saline soddy soils, Puccinellia-Achnatherum and Suaeda Achnatherum meadows on meadow solonchacks and saline meadow-chestnut soils with participation of Trisetum-Carex meadows, locally with Phragmites, halophytic forb-grass, Puccinella-Achnatherum meadows on saline meadow-chestnut soils
57	Carex duriuscula-Iris and Anchnatherum communities on saline soddy soils, halophytic grass communities on saline meadow soils in combination with: a) Artemisia frigida-Cleistogenes communities on soddy and chestnut soils, b) Allium and Leymus communities on soddy desertificating calcareous soils
58	Puccenilia, Calamagrostis communities on saline meadow soils, Juncus, Eleocharis-Carex communities on swampy clay mucky-gley soils, Achnatherum and Iris communities with Caragana on soddy desertificating calcareous soils, locally with Phragmites on meadow-swampy soils in combination with: a) poplar stands with shrubs on soddy primitive soils
59	Combination of halophitic meadow communities (Phragmites, Carex, Achnatherum) and shrub tugals (Tamarix, Hallmodendron halodendron), locally with Populus on saline meadow and meadow -desert soils.
60	Shrub (Caragana, Halimodentron, Tamarix) Achnatherum splendens communities with Artemisia and halophytic forbs locally with Stipa on soddy desertificating calcareous soils
61	Phragmites, Eleocharis-Phragmites communities on meadow-swampy soils in combination with: a) Elymus-Carex communites on saline swampy clay-mucky gley soils and forb-Puccinella communities with Achnatherum on saline meadow soils; b) Eleocharis-Juncus communities on swampy peaty soils, Leymus communities with Limonium and Achnatherum, locally with shrubs (Tamarix, Caragana) on saline meadow soils; c) Phragmites, Carex-Phragmites communities, locally on peaty gley soils
62	Achnatherum communites (with Carex spp, Carex -Agropyron, Potentilla-Artemisia -Stipa krylovii, Allium-Carex-Stipa krylovii) on meadow -chestnut, locally solonetz soils
63	Combinations of halophitic (perenial saltwort Reaumuria, Kalidum, Nitraria, Haloxylon) communities on meadow and fluffy solonchaks
64	Haloxylon (Reaumuria, Nitraria) with shrubs, sometimes in combination with Tamarix tugals and psammophytic communities on primitive sair soils

Appendix 2. Insights of rural residents in the study area.

A. Herder in the SW Dorngov Study Area

The following insights by herder #7, who agreed to carry a backpack GPS unit while herding small stock, were recorded in his daily log from 19.08.-13.09.2005 (Enkhjargal Darambaza translated).

08.19.05 Tuesday
Today going for my sheep herding I took the equipment in the backpack for the first time to the rangeland. It was very hot day. Four khulans were sighted.

08.20.05 Wednesday
It was a hot day, too. Saw 2 khulans while I was walking with the herd.

08.21.05 Thursday
The sky was clear and sunny. It was hot, although has become cloudy in the afternoon.

08.22.05 Friday
Since the afternoon it was raining, so I didn't go much far with the sheep. No khulan was sighted.

08.23.05 Saturday
It was sunny earlier in the morning. Saw 3 khulans. But clouds came up in the afternoon and there was a brief rain shower which lasted about 25 min and now it has become quite wet everywhere. Think khulans movement may benefit from this.

08.24.05 Sunday
Today was a very hot day with little clouds. No khulan was sighted.

08.25.05 Monday
Today we are moving out of the place near Khaliv Bagg into a place called West Toirom. While we have traveled approximately 16 km we've seen 2 separate groups of khulans with fewer khulans in each. Couldn't get their numbers though.

08.26.05 Tuesday
The place we moved into seems to have plenty of water sources like ponds and streams. So khulans could be seen quite a lot, almost everywhere. Again couldn't count them though. It seems there may be over a hundred of them around here.

08.27.05 Wednesday
Sunny and clear sky and a pretty hot day. Khulan herds were seen quite a bit and located pretty close to each other. Tried to count their number. There were around 40-43 khulans.

Found khulan pellets (fresh), put them in a sunny spot to get them dried, marked the spot with a small pile of rocks.

08.28.05 Thursday
The day has been little breezy but still hot. Some khulans could be seen on the hilltops or around in separate groups. It was not possible to get their numbers. But anyway, there may have been somewhere around 50-60 of them. Mongol horses have been spotted occasionally, their pellets were found and left to dry.

08.29.05 Friday
No khulan was seen today, although their screaming noise could be heard from distance. Apparently they were at the pond having water.

08.30.05 Saturday
Haven't seen any khulan today. Weather has been bad: foggy and therefore poor visibility.

08.31.05 Sunday
Today I felt tired, so stayed at home. A kid sent to herd the sheep and was carrying the equipment, but when the kid got back home didn't say anything about khulan, I didn't ask, either.

09.01.05 Thursday
Today there was a clear sky and really hot. There were some errors in putting days for the previous dates, so I made corrections to them. Quite a few khulans were seen running along the hills. Tried to count them; it seems more than 110 of them there. Didn't go much far away this afternoon; nevertheless, 17 more khulans were sighted.

09.02.05 Friday
It was much cooler day today, so I was able to go pretty farther than usual but was not able to sight any khulan. No khulan pellets was found either. I was thinking may be this equipment can detect some signal even if khulans may have escaped somewhere, because it was making some buzzing noise in the backpack. Hope it doesn't read mind.

09.03.05 Saturday
Distant visibility was poor because of the foggy and windy condition. Haven't sighted khulan yet, but fresh traces could be seen quite often. They might have been run away from me, since khulans don't usually avoid livestock on rangelands.

09.04.05 Sunday
Although I didn't see khulan today, I could hear clearly that they have come to the lake by their screaming and fighting with each other noises.

09.05.05 Monday
Today I brought my sheep to the lake for water. Tried to collect khulan pellets but couldn't identify them. Collected few bunches tried to separate them from mongol horses

pellets but wasn't successful. So I think may be khulans and mongol horses eat very much similar diet when there is lush vegetation which is the case for this rangeland around the lake area.

09.06.05 Tuesday
I still keep trying to identify the pellets of khulans and mongol horses. Collected some fresh and quite wet pellets, crushed them pressing in between of two rocks, and looked inside. Some were quite wet with liquid coming out when squeezed, some were not so much. Still was not successful to recognize them, although it seems they may be differentiated by the shapes.

09.07.05 Wednesday
As autumn is coming, water is getting scarce around here, at least around our camp location and may be because of that khulans have been sighted fewer and fewer. Then I saw 2 khulans first, and then 4, in total 6 of them for today.

09.08.05 Thursday
Again tried to see how khulans and mongol horses pellets are different; crushed and split them. Again couldn't see any difference. Anyway, it seems that I usually travel from 13 to 18 km a day herding my sheep, I estimated.

09.09.05 Friday
Made an attempt to separate sheep pellets from those of goats. Not much difference visually, it seems. But goats prefer plant tops flowers leaves and seeds more than sheep. Therefore, composition of the pellets inside might be a bit different, I guess. Today I traveled farther than I had the previous days and as a result saw 13 khulans.

09.10.05 Saturday
Didn't see any khulan today. Although I saw some signs of their fightings with each other; a khulan's tail cut off by its end was laying on the ground. Looks like these animals have got very aggressive behavior.

09.11.05 Sunday
For days I have been trying to identify khulans and mongol horses pellets. Asked about it the people I've seen on the way, but still didn't find anything that could differentiate them.

09.12.05 Monday
Collected a sample from camel feces. The feces were of pretty liquid consistency. Probably camels that are on a green, lush rangeland and gaining weight, have got this liquid kind of feces. Meanwhile, during the heat of a day and when flies come out, goats seem to move grazing along the wind direction following after each other and/or they lay down near water or ponds and would get up to graze only after it cools down in the mornings and evenings. The forage plants that camels like to graze and seem to gain weight from them would be: Anabasis spp., Berberis sibirica, Reaumuria soongorica, Salsola passerine, Caragana pygmaea, Allium polyrrhizum, Allium mongolicum, Bassia

spp., Artemisia spp., and Artemisia anethifolia. These are the most nutritionally valued forages in gobi desert rangelands.

09.13.05 Tuesday
Today I brought the sheep herd pretty far hoping to get khulans sight. But failed to see any khulan for the last couple of days. This is probably due to that the nearest water sources- ponds and streams have been shrinking or dried out, and khulans may be moved elsewhere relocating to the other ranges. So, from this day on I decided to quit chasing khulans, although I will be carrying that backpack with me anyway.

The interest of herder #7 in khulan and the collection of fecal samples for later analysis certainly was exceptional high. However, his cooperation shows the potential for involvement of selected local people to gather local information on wildlife. During his 4 week study period herder #7 saw over 250 khulan near or on the pasture his livestock was using.

B. Interviews with residents of the SE Gobi Study Area.

Selected statements from 4 in-depth interviews about human-wildlife relationships

(1) 48-year old women – former herder, now works for public service in a soum center:

…Well, of course it is right that wildlife should exist and stay together with people. It is a natural law. From the early time, wildlife was together with people. Well, many years ago, the time was good. We used to have many livestock and nature was in good condition. But now the natural situation has totally changed…
…People's negative treatment to nature and poverty all these issues are reasons to the change in the behavior of wildlife. When I was a child, time used to be very nice. All things were in good condition. There used to be rich green vegetation by mid May and livestock already gained weight by that time. But today, almost July is coming, yet we have had no rain. So, I think as people miss that nice time, so do wildlife…
...Now, because of poverty and natural disaster, number of wildlife extremely decreased. People who lost their livestock in the disaster, I heard that (it is not my experience) they kill or run after or scare the animals like wild ass, gazelle that live in the low areas. Not many such cases for mountain animals. So, I don't know how we need to combat it and protect wildlife. I think local people, those who live in the area and the pasture should protect…
…There are many people who think and wish that wildlife live together with livestock and worried about their leave and decrease. It would be good if we encourage those people. We have many of such people who can talk about earlier times. Especially elders, they talk that those animals were abundant before but today's young people are scaring and killing them. So it would be good if we use such people who have a heart towards wildlife and who live in the area, in the conservation work…

…Broad awareness of nature conservation is needed for local people. Only herders know the wildlife in the mountains. To protect or to kill should be under the herders' responsibility and management. In that case, if someone from outside the area come and tries to kill the wildlife, local people would resist them and protect the wildlife. Therefore it would be right to talk to local people and cooperate with them. For example, you can research what families live near what kind of wildlife and talk to the families…

(2) 62-year old man – retired herder:
…In the earlier times, hunters hunted with horse and camel. But today, people are hunting with vehicles and machines!...
…Wild asses destroy the nature a lot. They really influence negatively on the yielding of vegetation. Their growth is actually slow. They give a birth to young ones not often…
…Today, number of wild ass is increasing and people's livelihood is deteriorating. It seems that people who are poor sometimes use wild ass for their own use. And the state is trying to control this through a law and regulation and government resolution was made on this, I heard it recently. It would be good if a government, Ministry of Nature and Environment takes an organized measure on hunting wild asses and give permissions to local people to hunt some number of wild asses to use for their livelihood. - Well, in the end, the state and government knows it. Wild ass is animal in the Red book. – But nowadays argali (wild sheep) is extremely decreasing. Argali is a nice animal. Also ibex became very rare…
..In earlier times, we used to kill the injured ones first. We used to tell that it is not good to leave a gazelle injured, it closes the hunting blessing. Today, there is no such kind of beliefs and rules. Today, people just let them leave with bleeding and injured. If they shoot baby gazelles or female gazelles or weak ones, they will just leave them. This is very wrong. In earlier times, we used to get whatever is shot down by the bullet whether it is to be a baby or an adult. And we used everything from the gazelle. Even we put the blood into the intestine and eat…

(3) 55-year old man – working in public service at a soum center:
…For example, when you are traveling in Gobi steppe and you see a camel, which is a pride of the Gobi people or wild asses, or gazelle herds, you feel very nice, don't you? The nature can be beautiful itself, but it's the wildlife that makes it more beautiful and lively and people can see it and feel happy. People feel proud of their country and talk the beauty of nature in relation to the existence of wildlife…
…So, wildlife purely depends on nature and natural survival. Besides, many of them die due to human negative influence. They are extremely reduced in number. For example, black tailed gazelles. They were abundant in earlier times. But today, you can hardly see them. Now in this market system, people treat to wildlife (even to their livestock) with violence and without love. Therefore, number of wildlife is decreasing significantly. Because of degrading living standards and high price of goods and high expenses to prepare food, people tend to kill more wildlife and use its meat for their food. In recent years, in our aimag, besides killing the gazelles, people are killing wild asses a lot. They slaughter them and sell it under the name of 'horse meat'. And there is a rumor that many of them loaded on the train wagon to UB. Wild ass meat from our area, supplies the needs of many of the canteens in UB that sell 'huushuur'. I believe it's true. So I feel very

sad about it. Even though a wild ass is considered as rare animal and written in the Red Book, nowadays, herders say that they destroy the pasture and especially in today's unfavorable natural condition, wild ass is known as the main animal that destroy the pasture. Well, maybe it's true. Wild asses are animals that go in big herds. Especially, today many of them are in the south west part of our aimag. Sometimes few of them can be seen in the west and east soums. So, there is a need of state regulation on this issue. If it is really true that they are increased in number, then it is okay to hunt them in certain number for food. Maybe they were very rare in the time of being included in the Red Book. And maybe they increased in number since then. If so, then they can be excluded from the Red Book list. Today, even though it is considered as Red Book animal, many of them are killed and eaten. So the state should do something about this. The state should research whether it is really increased in number or if they are still need to be strictly protected then, the state should take a policy that ensures their peace and safety. Otherwise, they cannot be left behind as it is today…
… Environmental inspectors who are in charge of this matter are not really productive in their work and don't do much on public awareness, inspection and control. Nothing such kind of activities today! They don't really do their basic job telling the excuses like no car and no fuel. So basically, nature is left with no owners and caretakers. And it encourages poachers and bad people to enjoy their freedom on nature with an idea that they can do and kill anything and make a profit out of it. That kind of attitude is there today in our aimag. Therefore, there is a necessity that the top (state) should do something about this through control, policy and manpower…
…But in today's market economy society, there is a harsh or unmerciful law that someone has to make a living with what he/she can find- If you can make a living, then you'll live and if you can't, then nobody will help you! Such a harsh law that you yourself have to work in order to live…And some kill and steal people's livestock and sell. Every one is thinking of some ways to make a living. In such wavy situation, wildlife is of course under the great threat and risk. If the condition continues this way, then, maybe one day we will be left with the photos of those animals once were abundant before…

(4) 69-year old man - herder
…We used only horse and camel in early times. Unfortunately, winter disaster has been around since 1997- 1998 and the white gazelles that used to be a lot grazing here have all disappeared. Now, you can hardly see them. Well, occasionally you can see a wild ass - two or three of them. Manlai area has a lot of wild asses. And there were wild asses in Zalaat area. But now, people from there are saying that there is no grass…
…There are many wolves. No wildlife, no gazelles in our area today. Well, when it rains, many white gazelles come to our area…
…We really need to increase number of wildlife. Generally, they have gone away and disappeared because of winter disaster and drought. Frankly saying, people chase them with motorbike and car and kill them. So wildlife is afraid and move further away. Now, in Mongolia, black-tailed gazelles are almost reduced to the number to be written in the Red Book, white gazelles are very rare, ground squirrel gets also rare…
…We used to have very rare white gazelles. But for some time, we had many of them from Dornod aimag and Inner Mongolia. We exactly don't know where they are from.

Many of them! In the morning that steppe looks yellow. You can see them in herds by herds. In the morning, I used to look through binoculars. But now, none of them is here. Well, time has changed. Wildlife has finished. We need to love them and protect them. We kill them a lot. I would like to tell that we can kill a wolf but not other wildlife. If there is a reporter, I would like to send a message to the state authorities that please protect wildlife…

(5) 75-year old women – retired Ulaanbaatar resident:
…Wildlife is rare in our Gobi area. We had a lot of livestock from Negdel in earlier time. Nature was nice at that time. But now, we face drought and it's very difficult…
…Well, we used to have many gazelles. But now people say they migrate to other better areas. We used to have many of them grazing around…
…I don't know about them [referring to wild ass] much. I just heard from people that they were grazing here and there occasionally. And I saw them on TV. Otherwise, I even haven't seen them with my eyes in reality…
…Also, on TV, I saw Przewalski's horse running around. Sometimes a view that a snow-leopard chasing after them. Only saw them on TV. I have never traveled far. I lived in a city since the age of 23. When I was in a city, I used to go only to resort places…

(6) 37-year old man – unemployed Ulaanbaatar resident, University degree:
…I am a young person so I don't have much life experiences with wildlife. But I would like to share about nature. I grew up in countryside so I can share my little knowledge about what I know about wildlife…
…Wildlife is getting rare these years. For instance, marmots. They were very abundant before. And gazelles as well. Well, gazelles are said to be animals that don't have permanent habitat. Our area and environment also degraded and have little grass. So maybe because of change in nature, they are moving around. I think wildlife is connected to each other…
…But I would like to say to young people that let us love nature and not kill wildlife. Please love wildlife…

In all of the interviews there was the notion that most wildlife populations are decreasing and nature in general is becoming degraded. In addition, the interviewees felt that old values are fading away due to socio-economic changes. All believe that wildlife is an important part of Mongolia's nature and all see a need for better protection. All four interviewees from the gobi stated that poaching by locals, as well as by market hunters is happening. Contrary to gazelles, khulan are seen somewhat ambivalent. One the one side, people wants to ensure their survival, but on the other hand khulan are also seen as pasture competitors. One possible solution offered to address human-khulan conflicts was providing incentives for conservation and involving local people in wildlife conservation. Outside of the khulan range, people seem to know very little about the species and are largely unaware of any conservation concerns.

Fig. X: H. Otgonbayar interviewing an elderly herder in the gobi.

Appendix 3. Using Near Real-Time Technologies to Assess and Monitor Habitat Needs of Large Herbivores in the Mongolian Gobi.

1. Introduction

The on-going transformation of Mongolia to a modern nation interacting with the global economy has important implications for conservation of large herbivore wildlife and sustained use of natural resources.

At the present time, Mongolia is gradually developing the framework and attributes of commercialized agricultural production. One aspect of this transformation that needs immediate assessment is the impact on large herbivore habitat of exploitative human intrusion driven by economic development. Commercialization without parallel development of safeguards that ensure protection of wildlife and wildlife habitat will allow greater intrusion of human activities and increased conflict over use of natural resources. Development of mining, road and railroad construction, and more intensive, industrialized livestock production systems will also impact security and habitat needs of large herbivore wildlife and the livelihood sustainability of rural herders and farmers.

The Gobi Region of Mongolia is especially sensitive to human intrusion and economic development. It contains the highest diversity of wildlife species and provides critical habitat for populations of threatened and endangered wildlife. The Gobi Region is also the primary focus of the developing eco-tourism industry. It is the eco-region most sensitive to drought and severe winter weather (i.e., dzud). The importance of the Gobi Region to conservation of Mongolian wildlife and traditional lifestyles is undeniable.

2. Project Goal

Several international and national institutions are currently developing a dynamic and functional Integrated Resource Assessment and Monitoring System (IRAMS) that uses easily accessible near-real time information to aid resource conservation. A key function of IRAMS will be obtaining relevant and accurate information on the position, security and habitat needs of large wild and domestic herbivores. This project will further test and demonstrate the applicability of near-real time data acquisition systems to acquire, process, and use natural resource information to define large herbivore habitat needs to ensure that those needs are realized as economic development transforms the Gobi Region. as a component of MIRAMS. KRESS (Kinetic Resource & Environmental Spatial Systems)

3. Project Objectives

The project objectives are:

1. Determine the position, movement, ecology, and habitat use of large wild and domestic ungulates.
2. Determine habitat and security needs of sympatric large wild and domestic herbivores.
3. Assess the impact of current and projected human intrusion activities on habitat use and security of large herbivore wildlife and pastoral livestock production systems.
4. Use outputs from the system to enhance conservation management of natural resources and aid rational planning of economic development in the region.

4. Project Location

The project will focus on the Gobi Region to initiate and demonstrate the utility of KRESS to model large herbivore habitat needs as a component of MIRAMS. The Gobi Region retains significant populations of large wild herbivores and the extensively managed, traditional pastoral livestock production. With successful application of KRESS and MIRAMS in the Gobi Region, the project will be expanded as a national program for natural resource conservation.

5. Relevance and Significance

Understanding the range, habitat, and ecology of large wild and domestic herbivores has long term implications for sustainability of Mongolia's wildlife, grazingland resources, and extensively managed livestock production. Mongolia needs to put into place, activate, and support a resource management system based on rational policies and conservation programs that can mitigate adverse impacts of privatization, natural resource exploitation, and human intrusion.

Integrating these technologies will improve the capacity to assess and monitor resource information on both a landscape and site-specific scale, develop and assess resource data, and generate near-real time output that can be immediately used by natural resource managers and users throughout Mongolia. A functioning IRAMS can be the basis for a relevant, practical, and accessible natural resource management system and decision-support system for national policy and program development concerning large herbivore wildlife and livestock. This project will have long-reaching impacts on development strategy and resource conservation in the Gobi Region and, ultimately, Mongolia through improved understanding of large herbivore habitat needs, the impact of various human development intrusions, and improved capacity to manage natural resources.

There are numerous advantages to implementing an IRAMS at the present time. The technology platforms on which IRAMS operates are developed and have been tested in other areas as resource conservation tools. GIS systems are becoming widely used in Mongolia for a variety of purposes. A large herbivore habitat modeler (KRESS) that uses Geographic Positioning System technology was tested during the preliminary study of impacts of human intrusion on the Asiatic wild ass (Khulan Project), and will provide site-specific habitat information that can be correlated with landscape scale information. The PHYGRO Forage Growth Modeler and Fecal Profiling are currently being developed and adapted to Mongolian conditions (Gobi Forage Project-USAID/Mercy Corps) as tools to mitigate financial and environmental risk factors affecting herders and farmers in the Gobi Region. Other applicable near-real time technologies have had several generations of use as resource management tools but have not been part of an integrated conservation management system. Decision Support Systems are available to assist managers and users to make appropriate decisions relative to sustainable use of natural resources (Grazing Land Applications, Nutritional Balance Analyzer).

Project Approach

This project will use near-real time technologies to define habitat needs of large wild and domestic herbivores in the Gobi Region relative to interactions between sympatric herbivores and between herbivores and human intrusion. KRESS uses landscape parameters to determine the suitability of each site on the landscape for use by animals based upon knowledge of experts in the discipline and GIS data layers. Information about how animals utilize a landscape is employed to construct models that predict landscape use with accuracy of the model or map produced based on actual observations of animals. In the KRESS Modeler, the relationship between suitability and the landscape is mediated via mathematical models that are created by researchers or managers who have extensive knowledge about a landscape.

The modeler is broadly useful across many types of systems. Since the systems in which large herbivores are found are primarily resource-based and involve lands used for domestic animals, water, and wildlife, natural resource applications are the primary focus and models reflect this natural resource/spatial perspective. The KRESS modeler software system is a tool that facilitates the evaluation and analysis of multiple factors that determine the suitability of sites on a landscape for a purpose. At its broadest it is a multi-criteria decision aid (MCDA) and uses classification techniques to rank alternative solutions to problems.

The KRESS multiple factor analysis is used to simultaneously take into account a series of factors that affect the preference of animals for a particular position on the landscape based on a deterministic applications of rules. The program was built to be flexible and uses an open "blackboard" format. Thus, a scientist or resource manager should be able to conceptualize linear, non-linear, or mixed models and, if spatial data exists for the parameters chosen, rapidly apply them to a landscape. The resource manager can

use information about the system to build a model that seems reasonable and generate the suitability for each cell on the landscape (Johnson 2004).

Study Approach

The general outline of the proposed study is:

The Gobi Region will be selected as the general study area. In two Gobi aimags, suoms will be selected that have the highest population density of targeted large wild herbivores.

The study in each aimag will be conducted by a Ph.D graduate student who will organize and train locally recruited field technicians.

Information on habitat needs will be collected over three full years to ensure that seasonal variances in large herbivore use of Gobi habitat are observed.

GPS collars will be placed on large and small livestock and on large wild herbivores to collect data on herbivore use of habitat (http://clark.nwrc.ars.usda.gov/collars/index.php).

Observation of large wild herbivores along fixed (spatial and temporal) routes will be established to track wild herbivore use of habitat and obtain information on large herbivore interactions.

The impact of existing human intrusion on large herbivore habitat needs and security will be evaluated from animal movement data collected by GPS collars and observations of field technicians.

Interactions between large herbivores will be determined from GPS data, observations, and collection and assessment of ancillary data.

Information on habitat and security needs of large wild and domestic herbivores will be obtained by placing GPS collars on target animals.

KRESS will use information from the field study to develop habitat models for large herbivores. The immediate purpose of the study will be development of a large herbivore habitat value index for each of the study areas.

The habitat value index will also contain values of habitat modified by human intrusion.
A regional habitat value index will be obtained by cross-referencing site specific habitat information with regional habitat information developed by the PHYGRO Forage growth modeler.

By the end of the study, a regional large herbivore habitat value database that can be accessed through IRAMS will be available to assist conservation of natural resources.

Project Budget.

This project will generate $750,000 from the World Bank through donor agencies. Of this money, around half, or $375,000, will benefit Mongolians that live within Mongolia. Of this, $200,000 will be deposited in the urban centers of Mongolia to support small field offices in aimag and suom centers, purchase vehicles and supplies, and employ operational staff (i.e., drivers, field technicians, translators, project coordinator, digital media technician, and pay for normal services). We will also train a Mongolian student to the Ph.D. level in rangeland/wildlife/natural resource science. The remaining money will benefit rural economies of the two aimags selected, including employing herders to track large wild and domestic herbivores. The

majority will be to support the field crews as they work in those regions. The remainder will be paid as salaries to herders participating in the GPS tracking of their livestock.

Principal Investigators	Project Focus	Year 1	Year 2	Year 3	Total
1. Dr. Dennis Sheehy	Habitat Classification /Large Herbivore Interactions/Livestock Production Systems	30,000	30,000	30,000	90,000
2. Dr. Petra Kazensky	Telemetry/Wild Herbivore Ecology	30,000	30,000	30,000	90,000
3. Dr. Douglas Johnson, Dr. Mounir Louhaichi, Dr. Pat Clark	GIS/Remote Sensing/KRESS Modeling	30,000	30,000	30,000	90,000
4. Texas A&M Dr. Jay Angerer	PHYGROW	5,000	5,000	5,000	15,000
Ph.D. Graduate Students (2 -one Mongolian & one Foreign)	Field Data Collection/ Data Analysis/Research Methods Training	35,000	35,000	35,000	105,000
	Research Support	20,000	20,000	20,000	60,000
Field staff (Mongolian)	Data collection	30,000	30,000		60,000
Materials and Supplies	12 GPS (with satellite service)	50,000	10,000	10,000	70,000
	GPS (with Drop Off)	30,000	5,000	5,000	40,000
	2 Digital cameras	3,000	1,000	1,000	5,000
	2 vehicles	50,000			50,000
	Supplies	20,000	20,000	20,000	60,000
Publications Conferences/Presentation			5,000	10,000	15,000
Total					750,000

Appendix 1. Conservation Technologies Integrated to Form a Mongolian Integrated Resource Assessment and Monitoring System (MIRAMS).

MIRAMS integrates several newly developed technologies to create a near-real time natural resource and resource-user impact assessment and management system. Technical components include:

KRESS Habitat Modeler (Kinetic Resource & Environmental Spatial Systems). KRESS is a computerized multifactor decision-making tool that evaluates the suitability of various locations across a landscape for use by domestic livestock and wildlife.

PHYGRO Forage Growth Modeler. The PHYGRO Forage Growth Modeler uses forage monitoring technologies that can be applied to resolving conflicts over habitat use by defining ecological land units as they relate to habitat and animal use and links habitat parameters to a NVDI generated "greenness" index for developing the forage growth and nutrient availability prediction capacity of PHYGRO.

Normalized Difference Vegetation Index (NDVI). NDVI provides near-real time remotely-sensed spatial imagery of vegetation distributed across large landscapes which, when correlated with known vegetation and ground surface attributes, can be used to interpret quality of vegetation for grazing herbivores and extrapolate PHYGROW values across large landscapes.

Fecal Profiling. Fecal Profiling using Near-Infra Red Spectroscopy (NIRS) allows prediction of diet quality of free ranging large herbivores via fecal scans.

Nutritional Balance Model (NUTBAL). The Nutritional Balance Model (NUTBAL) uses measures of forage growth (kg/ha DW) predicted from PHYGROW, available nutrients (CP and DOM predicted by Fecal Profiling) and expected weather conditions to project desired body condition of large herbivores at a future time.

Clark GPS Animal Tracking System. A GPS-based animal tracking system with the following capabilities: 1) Large and easily expandable on-collar data storage capacity, 2) spread-spectrum radio frequency (RF) link enabling data downloading and program uploading between collars and base stations, 3) low-power hardware components, software-controlled power management and high power-density batteries to enable long deployments, and 4) real-time collar tracking capabilities where the GPS data describing the current location of the collar are transmitted via the RF link to a hand-held basestation capable of receiving and displaying collar locations on a digital map.

Near-real time technologies KRESS, PHYGRO allow near real time decision-making concerning altering current grazing strategies to avert herbivore risk from local or regional drought and/or habitat overlap. PHYGROW addresses habitat condition relative to vegetation growth at landscape scales and NUTBAL addresses animal condition relative to improving or declining nutrient availability, which becomes a key indicator and estimator of lowered body condition and winter survival. KRESS allows habitat needs of specific herbivores to be identified spatially at scales related to actual, real-time herbivore use. Results obtained from these technologies and methods can be used to design, implement, and institutionalize a conservation management and planning program for the Gobi Region.

. KRESS uses landscape parameters to determine the suitability of each site on the landscape for use by animals based upon knowledge of experts in the discipline and GIS data layers. Information about how animals utilize a landscape is employed to construct models that predict landscape use with accuracy of the model or map produced based on actual observations of animals. In the KRESS Modeler, the relationship between suitability and the landscape is mediated via mathematical models that are created by researchers or managers who have extensive knowledge about a landscape.

The modeler is broadly useful across many types of systems. Since the systems in which large herbivores are found are primarily resource-based and involve lands used for domestic animals, water, and wildlife, natural resource applications are the primary focus and models reflect this natural resource/spatial perspective. The KRESS modeler software system is a tool that facilitates the evaluation and analysis of

multiple factors that determine the suitability of sites on a landscape for a purpose. At its broadest it is a multi-criteria decision aid (MCDA) and uses classification techniques to rank alternative solutions to problems.

The KRESS multiple factor analysis is used to simultaneously take into account a series of factors that affect the preference of animals for a particular position on the landscape based on a deterministic applications of rules. The program was built to be flexible and uses an open "blackboard" format. Thus, a scientist or resource manager should be able to conceptualize linear, non-linear, or mixed models and, if spatial data exists for the parameters chosen, rapidly apply them to a landscape. The resource manager can use information about the system to build a model that seems reasonable and generate the suitability for each cell on the landscape (Johnson 2004).