

Project Proposal

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Evaluating effects of climate change, intensified livestock production, and economic development on sustainability of large wild herbivore populations in the South Gobi

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Introduction

Mongolia is one of the last best places on earth; it still has relatively intact ecosystems, a culture and history of pastoral livestock herding that mimics habitat use by large, wild herbivores and that has changed very little over the centuries. Territorially, Mongolia is a small country compared to its large neighbors China and Russia. However, Mongolia has a greater diversity of flora and fauna that is found in a wider variety of habitats throughout the country. Even more uniquely compared to its large neighbors, development and modernization in the 20th Century have had relatively little impact as of yet on habitat and species diversity, and on traditional pastoral production systems. The reasons for this are many, and include: 1) a relatively small human population, 2) a form of pastoral livestock production that put little pressure on wildlife populations or habitat, 3) an ingrained conservation ethic, 4) restricted access to firearms and vehicles during much of the 20th Century, and 5) lack of emphasis on development of a large-scale production infrastructure. However, there is a high probability that new and on-going changes being fostered by capitalism and the market economy will be irreversible.

The current emphasis on economic development which is on-going without sufficient understanding of potential impacts and without adequate safeguards in place, is rapidly changing the natural conservation ethic of Mongolians to an exploitation ethic. Mongolia as a country is still trying to adjust to a market economy. In doing so, exploitation of resources to support individual and national economies is becoming a major cause of diminishing wildlife populations that have co-existed with the human population for millennia. Resource extraction industries, especially mining, are supplanting agriculture and livestock production as the primary source of national wealth. With the introduction of capitalism and the market economy in the 1990s, new threats to Mongolian biodiversity and traditional livelihoods are emerging. These threats include: 1) fragmentation of fish and wildlife habitat as infrastructure development accelerates to accommodate the global economy, 2) rampant poaching and sale of wildlife meat and body parts, both for “sport” and as a source of income, 3) lack of an enforcement capability to prevent destruction of wildlife populations and degradation of habitat, 4) changes in population and income demographics that encourages degradation of natural resources, and 5) acceleration of these impacts from the on-going climate warming, especially in the Gobi Region of Mongolia.

The on-going transformation of Mongolia into a modern nation has important implications for conservation of wildlife, wildlife habitat, and sustained use of natural resources (Fuentes-Quezada et al., 2000; Thacker, 2004; Reading et al., 2006; Kaczensky et al., 2006). At the present time, Mongolia is gradually developing the framework and attributes for commercialized agricultural production and large-scale mineral extraction (Sneath, 2003; World Bank, 2003; Mearns, 2004a,b). Development, without parallel development of safeguards that ensure protection of wildlife and wildlife habitat, can increase adverse environmental impacts from human activities and intensify conflicts over natural resource use (Frisina and Valdez, 1994; Valdez et al., 1995; Reading et al.,

1999b; Pratt et al., 2004; Sheehy et. al, 2006). For example, Mongolia has numerous large wild herbivores including the wild ass (*khulan*), wild camel, wild sheep (*argali*), wild goat (*ibex*), deer, gazelle, antelope (*Saiga*), and elk. An international effort has been initiated to restore the Mongolian wild horse (Mon. “**tachi**”) to its natural habitat. At the same time, most large wild herbivore populations are apparently in decline (Figure 1).

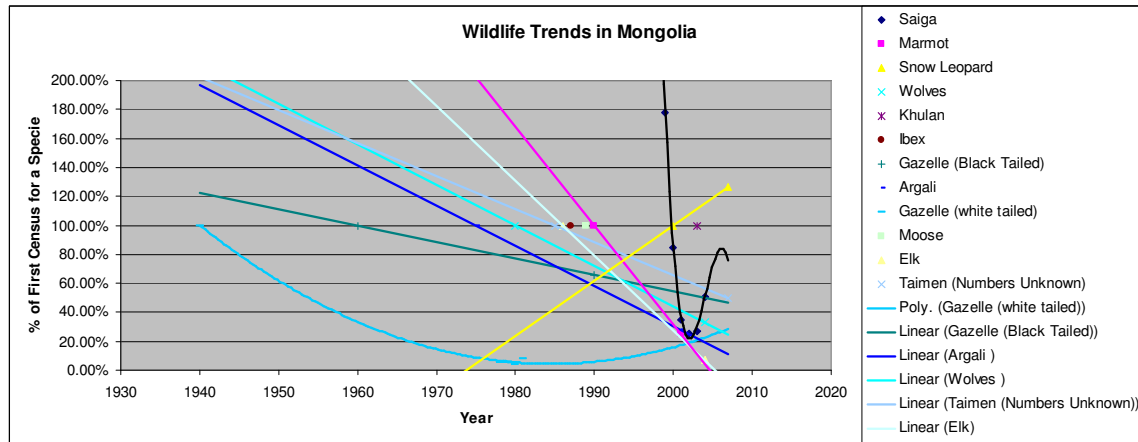


Figure 1. Population Trends of large herbivorous wildlife as a percentages of the first census of each specie. Only the White Tailed Gazelle and the tenuous populations of Saiga and Snow Leopard appear to have increasing trends at present. Sources: Batbold 2002, Clark et al. 2006, Dulamtseren 1989, Kaczensky et al. 2006, Lkhagvasuren et al. 2001, Mech et al. 2004, McCarthy et al. 2003, Ocock 2006, Reading et al. 1997, Shagdarsuren 1987, Winegard 2006, and WWF website 2007]

The South Gobi Region of Mongolia is especially sensitive to human intrusion. It contains a high diversity of wildlife species and provides critical habitat for populations of threatened and endangered wildlife (Reading et al., 1999a). The Gobi Region is also the primary focus of a developing eco-tourism industry and is the eco-region most sensitive to drought and severe winter weather (i.e., Mon. *dzud*). The importance of the Gobi Region to conservation of Mongolian wildlife and traditional lifestyles is undeniable but pressure exists to exploit land and water resources for mineral extraction, construct transportation corridors, and develop more intensive livestock production systems. These activities reduce the availability of forage and habitat for both wildlife and herded livestock (Sheehy et al., 2006).

During the early “transition period” (1990-2000), urban-to-rural migration of the Mongolian human population increased the number of herders and herded livestock in the Gobi. Although currently out-migration of livestock herders from the South Gobi Region is occurring, the demand for resource development, especially water development, by remaining livestock herders is increasing. Many livestock watering wells, built in the Gobi during the collective period (1968-1990), are no longer serviceable (JICA, 2003/2004, Kaczensky et al., 2006) causing livestock herders to become concentrated in habitats retaining surface water or functioning wells (Fernandez-Gimenez, 1999; Fernandez-Gimenez and Batbuyan, 2004). The current and potential effects of water development and other forms of human intrusion on natural resources in the Gobi are largely unknown.

Large wild herbivores species of critical concern in Mongolia include the Argali Bighorn

Sheep, the endangered Asiatic wild ass or khulan (*Equus hemionus*) and the Black-tailed gazelle (Clark et al., 2006a; Wingard and Zahler, 2006, World Bank, 2006). The khulan is extirpated from most of its former range, remnant populations exist in the Gobi Region (Feh et al., 2001; Reading et al., 2001; Kaczensky et al., 2006). Previous studies in the Gobi, using tracking collars of older technology, provided an initial evaluation of long-distance migrations and broad-scale distribution patterns of khulan (Kaczensky et al., 2006). The spatial and temporal resolutions of these data, however, were too coarse to provide an adequate understanding of khulan habitat-use patterns, activity budgets, and potential overlap and competition with livestock. New technologies are becoming available that will help resolve natural resource allocation issues involving livestock and large herbivore wildlife such as the khulan (Sheehy et al, 2007). Evolving research technologies such as next-generation animal tracking systems (Clark et al., 2006b), Near Infra-Red Spectroscopy (NIRS) fecal profiling for assessing diet quality (Sheehy et al., 2007), and habitat monitoring can now help us understand the nature and scope of the impacts on wildlife from intensified livestock production. New developments in digital videography are improving transfer of information to the public on almost a near real-time basis.

Project Goal

We will acquire an in-depth understanding of habitat use and activity patterns of khulan and herded livestock species such that current and potential interspecific competition for food and habitat in a changing climate can be identified or accurately predicted and understood for the South Gobi Region (i.e., Omnigov, Dundgov, and Dorngov aimags). We will also provide scientific data and findings critically needed by Mongolians for: 1) conserving wildlife and preventing exploitation by economic development, 2) maintaining optimal habitat resources for wildlife and ecologically-adaptive pastoral production systems, 3) monitoring the impact of climate change on these habitats, Finally, we will present the results of this study in a format (e.g., documentary film) easily understood by the public to improve the public's willingness to engage in finding and implementing solutions to identified problems.

Project Objectives

- Develop an in-depth understanding of both broad and fine-scale habitat and activity patterns of khulan and livestock.
- Quantify existing levels of competition between khulan and livestock for habitat and forage resources.
- Predict effects of intensified livestock production on competitive relationships of khulan and livestock species in response to climate change.
- Use documentary film media to inform the Mongolian public of current and future issues affecting populations of large wild herbivores.
- Provide a website for continued access to project information and video beyond the length of the study.
- Directly engage herders in protection of endangered large wild herbivores.

Project Location

The South Gobi Region retains significant populations of khulan and other large wild herbivores as well as herder families practicing traditional pastoral livestock production. Study areas will be selected from the current range of large wild herbivores and will be representative of different habitats found in the South Gobi Region.

Relevance and Significance

The World Bank discussion paper titled “Room to Roam? The Threat to Khulan (Wild Ass) from Human Intrusion” (Kaczensky et al., 2006) recommended several actions needed to address human-wildlife actions in the Gobi Region of Mongolia. Recommended actions that will be wholly or partially addressed in this study include: a) developing a Gobi-wide strategy focusing on conservation and controlling habitat fragmentation, b) tracking movements of migratory large herbivore wildlife to provide baseline information for ensuring movement corridors and ensuring continuity of habitats, c) improving capacity of local government to prepare and update resource development and management plans, d) using media to inform the public about issues threatening wildlife and the Gobi Region, e) assisting preparation of a common database needed to assess and monitor current and future changes in land use patterns and infrastructure development, f) assessing impacts of pasture development projects, and g) providing information on numbers and herd composition of livestock possessed by individual herders.

Understanding the range use, habitat needs, and ecology of large wild and domestic herbivores has long-term implications for sustainability of Mongolia’s wildlife, pastureland resources, and extensively-managed livestock economy. Mongolia needs to put into place, activate, and support a conservation management system based on rational policies and conservation programs that can mitigate adverse impacts of climate change, privatization, natural resource exploitation, and human intrusion (Kaczensky et al., 2006). Although laws designed to protect natural resources exist, and the khulan is already listed in the “Red Book” as a threatened species (Clark et al., 2006a), very little active protection exists because of a lack of funding capacity and basic information about needs of the khulan and other large wild herbivores in the South Gobi Region.

This research project will greatly improve the knowledge-base and technologies available to Mongolia’s natural resource managers for monitoring resource conditions, efficiently handling resource data, and for modeling future resource responses to human intrusion. There is a critical need in Mongolia for a relevant, practical, and accessible natural resource management and decision-support system for national policy and program development concerning wildlife conservation, pastoral livestock production and climate change (Sheehy, 1996; Sheehy et al., 2006). Results from this research project will provide a firm, scientific basis from which to develop a conservation management system.

SubProject 1: Evaluating of Herder Density and Habitat Availability

Herder Density. Besides its widely recognized utility to the general public, freely-accessible satellite imagery (e.g., QuickBird) provided by the Google Earth™ software package and internet service have proved extremely valuable for scientific pursuits (e.g., Begall et al., 2008). High resolution satellite imagery will be used, via Google Earth to systematically survey the presence of herder gers, animal shelters and corral structures in the Omnigov, Dundgov, and Dorngov aimags (Fig. 2). Augmented with livestock census data acquired from **Mongolian Ministry of Agriculture**, this remote sensing evaluation will identify areas of high, moderate, and low herder density in the South Gobi and allow us to test for herder density effects on khulan-livestock interactions.

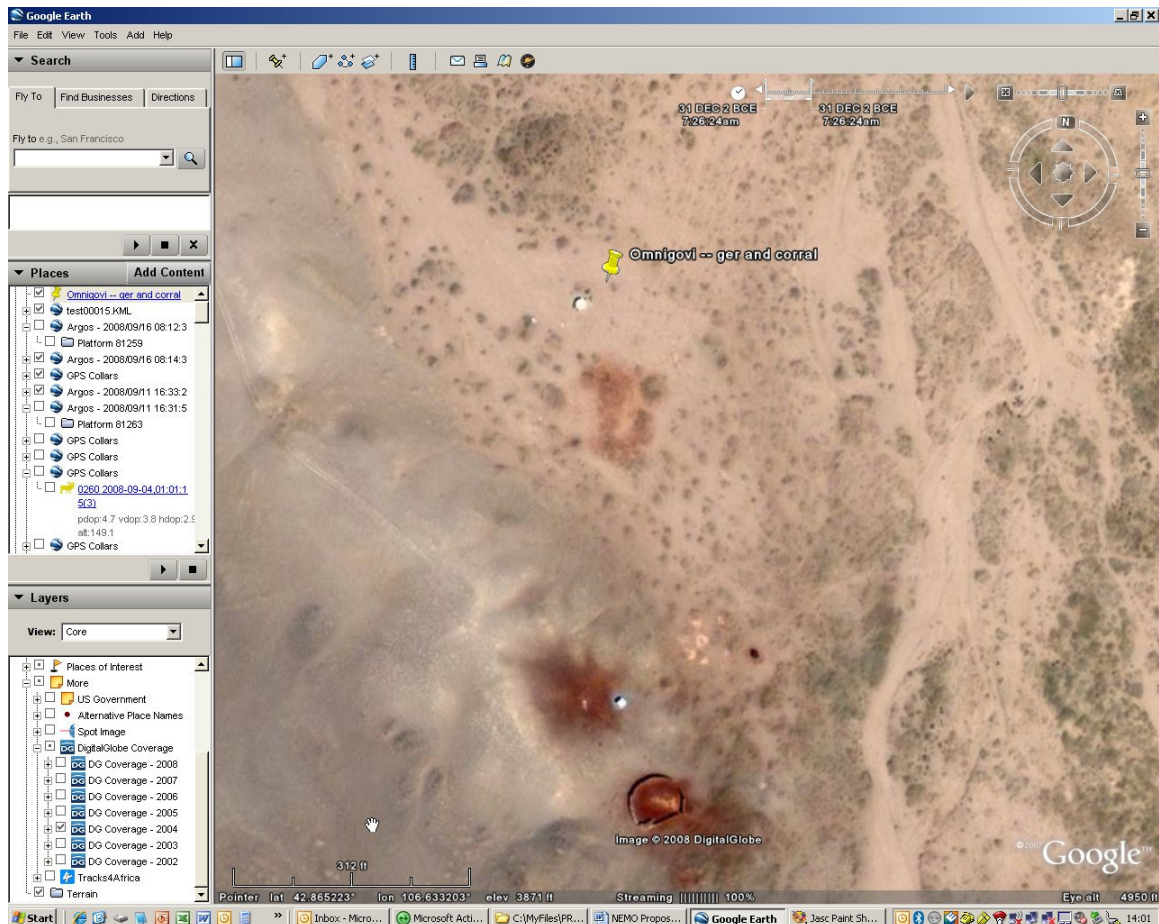


Figure 2. High resolution satellite imagery (Quickbird 2.4-m color) accessed via Google Earth™ illustrating the presence of herder ger and corral structures at Lat: 42.867094N, Long: 106.634131E on 7-24-2004 in the Omnigovi aimag, Mongolia.

Habitat Availability. Habitat maps (30 m GSD) will be developed via unsupervised classification of ortho-rectified satellite imagery (i.e., Landsat ETM+). Existing vegetation maps (e.g., Russian-Mongolian Complex Ecological Survey 1999) and aerial photograph interpretation will be used to assign habitat types to resultant imagery classes.

Field checks at random points, conducted during collaring operations and forage production sampling campaigns, will be used to assess the user accuracy of the habitat maps.

SubProject 2: Investigating Khulan-Livestock Interactions.

Habitat Overlap. We will test the hypothesis that intensified rangeland livestock production in the Gobi Region will increase competitive exclusion of large wild herbivores by livestock, thus decreasing the amount of habitat available to the wild herbivores. Under a split-plot experimental design, the effects of low, moderate, and high levels of livestock herder density (whole plot effect) on habitat overlap and competition between khulan and livestock will be evaluated. One complete experiment will be conducted in each of 3 study areas (blocks). Each study area will be representative of the distinct forage/habitat conditions, livestock herding practices, and khulan populations of that particular area of the South Gobi. The entire study of 3 experiments will be replicated during the second year of the project (2 years total).

The experimental unit will be a GPS/SAT-collared animal. In each study area, at least 5 adult khulan will be captured and instrumented with a GPS satellite tracking collar (Clark ATS+) equipped with activity sensors (3-axis accelerometers) and an Iridium™ satellite data modem (i.e., 15 collared animals total) (Fig. 3). Capture procedures will follow those described by Walzer and Kaczensky (2004). Khulan GPS locations (± 5 m accuracy) will be sampled every 15 min but this rate can be changed remotely, if necessary (see below). Using the Clark ATS+ collars and the Iridium satellite constellation and gateway network, we will regularly receive email downloads of stored GPS location and sensor data from collared khulan, make real-time queries of collar location and status, and upload new programming to change data collection parameters or revitalize malfunctioning collars, as necessary. These collars will also contain an autonomous, VHF tracking beacon to allow location and recovery of the collar should the main power supply become depleted or the system becomes unresponsive. To compensate for normal attrition and maintain adequate sample size, a new set of Clark ATS+ collars will be constructed and deployed on 15 additional khulan during the second year of the project.

Because individual livestock herders in the Gobi region typically graze several species of livestock simultaneously, livestock species can be tested as a sub-plot effect while any variability due herder effects is minimized. Within each of the 3 treatment levels of each study area, at least 3 mature animals from each livestock species (i.e., cattle, horses, sheep, goats, and/or camels) present in the study areas will be instrumented with GPS collars (i.e., 135 collared animals total). Livestock locations (± 5 m accuracy) will also be sampled every 15 min. Livestock collars will be a simpler, low-cost, store-on-board technology; thus location and sensor data collected and stored on the collar will be retrieved only when the animal is recaptured and the collar removed at the end of each spring-summer grazing season. Real-time data access is not necessary in this application, thus allowing us to economically increase the number of collared livestock and the statistical power of our study. Once retrieved, the livestock collars will be refitted and

used again the following year of the project.

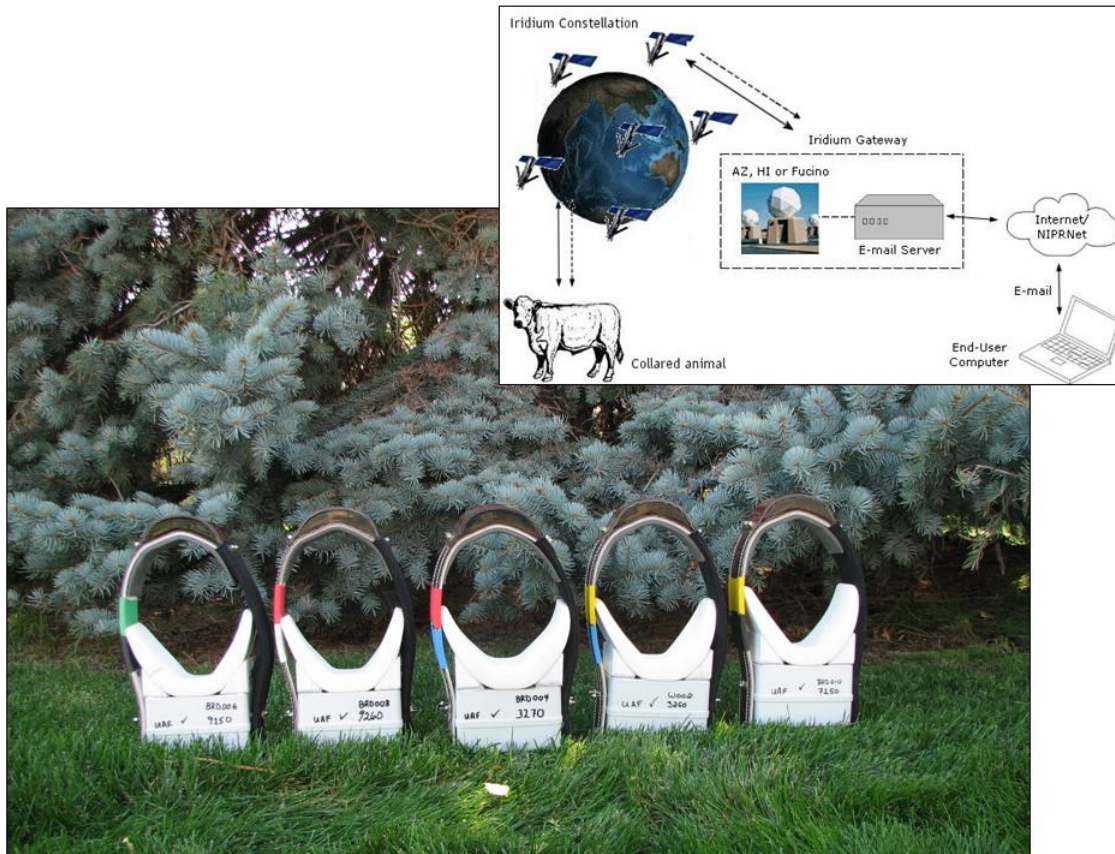


Figure 3. Clark ATS+ tracking collars utilizing GPS and Iridium SBD satellite communications technologies for intensive studies of animal behavior while allowing the user global, 24/7 access to GPS data and programming stored on each collar.

The frequency and duration of khulan and livestock occupancy within different habitat types will be determined from collar location data and habitat maps using the KRESS modeler (Johnson et al., 2005, Sheehy et al, 2007). KRESS will also be used to classify collar data into at least 3 different activity types; resting (stationary), foraging, and traveling thus allowing quantification of habitat-specific activity budgets for livestock and khulan. Finally, the occurrence of interspecific overlaps in habitat use and occurrences of competitive exclusion of khulan from habitats used by livestock will be determined using KRESS. A General Linear Mixed Model (GLMM) procedure will be used to test the effect of livestock herder density levels on competitive exclusion of khulan by livestock.

Dietary Overlap. Fecal Profiling will be used to evaluate dietary overlap between khulan and livestock in the study areas. Representative fecal samples will be collected monthly over two years from khulan (648 samples total) and livestock species (1,080 samples total) using rangeland habitat in the 3 study areas. Livestock fecal samples will be collected from collared livestock to determine spatial habitat use. Khulan fecal samples will be collected from khulan using the same pastureland area as the collared livestock.

Samples will be analyzed using NIRS fecal profiling equations developed for Mongolian livestock (Angerer and Tollison, Personal Communication, 2007) to determine Crude Protein (CP) and Digestible Dry Matter (DDM) in the diets of livestock species and khulan (Lyons, R.K. and J.W. Stuth, 1992). Nutritional dietary similarity on a monthly and seasonal basis will be determined by analyzing similarity of dietary nutrition among large herbivore species co-using pastureland habitat. If available, a mobile laboratory for determining real-time livestock and khulan nutritional profiles will be tested. This information combined with habitat-use data from the KRESS model will improve our understanding of current and potential khulan-livestock competition in the Gobi Region

SubProject 3: Monitoring Climate Change Effects

In 1997, an ecological-condition monitoring transect consisting of 114 monitoring points was established in the four major ecological zones of Mongolia (Desert, Shrub Steppe, Grass Steppe, Forest Steppe). At each monitoring point, ecological condition was determined from site attributes that included species composition, cover, and productivity of vegetation, soil nutrients, and site attributes. Sites were measured in May (initiation of vegetation growth) and September (end of growing season). All site locations were determined by GPS.

In the intervening 11 years since 1997, Mongolia as a country has undergone tremendous change. Livestock production is on the verge of commercialization, negative impacts from exploitative use of resources, especially mining, is growing; livestock have increased to historically high numbers (1999 and 2007) with unknown impacts on sustainability of rangeland forage resources; drought and dzud have caused die-off of large numbers of livestock (2000/02) and increased the level of conflict between livestock and large wild herbivores; and demographic shifts in the Mongolian population from rural to urban areas has occurred. Information obtained from re-measuring the 1997 measurement points and establishing a formal vegetation monitoring system based on the established monitoring points is critical to determining ecological trends in rangeland vegetation and planning the future use of Mongolian natural resources.

An initial re-measurement of the 1997 ecological monitoring points was completed in August 2008. Data is currently being analyzed. The objective of this project component is re-measurement of the 114 ecological monitoring points in 2009 and 2010 to determine ecological trends in rangeland vegetation needed to plan use of natural resources.

The project will also modify vegetation monitoring points established to provide near-real time information for a Livestock Early Warning System (USAID Global Livestock-Collaborative Research Studies Program) to monitor impacts of climate change on natural resources of the South Gobi Region. Significant climate change has occurred in Mongolia during the previous 60 years and is predicted to continue for the next 25 to 80 years. In order to accurately gauge the impact of this change on the Mongolian pastureland environment, it is necessary to verify recent shifting environmental trends.

The main objective of this project component is the temporal comparison of key site and vegetation indicators at vegetation monitoring sites established by the Gobi Forage project in the South Gobi Region. At already established monitoring points, the impact of weather events, changes in livestock numbers, and climate warming will be analyzed to determine trends in ecological condition of pastureland communities. The PHYGROW Forage Forecasting model will be used to extrapolate study results spatially within the Gobi Desert ecological zone (Sheehy et. al, 2007, Figures 4 & 5).

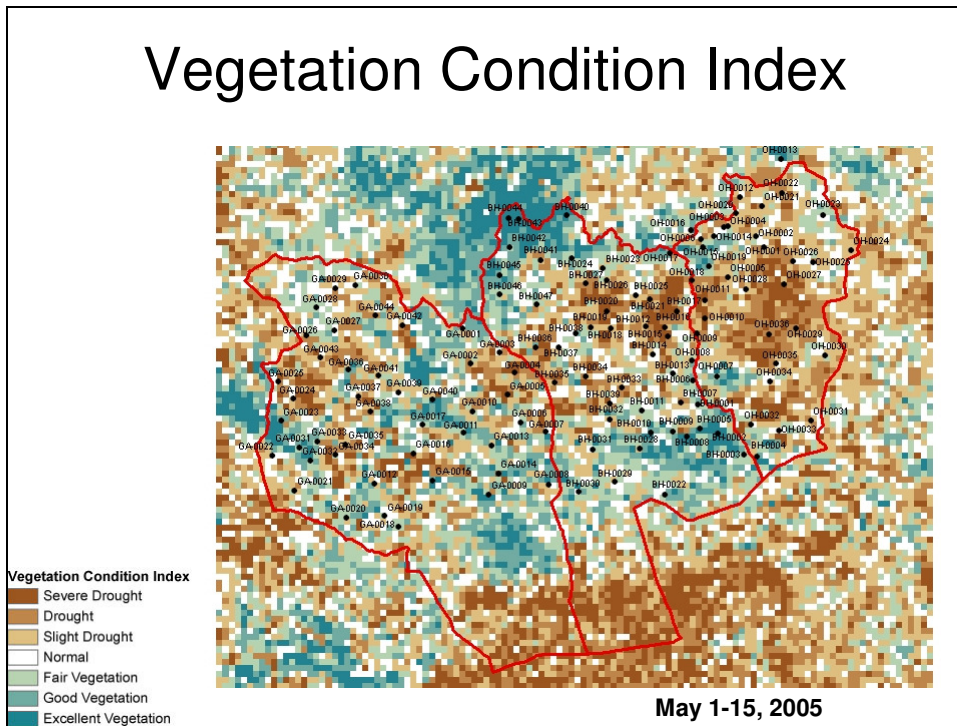


Figure 4. PHYGROW output map reflecting vegetation condition in the western Gobi in the May 1-15, 2005 period. PHYGROW forage condition maps are available for all the Gobi provinces. Source: Gobi Forage Project, Mercy Corps/Texas A&M University.

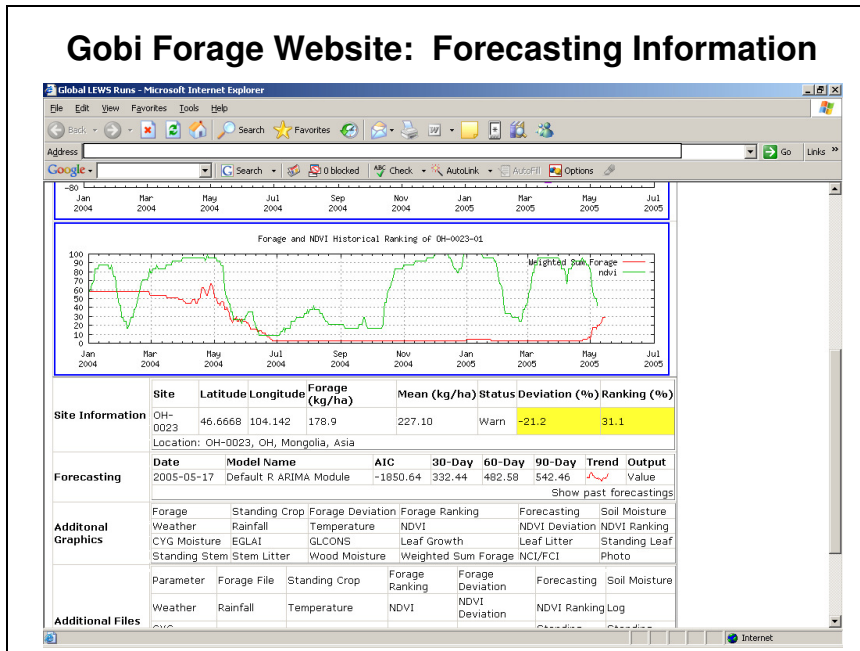


Figure 5. Data-base provided for each established vegetation monitoring point in the South Gobi Region.

Study results will provide useful information on:

- Changes in plant community ecological condition and ecological trends,
- Impacts livestock grazing on vegetation condition in four ecological zones.
- Impacts of weather related events (drought & severe winter weather) on condition of livestock grazed pastureland vegetation communities.
- Impacts of climate factor variation, especially precipitation, on condition and trend of livestock grazed plant communities.

Extrapolation of this information across zones using PHYGROW will allow inference to be made about:

- Zonal vegetation changes due to variations in livestock numbers, severe weather events, and climate warming.
- Environmental impacts of climate change in Mongolia.
- Facilitate predictive modeling of the likely effects of climate change on khulan-livestock competitive relationships and risks to the sustainability of khulan populations in Mongolia.

SubProject 4: Media Outreach.

Documentary Film. Prior to the end of the socialist period in 1990, most populations of wild species found in Mongolia were relatively healthy. Taking of these species was tightly controlled by the state; access to firearms was limited to herders who needed to

protect livestock against large predators, especially wolves, and few people, whether urban or rural had any inclination to sport hunt or fish. Over the past 17 years, the situation has changed, with populations of large wild herbivore species legally and illegally being over-hunted, or captured and sold for monetary purposes; illicit export and sale of birds of prey is occurring; and illegal take of rare fish species is occurring. Although laws exist to protect fish and wildlife species, and environmental inspectors have power to enforce regulations, the illegal take of these species continues, at least partially because of a generally uninformed public.

A documentary film will be made to inform the Mongolian public and the world about vanishing fish and wildlife of Mongolia. Although wildlife populations in general are being impacted, the documentary film will focus on three large wild herbivores (i.e., the wild sheep (*Mon. Argali*), the Asiatic Wild Ass (*Mon. Khulan*), and the Mongolian elk, one freshwater fish found only in Asia (*Mon Taiman*), and one bird of prey (i.e., Gyr falcon). The three large wild herbivores occupy different terrestrial habitats and are being severely impacted by legal and illegal hunting and other forms of human intrusion. The population of Taiman, which is the largest salmonid and is found only in fresh water rivers in Mongolia and eastern Siberia, is being seriously affected by illegal take. The population status of the Gyr falcon is unknown, but illegal capture of young falcons for sale to the Middle East is very lucrative for participants.

The intention of the sub-project is to make a film that informs the public about habitat needs of these diminishing wildlife and recommends approaches to ensure survival of these species in a rapidly changing economic and social environment. The film would address negative impacts of economic development and the market economy on ecologically important species of Mongolia with focus on large herbivore species in the South Gobi Region. There is a need for compelling media to communicate wildlife decline and scientific research findings. Poaching, development and other threats are exacerbated by very limited public awareness of the khulan endangered status (Kaczensky 2006). A dynamic story that drives a broadcast quality video, informational website, and DVD will be the best way to quickly reach a large number of people. Important audiences would be both English and Mongolia officials, researchers, granting agencies, and the public.

Creation of this media will be guided and expanded based on the success of the explorative video produced in 2006 (Sheehy 2006). It was distributed via Mongolian National Television and the internet at www.khulan.org. The expanded media will be broken into pre-production, production, and post production activities. During pre-production, a development team will write a shooting script and attempt to establish relationships with broadcast channels prior to shooting. During production, a film crew will travel with the researchers to capture relevant footage and interviews. Other critical footage of wildlife, local interviews, and habitat will be generated independent of the research group. Post production will be accomplished in production studios located in both the United States and Mongolia. Final products will be; 1) a documentary feature designed for a one hour time slot on both western and Mongolia broadcast channels, 2) a webpage that will promote the video and disseminate online versions of all products

generated in the study, 3) and a set number of DVDs for physical distribution.

Documentary Film Timeline:

January 2009 - **Pre-production** (Script writing, correspondence with distribution, commissioning of music, generation of webpage to track activities of research program)

June 2009 – **Production Phase 1** (Videography of khulan collaring, livestock collar deployment, interviews)

July and August 2009 – (Videography habitat classification, herder production cycle, interviews)

January 2010 – **Post- production** (Assembly cut of video, reworking of script)

June 2010 – **Production Phase 2** (Videography, khulan collaring, khulan behaviors, habitat, interviews)

July 2010 – Independent trip (Videography of poaching, development, khulan behaviors, herders, interviews)

August 2010 – **Post-production** (Complete rough cut assembled, narration finalized and recorded, music finalized)

December 2010 – Draft cut submitted for review

March 2011 - Final cut

Web-Site. ...

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Web-Site Timeline:

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Project-Wide Itinerary

January 2009 – Herder Density Survey/Habitat Mapping initiated using remotely-sensed information.

June 2009- Khulan and livestock will be collared in the 3 study areas.

June 2009-Fecal collection initiated on a monthly basis and continued throughout the study.

July/August 2009 – Field habitat verification initiated

October 2009 – Khulan and livestock collars recovered at end of first trial.

November/April – 2009/2010. Preliminary data analysis initiated, animal tracking collars refitted.

May 2010 – Annual report submitted

June 2010 – Khulan and livestock will be collared in the three study areas.

October 2010 – Khulan and livestock collars recovered at completion of 2nd trial.

November/February 2010/2011 – data analysis and final report preparation.

Project Products and Outcomes

- Peer-reviewed journal articles describing habitat use and activity patterns of khulan and the effects of livestock density on the competitive relationships between khulan and livestock.
- A television-quality documentary film (30 minutes) in English and Mongolian to inform the public on habitat needs of the khulan and the potential for intensified livestock production and climate change impacts on sustainability of khulan populations
- A firm, scientific knowledge base concerning livestock-khulan relations and the impact of climate change on habitat for use in development of a viable Mongolian natural resource management and decision-support system
- Webpage for project updates and dissemination of products
- DVDs for physical distribution of project products

Potential Participating Institutions

The International Center for the Advancement of Pastoral Systems (ICAPS) will be the contracting organization for the project.

The Mongolian Research Institute of Animal Husbandry (RIAH) will be the cooperating Mongolian institution for the project.

The Ministry of Nature and Environment.

Principal Investigators

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Dr. Daalkhaijav Damiran, University of Saskatchewan, Saskatoon, Saskatchewan, Canada. Principle investigator for animal dietary nutrition.

Mr. Cody M. Sheehy, Research Associate, University of California at Davis, Davis, California, USA. Project videographer.

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Appendices

Appendix A. Budget

Budget Elements	Year 1	Year 2
Project Administration	\$45,800	\$48,300
Subproject 1: Herder Density Survey/Habitat Mapping (RS/GIS)	6,000	6,000
Subproject 2: Khulan-Livestock Interactions (Habitat/Diet Overlap)	136,195	68,545
Subproject 3: Monitoring Climate Change Effects
Subproject 4: Media Outreach (Videography/webpage)	12,500	27,500
Annual Totals	\$.....	\$.....
Grand Total		\$.....

<i>Project Administration</i>	Year 1	Year 2
Salaries		
Principle Investigator (D. Sheehy)	\$10,000	\$10,000
Co-PI (Clark)	0	0
Project Coordinator (Mongolian-RIAH) 1 person	2,500	2,500
Contract Services		
Interpreter (Mongolian-RIAH) 1 person	1,000	1,000
Driver/Vehicle (Mongolian) 1 person	2,500	2,500
Travel		
Air Transportation (2 trips/yr) 4 persons	20,000	20,000
Lodging (8 nights/yr) 4 persons	3,200	3,200
Per diem (15 days/yr) 8 persons	3,600	3,600
Supplies (Travel/camping related)	2,500	2,500
Publication		
Annual reports	500	
Final report		1,000
Peer-reviewed journal 2 articles@\$1,000 ea		2,000
Annual Totals	\$45,800	\$48,300
Administration Grand Total		\$94,100

<i>Subproject 1: Herder Density Survey/Habitat Mapping (RS/GIS)</i>	Year 1	Year 2
Salaries		
Technician, GIS/RS (USA) 1 person	\$5,000	0
Remote Sensing Imagery		
Landsat (TM/ETM+ GEOCover) 30 scenes@\$0 ea	0	0
Contract Services		
Programmer (KRESS Modeler) 1 person		5,000
Supplies	1,000	1,000
Annual Totals	\$6,000	\$6,000
Subproject 1 Grand Total		\$12,000

Subproject 2a: Khulan-Livestock Interactions (Habitat Overlap) Year 1 Year 2

Salaries			
Technician, Collar Construct. (ARS) 1 person		\$5,000	\$2,000
Tracking collars			
GPS/Sat Comm 15 @ \$1,500 each (khulan)		22,500	\$22,500
GPS store-on-board 135 @ \$450 each (livestock)		60,750	0
Collar pre-deployment tests 150 collars		6,000	1,500
Collar refurbish/refit 135 @ \$56 each (livestock)		0	6,750
Contract Services			
Driver/Chase vehicle (Mongolian) 1 person		2,500	2,500
Veterinarian (includes travel) 1 person		10,000	10,000
Supplies		2,500	2,500
Administrative Overhead USDA-ARS 10%		10,925	4,775
Annual Totals		\$120,175	\$52,525
Subproject 2a Grand Total			\$172,700

Subproject 2b: Khulan-Livestock Interactions (Diet Overlap) Year 1 Year 2

Salaries			
Technician (Mongolian-RIAH) 1 person		\$2,000	\$2,000
Herders (Mongolian) 36 persons@\$100 ea		3,600	3,600
Contract Services			
Lab Analysis (Mongolian-RIAH)540 samples/yr (livestock)		2,700	2,700
324 samples/yr (khulan)		1,620	1,620
Vehicle Rental (Mongolian) 1 vehicle (4x4)		3,600	3,600
Supplies (Fuel)		2,500	2,500
Annual Totals		\$16,020	\$16,020
Subproject 2b Grand Total			\$32,040

Subproject 3: Monitoring Climate Change Effects Year 1 Year 2

Salaries			
Technician (Mongolian-RIAH) 1 person		\$2,000	\$2,000
Herders (Mongolian) 36 persons@\$100 ea		3,600	3,600
Contract Services			
Vehicle Rental (Mongolian) 1 vehicle (4x4)		3,600	3,600
Supplies (Fuel)		2,500	2,500
Annual Totals		\$.....	\$.....
Subproject 3 Grand Total			\$.....

Subproject 4: Media Outreach Year 1 Year 2

Contract Services			
Driver/Vehicle (1 trip/yr) 1 person		\$2,500	\$2,500
Post Production			20,000
Webpage		5,000	
Distribution (DVD processing/mailing)			2,500

Salary	2,500	2,500
Supplies	2,500	5,000
Annual Totals	\$12,500	\$27,500
Subproject 4 Grand Total	\$40,000	