GOBI BEAR CONSERVATION IN MONGOLIA

GOBI BEAR PROJECT TEAM

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CURRENT STATUS OF THE GOBI BEAR:

Gobi bears are listed as Critically Endangered in the Mongolian Redbook of Endangered Species and by. by the Zoological Society of London using IUCN standards, This assessment was based on estimates that the population included less than 50 adult animals, and were separated by enough distance from other closely genetically-related populations that immigration/emigration would not reasonably be expected to occur. It is included as an Appendix I species (critically threatened with extinction) under the Convention on International Trade in Endangered Species (CITES), to which Mongolia is a signatory country. No Gobi bears are known to exist in captivity anywhere in the world.

Gobi bears persist as a unique ecotype in the Gobi Desert of southwestern Mongolia. They are superbly adapted to low food availability and harsh environment of the Gobi Desert, where annual temperature may vary between 46°C in summer to -34°C in winter. Also known as "Mazaalai" and regarded as a national treasure by Mongolians, Gobi bears occupy three main areas, or oasis complexes, within the 45,784-km^2 Great Gobi Strictly Protected Area (GGSPA, Zone "A"): Atas Bogd Mountain, Shar Khuls Oasis, and Tsagaan Bogd Mountain. Each oasis complex is comprised of seven or more springs of various sizes, separated by about 70-100 km from the adjacent complex.

Prior to the 1970's, Gobi bear distribution in southwestern Mongolia extended beyond its present confines and included areas adjacent to the GGSPA to the north and east. This area encompassed Edriin Ridge, the Eej Khayrkhan Nature Reserve to the west of Bayantoorai, and portions of Gurvan Saykhan National Park to the east. The reasons that these areas are no longer occupied are not known.

Rangers of the Great Gobi Strictly Protected Area reported that the area experienced a 14-year drought from 1993-2007, in which annual precipitation declined from approximately 100 mm to 50 mm. Because Gobi bears are heavily dependent upon vegetation that requires precipitation for growth and fruiting, the drought may have affected body condition and reproductive success of bears during this period.

Biological Characteristics

Gobi bears subsist primarily on roots, berries, other vegetation, insects and occasionally rodents. However, unlike other brown bear subspecies no evidence was found that they kill or scavenge carcasses of ibex, argali, wild camels, and wild ass that occur in the GGSPA. While this

may be a nutritional disadvantage, as a result they do not prey on livestock that are important to herders in the region.

Gobi bears are small compared to most other members of the brown bear family; female adults weigh only 51-78 kg and males only 96-138 kg. Their fur is light brown in color, but with a noticeably darker head, belly and legs. Patches or natural collars of lighter fur is often present on the neck or shoulder of individuals are also a distinguishing characteristic (Anon 1988).

To effectively accomplish recovery and conservation of the Gobi bear, its taxonomic status needs to be confirmed. Based on their morphology and habitat references, some scientists have classified the Gobi bear as a separate and distinct species, *Ursus gobiensis* (Sokolov and Orlov 1992). Others classify them at the subspecies level, such as *Ursus arctos pruinosus* (Zhirnov and Ilyinski, 1986) or *Ursus arctos gobiensis* (Red Book 1997). Still others suggest that the Gobi bear is closely related to brown bears that occupy the nearby Tian Shan Mountains, *U. arctos isabellinus (Galbreath et al. 2007, McCarthy et al. 2009)*, or even the Tibetan bear of the Altai Mountains, *U. arctos arctos* (Schaller et al. 1993).

Using genetic analyses of hair samples McCarthy et al, (1996) found that the Gobi bear occupies a separate clade, different from that found in the bears of Europe, Russia, Alaska and Western Canada. This analysis indicated that the Gobi bear was separate and distinct from the other brown bears of Europe and North America. However, the authors also suggested that additional genetic sampling and analysis is needed, using noninvasive collection techniques (i.e. samples taken without disturbing or harming the animal), in order to further refine taxonomic status of the Gobi bear. Based on these same collections, McCarthy et al. (2009) concluded that Gobi bears are genetically isolated, making them a single conservation unit (Moritz 1994, Palsboll et al. 2007), which provides additional support for classifying their conservation status as Critically Endangered.

In the early 1990's, in an effort to improve the nutritional status of the bears, supplemental pelletized feed composed of grains were provided at feeders near major springs in the GGSPA. This supplemental fodder was primarily provided during March or early April, when the bears emerge from winter dens. Beginning in 2005, feeders were placed at additional sites and when funding was available, additional fodder was provided during autumn in some years.

Because of their present low population size, restricted range and limited available habitat, further declines may occur. However, if effective conservation efforts are applied, Gobi bears have a much greater chance for recovery.

CONSERVATION CHALLENGES:

The most immediate conservation challenge to achieve population recovery will be to identify and address the factors that limit the population. This will require an assessment of: (1) population demography, size, structure and reproductive performance; (2) genetic and physical

well-being, including stress factors; (3) food resources needed to provide for growth, survival and reproduction; and (4) movement patterns and habitat use in the landscape. (5) Just as important will be improving the management and research capacity of the GGSPA staff and Mongolian specialists and students.

Achieving long-term recovery and conservation of the endangered Gobi bear population will require more than appropriate application of what is learned through scientific research. Building the capacity of the GGSPA will be critical in the long-term survival of the Gobi bear. This can be accomplished through training and education, and by providing the tools and logistic capabilities necessary for monitoring and patrol programs that are integral to maintaining the integrity and security of the ecosystem upon which the bears depend.

Close cooperation needs to be maintained between the Gobi Bear Project and the Ministry of Nature, Environment and Tourism, the Mongolian Academy of Sciences, and experts within Mongolian universities. Support for Mongolian graduate students should continue to be a priority for the project. Their involvement will build field skills and expertise needed for the future.

In addition, it is important to maintain close contact with herders and local people who use land within and adjacent to the Buffer Zone of the GGSPA and to develop a plan that benefits both bear conservation and local people. Educational programs in local schools should be developed. These should include curricula in conservation and biodiversity in the ecosystem of the region, especially in aspects related to Gobi bears.

GOBI BEAR PROJECT ACHIEVEMENTS TO DATE:

The Gobi Bear Project is addressing conservation issues crucial to the conservation and recovery of Gobi bears and has obtained preliminary information not previously available, a more comprehensive effort will be necessary if the bear is to avoid extinction. The achievements listed include necessary first steps, but by themselves are inadequate to accomplish conservation actions required for recovery.

Capture and Monitoring:

Gobi bears are widely dispersed throughout the portions of the Great Gobi Strictly Protected Area that they inhabit. They are shy and have been very difficult to capture; however, during 2005-2010, 10 individuals, 6 males and 4 females, were captured and fitted with GPS satellite radio collars. Because of satellite frequency interference that began in the central Asia in 2006, GPS data from bears could not be uplinked to satellites. Instead, locations were stored in the collar and downloaded after collars were retrieved. All collars contained mechanisms designed to release the collar from the bear in 11-15 months so that GPS locations stored within the units could be recovered.

Five of the bears captured were later recaptured and fitted with new collars. One 2-year-old male was originally fitted with a non-GPS collar in 2005 which dropped off in 2006, but re-collared with a GPS satellite collar when he was recaptured in 2010. By 2010, GPS locations were recovered from 9 collars carried by 8 bears. Three collars deployed in 2010 will drop off in 2011. One collar from a bear captured in 2006 will not likely be located, and 1 that dropped off in 2010, has not yet been recovered.

Population Size:
Past estimates of a population size of 20-50 Gobi bears were based on direct observations and assessment of Gobi bear use of the three oasis complexes. In 2006, an estimate based on remote cameras at feeding sites indicated that a minimum of 19 bears were present in the area (Amgalan et al. 2006). By 2010, a more statistically-rigorous estimate was calculated based on genetic fingerprinting of hair collected near feeding sites at springs within the area (Tumendemberel et al. 2010). This estimate indicated that a minimum of 22-31 (CI = 95%) Gobi bears remain in the wild, including at least 8 females and 14 males. Additional work is needed to confirm the numbers and sex ratios for the estimate.

Reproductive Performance:
Successful production and rearing of offspring continues in the population. Based on ages of bears captured, photographic documentation of family groups at feeder sites, and direct observations of bears by the Gobi Bear Project Team and GGSPA rangers indicate that a minimum of 10 offspring were born during 1999-2009 and survived until they were observed or captured during our study.

The age at which female Gobi bears first produce surviving offspring is not yet known. The estimated ages of the 4 females captured were 7, 8, 15, 22 years old. Examination of their mammary glands provided evidence that all had produced cubs. The two youngest females were not accompanied by offspring and lost cubs that they produced. Brown bears living in environments like the Gobi desert where food resource are limited and environment harsh, often do not successfully produce cubs that survive until at least age 7 or 8. In order for the two young females to have produced offspring that survived to the age of self-sufficiency of 2 or 3, they would have had to breed successfully from ages of 3-5 years. This is very unlikely, especially considering the probable effects that the 1993-2007 drought would likely have on physical condition and fat reserves of the bears that is required for successful hibernation and cub survival.

The oldest female captured was accompanied by a 2-year-old offspring in 2005, but not in 2006, presumably because he had been weaned. A female closely matching her characteristic color and body confirmation was observed in 2010 accompanied by 2 3-year-olds near where she had denned during the winter of 2005-2006. If these observations were of the same bear, her inter-birth interval was 3 years for her 2003 litter and 4 years for her 2007 litter, assuming that she weaned her 3-year-old offspring in 2010 and produces another litter of cubs in 2011.

These observations indicate that production of young in the population was reasonably good, especially considering that there was a 14-year drought in the area from 1994-2007. According to GGSPA staff the drought resulted in a decline in mean annual precipitation from 100 mm/yr to ~50 mm/yr, which would have affected growth and availability of plants that comprise the Gobi bears primary food sources. Such environmental conditions, in turn, would likely result in lowered successful reproduction during the period. If drought conditions are over, increased precipitation should result in more and greater food availability for bears. Improvements in nutritional status should increase the production of more cubs with higher rates of survival.

Mortality and survival:
No mortality was observed among Gobi bears, either of radio-collared individuals or other bears present in the area. We found no evidence that any poaching, illegal activities or accidents resulting in bear deaths during the 2005-2010 study period.

Genetic Analysis:

Subspecies confirmation: The best data presently available, based on comparison of one set of mitochondrial DNA (mtDNA) samples of hair collected from Gobi bears in Mongolia with samples collected in Pakistan, ~1900 km southwest of the Mongolian distribution, and other distant locations in Europe and North America, indicates that Gobi bears belong to the subspecies *Ursus arctos isabellinus* (Miller et al. 2006; Galbreath et al. 2007; McCarthy et al. 2009). Hair from Gobi bears collected during our study and analyzed by Lisette Waits who conducted the genetic assessments of the previous studies also showed that Gobi bears belong to the subspecies *Ursus arctos isabellinus.*

However, because analyses based solely on mtDNA alone can yield biased results, the addition of analyses using nuclear DNA will improve our ability to provide more accurate results. Therefore, DNA samples from hair should be collected to more positively confirm subspecies designation (M. Proctor, personal communication, 2010).

Population size, composition and trend: Based on DNA analysis of 950 hair samples collected at feeder sites within the 45,000 km^2-area in 2008-2009, a mark-recapture population estimate of 22-31 Gobi bears live in the GGSPA (95% confidence interval; Tumendemberel et al., 2010). Of the minimum number of bears individually identified through genetic fingerprinting, 8 were females and 14 were males. This imbalance of the sex ratio may reflect the true proportion of the sexes in the population; alternately, it could be due to less use of feeders by females because of habitat selection or avoidance of sites frequented by the larger, more aggressive, males.

Determining population trend will depend on completing additional estimates through time, utilizing the same techniques.

Assessment of inbreeding and population effects: The genetic diversity of the Gobi bear population is low; however, populations of other brown bear populations displaying similarly

low genetic diversity remain healthy, such as on Kodiak Island, Alaska, where bears have persisted at high densities with no ill effects. Physical anomalies, reproductive problems, or susceptibility to disease, often indicators of inbreeding problems, have not been identified in the Gobi bear population.

As previously mentioned, present Gobi bear reproductive performance could be related to drought conditions that reduced cub production and survival rates. However, veterinary examination and disease assessments should be conducted to further confirm these indications. In any case, if the population does not respond to improved annual precipitation with associated increases in availability of vegetative food resources, or to increases or improvement in supplemental food, the possibility of augmenting the population should be explored. If such an action is deemed appropriate after careful consideration, IUCN guidelines should be followed.

Habitat Use, Food Availability and Contaminants

Natural foods: Our observations support the findings of Schaller et al. (1993) that Gobi bears primarily eat the rhizomes of wild rhubarb (*Rheum nanum*), berries, including nitre bush (*Nitraria* spp.), grass shoots (e.g., *Phragmites*), wild onion (*Allium* spp.), *Ephedra*, and other plants supported by desert springs. Small amounts of animal matter (mostly rodents and reported to be approximately 1% of total intake) are also consumed. Evidence that brown bears scavenge large mammals usually consists of the remains of broken long bones or craniums. We found no such evidence that Gobi bears kill or scavenge large mammals. Similarly, bears were not attracted to, nor consumed any bacon or other meat which we placed as baits in traps used for capture.

The availability of wild rhubarb appears dependent upon timing and amount of rainfall. We established line transects to assess this relationship. Tentative results support this hypothesis—during 2007, a year of increased rainfall, 23 rhubarb plants were observed in one 200m x 20m transect of typical habitat. The following year, when rainfall improved, another transect of similar size included more than 300 rhubarb plants.

Supplemental food: Supplemental food was provided for bears at feeder sites in the GGSPA but because of lack of dedicated funds, fodder usually only available for the bears during the spring and only during the fall in 2006-2007 and 2009. During 2006-2008, the pelletized food made available for bears was supplemented with commercial dog food to increase its fat content and caloric value. In the single test we conducted, the nutrient composition of the supplemental feed pellets appeared similar to that present in sample rhizomes of wild rhubarb, except that the pellets contained much higher levels of protein, phosphorus, zinc, vitamin E, niacin, and pantothenic acid and less calcium and folic acid than the rhubarb.

It is well known that brown bear subspecies undergo a period of high food intake (hyperfagia) during late summer and fall in order to build the fat reserves necessary for hibernation and production of offspring while in winter dens. Consistent availability of high-caloric foods during

this period should improve reproductive performance as outlined in the workshops dedicated to conservation of Gobi bears that were sponsored by the Ministry in 2010.

Contaminants/Stress analysis: In order to test for contaminants in the environment of the Gobi bear, we collected and tested water from springs from which bears and other wildlife in the area drink. Samples collected during 2008 and 2009 showed the presence of cyanotoxins that may be produced by blue-green algae in stagnant water sources (Craighead et al., 2009). Although these neurotoxins have been identified as having the potential to cause serious disease in humans, we presently have no evidence that these effects occur in the GGSPA, either with humans or wildlife. In addition, analysis of salt exudates collected near some springs indicated that the dominant crystalline constituent was sodium sulfate with lesser amounts of sodium chloride, calcium sulfate, and calcium carbonate.

In a preliminary approach, we tested physical stress levels in Gobi bears by measuring cortisol levels in hair. Cortisol is a hormone whose function is to help mammals use glucose or fat in metabolism and helps the body to manage stress. A colleague tested 21 hair samples collected at feeder sites and found that only 1 showed high levels of cortisol. THair cortisol levels reflect stress exposure over the period of hair growth such that the higher the level of cortisol in the hair, the greater the stress faced by an animal. Further tests should be done before any conclusions are drawn from this test.

Movement and Landscape Use:
Distribution of Gobi bears was determined from locations GPS satellite collared bears and from matching the samples of genetic fingerprints from hair collected at feeder sites. Based on 242 GPS locations, the home range size of an adult female that stayed within the Shar Khuls oasis complex was 514 km^2. This female utilized habitat between elevations of 1009-1532m. In comparison, 2 adult males that traveled between oasis complexes had home ranges of 2465km^2 and 2485$km^{2,}$ respectively. One of these males used elevations between 1122 and 1492m.

Patterns of use and movement between oasis complexes were complimented by genetic data from hair at feeder sites. Of the 8 individual females identified by their DNA fingerprints, 1 was identified at 2 oasis complexes, and the rest were identified only at sites within a single oasis complex. Of the 14 males, 7 were identified within only 1 oasis complex, 5 were identified at 2 complexes, and 1 at all 3 oases complexes, a distance of approximately 200 km. Based on these findings, it is apparent that the movement occurring between oases complexes is enough to assure genetic interchange between them. Once, DNA is isolated from the hair collected from captured bears, a more complete picture of movement between and within complexes by both sexes will be possible.

Building Capacity for Conservation Actions:

Rangers from the GGSPA participated in all phases of the conservation effort. We conducted training sessions for use of telemetry equipment, construction of hair snag structures needed

for DNA fingerprinting, data collection, record keeping of observations, and other aspects important for conservation management. In addition, individual rangers were trained in all aspects of safe capture, handling, recording measurements and advanced data management. These programs need to be intensified for long-term conservation.

A total of 26 laptop computers have been donated to the Gobi bear project—23 are being prepared for use by Gobi Bear Children's' Clubs in village schools adjacent to GGSPA. The other 3 are being used by ranger staff of the GGSPA for downloading images from camera traps and for data collection and analysis.

School children in the region do not have ready access to computer technology. A school curriculum is being prepared that emphasizes the importance of biodiversity in the world's ecosystems, as well as other conservation-related issues that should interest Mongolian school children. Both the computers and curricula will be distributed this autumn following consultation with Mongolian educators.

PROPOSED IMMEDIATE CONSERVATION MEASURES AND APPROACHES

During April, 2010, the Mongolian Ministry of Nature, Environment and Tourism held an International Workshop on Gobi Bear Conservation. Based on findings from the workshop and on strategies developed from information presented here to determine factors limiting population growth and recovery, the following conservation measures and methods or approaches are proposed. (Each conservation measure, followed by the method or approach to be used to achieve the measure, is listed in summary form.):

(1) Population size and structure

a. Determine by using mark-recapture methods, based on DNA fingerprinting of hair samples collected at feeder sites.
b. Determine from DNA fingerprints of all captured bears; compare with DNA fingerprints of bear samples collected at feeder sites.
c. Determine from sex ratios, based on DNA analyses and from age structure based on examination of captured bears.
d. Improve safety and effectiveness of traps used to capture bears for this project.
e. Translate thesis by B. Mijiddorj that provides an excellent resource for conservation background of the Gobi bear and provide for its wide use by publishing it in English.

(2) Reproductive performance

a. Document from remote cameras at feeder sites, in conjunction with DNA analysis of hair left at site when hair can be matched with individual bears in camera images, observations of cub tracks by rangers or project team, and age and reproductive conditions of captured bears.
b. Document age at 1st production of offspring and indications of breeding and cub rearing activity from direct examination of captured bears and by examining images provided by the Pathfinder attachment to GPS satellite radio collars.

(3) Genetic assessment

a. Develop capacity to conduct DNA extraction and analysis by MNET and Mongolian Academy of Sciences Genetics Laboratory through improvements in education, training and equipment.
b. Determine species/subspecies status based on nuclear DNA and mtDNA comparison of Gobi bears with nearest populations of bears within or immediately adjacent to northern Mongolia, western Mongolia, northwestern China.
c. Determine evidence of inbreeding problems by correlating incidence of problems related to reproductive or physical health, survival of offspring or susceptibility to disease with low genetic diversity.
d. Explore the comparative efficacy of conservation recovery through augmentation or captive breeding based on the above assessments, the strength of response by the population to other conservation measures, and concurrence of approach by appropriate IUCN Specialist Group.

(4) Physical condition

a. Determine from direct observation of captured bears.
b. Determine from examination by veterinarian experts and analysis of disease exposure from serum.
c. Determine and calibrate cortisol stress levels using hair samples collected at feeder sites.

(5) Resource importance and availability

a. Document food habits and resource use by visiting GPS locations.
b. Confirm plant and mammal contributions to food intake from vegetative analysis by Mongolian botanical experts, scat analysis by students and from images provided by using Pathfinder attachment to GPS satellite radio collars.
c. Utilize remote sensing imagery and GIS software to produce a map to identify vegetation types throughout GGSPA and can be used for resource selection and movement data.
d. Assess presence and abundance of food plants used by bears within and adjacent to the study area, especially in areas those locations formerly occupied by bears in the 1970's.
e. Monitor weather conditions related to spring performance (flow rate, availability at surface, etc.), plant growth and vegetation availability to bears.
f. to provide supplemental food for bears in both spring and fall seasons and improve its nutritional quality.
g. Assess comparative ability of habitat to support bears in each oasis complex. Utilize this analysis to explore possibilities to improve habitat in other oasis complexes and in adjacent areas that supported Gobi bears in the 1970's.
h. Assess variation in long-term water availability at springs by determining variation in tree ring growth.

(6) Movement and spatial use of landscape

a. Determine movement patterns from GPS locations provided by satellite radio collars.
b. Determine more detailed travel routes, and behavioral response by use of by using Pathfinder attachments to a small number of GPS satellite radio collars.

c. Continue to document movement by individual bears from DNA fingerprints of hair collected at feeders
d. Document emigration or dispersal patterns using GPS satellite collars of captured bears.
e. Determine areas used by Gobi bears for denning from GPS locations of satellite collars.

(7) <u>Building capacity for conservation management and research of Mongolian specialists</u>.

a. Provide additional training and educational opportunities to staff of GGSPA in conservation biology and management principles.
b. Develop expertise in Mongolian specialists in genetics, wildlife research and management principles through graduate education and on-site involvement in the Gobi Bear Project that can be applied to protected area
c. Develop and continue to support an educational curriculum for schools in villages adjacent to the GGSPA that emphasizes the values of Gobi bear conservation specifically and for biodiversity in general.
d. Provide the GGSPA staff with the equipment, logistics, and supplies, including necessary vehicles and support to adequately patrol the area to protect habitat for Gobi bears and other ecosystem species.
f. Provide the opportunity for Mongolian specialists to interact with international counterparts through attendance and presentation of findings at conferences.
g. Support local manufacture of feed to both make fodder more locally available and to provide direct economic benefit of Gobi bear conservation to local residents.
h. Support collaboration with local Sums to provide public programs that would benefit both Gobi bear recovery and local economic well-being
i. Establish a system to register all visitors to GGSPA, including length of visits at each site; record locations, timing, etc., of all management patrols by rangers, including observations of wildlife, environmental data, research and monitoring accomplishments.

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