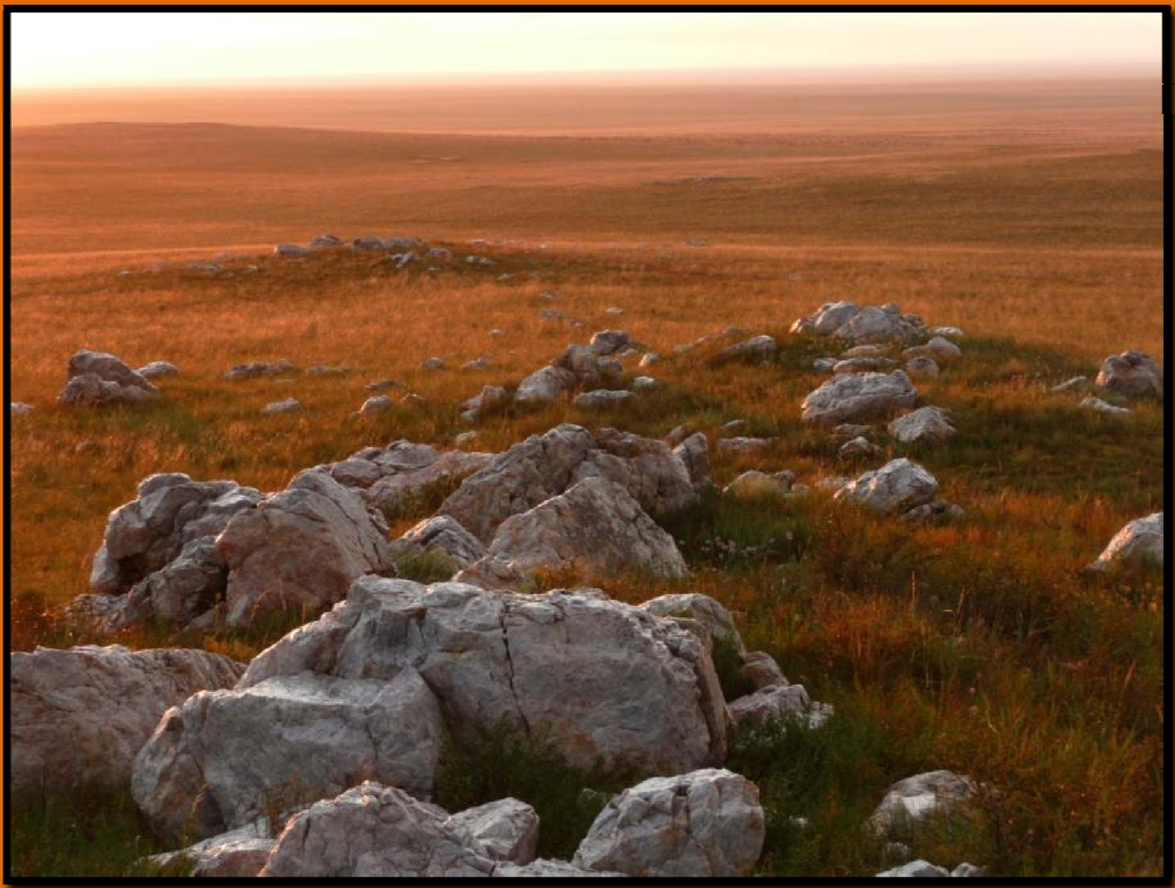
Measuring Conservation Efforts: Developing a Monitoring Program for Tosonkhulstai Nature Reserve



No form of wildlife management, whether it is the establishment of cropping or hunting quotas, the development of tourism, or the demarcation of boundaries, is possible without reliable information on the numbers, population dynamics, and movements of the animals concerned.

Mike Norton-Griffiths, 1978
Counting Animals

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and

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Ulaanbaatar, 2010

The Nature Conservancy

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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

Tosonkkhulstai is a 4,600 kilometer square nature reserve which was established in 1998. It is administered by the Eastern Steppes Protected Areas Administration and is patrolled by 6 rangers (5 from soum administration and 1 from ESPAA). The reserve is an excellent example of a temperate feathergrass (Stipa sp) dominated grassland. It represents just a fraction of the entire ecosystem (<2%).

After a series of community consultations and workshops which identified perceived threats to the reserve and their potential sources The Nature Conservancy (TNC) began supporting ranger patrol efforts through the provision of additional equipment and vehicles to facilitate patrols. A monitoring program focusing on medium sized carnivores and marmots will be used to evaluate the effectiveness of increased ranger vigilance.

Initial efforts included developing a short course in statistics and population monitoring techniques to expose the TNC assistant field biologist to some of the tools and concepts necessary to develop a monitoring program. Topics ranged from introducing the scientific method, probability, basic introductory statistics, and basic field survey concepts.

Ranger involvement in developing the monitoring program at this stage was premature as methods and techniques need to first be evaluated and developed. Rangers will be most effective if they are able to concentrate on their primary duty and enforce the regulations of the nature reserve. Ranger patrols should be diversified to ensure that the entire reserve is being sufficiently monitored rather than focus on what is believed to be a few hot spots of animal abundance. This could include monitoring along the reserve boundary, roads used to traverse the reserve, and include household visitations.

Baited track stations would be used to detect carnivore presence/absence. Monitoring will focus on following trends in percentage of stations visited by target species. Two types of track stations were evaluated – stations with a layer of sand treated with mineral oil and stations without – to test whether the use of a moistening agent to better preserve tracks would not deter animals from the station.

Marmot density and distribution within Tosonkhulstai would be evaluated using line transect surveys and distance data and also estimating marmot density using quadrat sampling within regions known to have higher density of marmots.

We successfully monitored 45 of 52 track stations. Untreated stations had 24% (11 or 45) of sites visited while treated stations had sign at 31% (14 of 45), indicating no negative effect of the moistening agent. Untreated stations had fox sign at 16% (7 of 45) of sites while treated stations had 22% (10 of 45) of sites visited by fox. Tracks were not as clear and readily identifiable as hoped resulting in less confidence in accuracy. The use of camera traps to positively identify species and their tracks will help improve this monitoring effort. Additionally the use of photos will help enhance public awareness activities.

Marmot density was estimated by driving along 13 transects for a total of 356 km's. Overall density (measured as burrow clusters) within Tosonkhulstai was 6.1 (95% CI 3.6 – 10.3) burrow clusters/km^2. Driving twice the length will help to decrease the variation and will enable changes to be detected in shorter time periods. Quadrat sampling produced similar results (20 clusters/km^2) as a previous foot survey in areas of high marmot abundance, however the estimate had high variance. Quadrat sampling will be an effective monitoring method in known marmot areas as the method is easier to implement (fewer assumptions) than distance sampling, however better understanding of marmot range within Tosonkhulstai is needed first.

TOSONKHULSTAI NATURE RESERVE

Administration and history

Tosonkhulstai (English: place with oily bamboo) is a roughly 4,600 square kilometer nature reserve originally intended to protect Mongolian gazelles (*Procapra gutturosa*), particularly during calving season. In reality Tosonkhulstai serves a greater role in the conservation of smaller species and an excellent example of a healthy temperate grassland ecosystem.

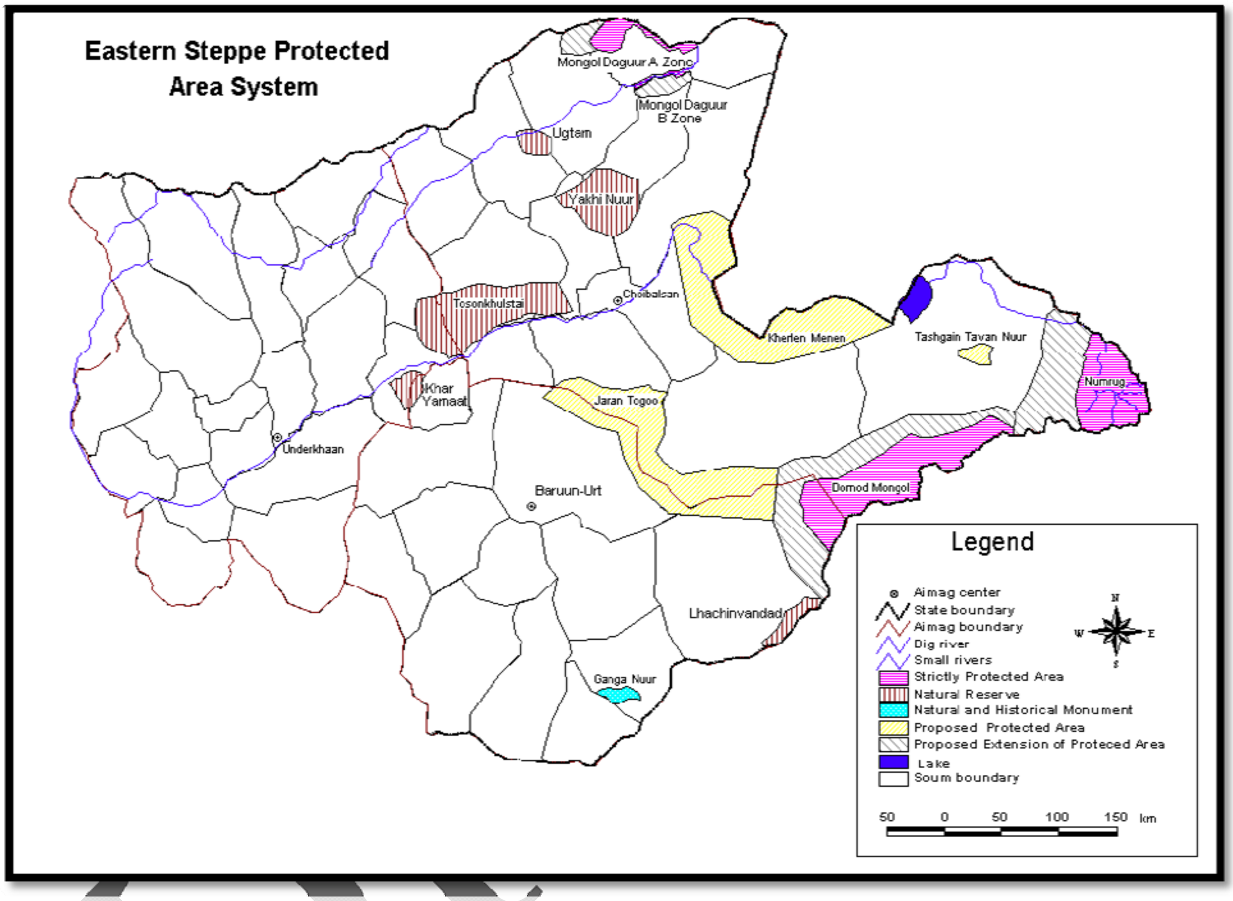
Established in 1998, Tosonkhulstai spans across two Aimag level administrative units (Dornod and Khenti) and 5 soum level administrative units (Bayan Ovoo, Norovolin, Khulun Buir, Tsagaan Ovoo, and Byantumen) (Figure 1). The administrative center for Tosonkhulstai is based at the Eastern Steppe Protected Areas Administration (ESPAA) center in Choibalsan and staffed with 6 protected area rangers, and to some extent enforced by soum level environmental rangers and community group volunteer rangers. Additional support is provided for activities within the park by The Nature Conservancy and Wildlife Conservation Society. Traditionally nature reserves are managed by the soum administration but in this case the Ministry for Nature, Environment, and Tourism called for the reserve to be administered by the ESPAA. As a stand-alone reserve, it consists of less than 2% of the entire Eastern Mongolian Ecosystem (approximately 285,000 sq. km [Lhamjav *et al*., 2008]).

Image 1. Stipa grassland habitat within Tosonkhulstai Nature Reserve (August 2010).

There has been a long history of people living within the region. Late Neolithic period (~6,500 to 4,500 B.C) graves have been found in Eastern Mongolia featuring the bones of domesticated animals. Ancient graves from the 3rd and 4th century B.C. can be found in the western portions of Tosonkhulstai. Dating back to the 9th century, the Kitan

State established a small settlement along the banks of the Kherlen River at the edge of the current day reserve boundaries. Throughout these periods wildlife in the region has managed to persist. Today the situation is different. A market economy, superior hunting technology, and a weakened state infrastructure to uphold environmental laws, the wildlife within the reserve (and outside) face a serious crisis.

Figure 1. The protected area system in Mongolia's Eastern Steppe.



In 2008, The Nature Conservancy implemented their Conservation Action Plan efforts for the Tosonkhulstai region. TNC began focusing efforts on improving the management of Tosonkhulstai Nature Reserve. The vision TNC has for Tosonkhulstai is to *"Protect integrity of Stipa grasslands, gazelle, and a full biodiversity of the system and improve local livelihoods by implementing participatory resource management"*. Initial efforts were focused on improving community participation in conservation of the biodiversity of Tosonkhulstai.

This consisted of entering into dialogue with stakeholders and knowledgeable experts to identify threats, needs, and actions to take in order to develop efficient and measurable conservation strategies for the target region. Community conservation consultations were conducted with the 5 soum administration officials, and local communities that resided in and around Tosonkhulstai Nature Reserve. This consisted of the following activities: Gathering local community member's perceptions of how natural resources, species status, and conservation values are changing over time. Identifying major ecological systems, their key ecological attributes, and the stresses and threats (and the sources of) to these systems.

Finally, to better understand how community livelihoods and biodiversity or natural resource abundance are linked.   Using this information and in workshops with community stakeholders a number of actions were identified to reduce the threats.

The CAP II efforts and final workshop produced a list of 8 conservation targets to focus on for the region. This includes Mongolian gazelle, Siberian marmot (*Marmota sibirica*), Grey wolf (*Canis lupus*), and medium sized carnivores (red fox [*Vulpes vulpes*], corsac fox [*Vulpes corsac*], Eurasian badger [*Meles meles*], steppe polecat [*Mustela eversmanii*], and manul [*Felis manul*]. In order to honor the obligations of the CAP process and to measure the effectiveness of increased support to rangers, a monitoring is needed.   It is believed that with better enforcement of the reserve (with respect to wildlife hunting) then there should be an observable increase in the abundance of the target species.

Currently, efforts to understand the ecology of the park and the abundance of important species lags behind other conservation efforts. The purpose of this effort was to develop and test monitoring methods that would produce repeatable estimates of distribution and relative abundance of key target species and recommend a ranger based monitoring program. Additional training in research methodology and data analysis was incorporated into the efforts to increase confidence in TNC assistant field biologist to carry out these tasks independently in the future.

Ecology of Tosonkhulstai

There are few resources available describing the diversity of flora and fauna within Tosonhulstai. The entire eastern steppe region consists of a mosaic of habitats, dominated specifically by two – the Daurian Forest Steppe Ecoregion and the Mongolian-Manchurian Ecoregion (Olson & Dinerstein, 2002). Tosonkhulstai Nature Reserve is habitat for as many as 80 species of plants [25 families], 33 species of mammals [13 families], 139 birds [31 families], 3 species of reptiles [3 families], and 2 species of amphibians [2 families].

Image 2. A Siberian toad (*Bufo raddei*).

The reserve consists of low rolling hills in the far eastern portion with topography gradually becoming steeper and more pronounced towards the western border. Rainfall in the reserve drains into two watersheds; the Kherlen River and the Gallin Gol which flows into a large flat alkaline basin known as Yaki Nuur which has no outlet. Scattered throughout are numerous shallow lakes which provides habitat for numerous groups of small invertebrates and halophytic plant forms.

Image 3. A triops (*notostracan branchiopods*) collected from a shallow pond in the Mongolian steppe.

Courtesy of: http://donosti.geodata.es/mongolian_lakes/index.php?page=types&lang=en

There are several ephemeral springs and seeps scattered throughout the park some know to provide refuge for amphibians such as the Asiatic grass frog (*Rana chensinensis*), while reeds provide nesting sites for bird species such as grey heron (*Ardea cinerea*). The northernmost and central region of the reserve consists of a broad flat plain known as Salbariin Tal portions of which were once ploughed lands. Globally Rare species such as the white-naped crane (*Grus vipio*) can be consistently observed during the summer months around permanent water points within Tosonkhulstai.

Tosonkhulstai is perhaps most well known as a frequently used calving region for Mongolian gazelles, although gazelles can be seen within the reserve at nearly all times of the years. Calving season for Mongolian gazelles typically begins in the last 10 days of June and by July birthing is over (Olson et al. 2005). This is followed by a brief lying out phase and then gazelles once again begin to wander in search of quality forage (Odonkhuu et al. 2009).

The conditions necessary for Mongolian gazelles during calving are not fully known but it is likely that Tosonkhulstai possesses the features required to be used as a calving regions more frequently than other places. Whatever the reason for calving area selection, it is important that access to the reserve remains open as gazelles use a much larger area of the grasslands throughout the year (Olson et al. 2010).

Large colonies of marmots once spread across large parts of the steppe. In the early 2000''s rampant poaching led to what is believed to be a staggering 95% drop in numbers (Wingard & Zahler, 2006). Their numbers greatly reduced; several pockets of large marmot colonies can be found within Tosokhulstai, making the reserve an important potential source population for the surrounding areas.

Image 4. A flock of demoiselle cranes (Grus gathers in preparation for fall migration in a flat plane in the northern region of Tosonkhulstai.

Threats to target species

According to outcomes from the CAP II workshop, unsustainable harvesting, mostly attributed to illegal hunting, is considered one of the biggest threats to the long term viability of the target species. Livestock competition is believed to be a medium to low threat to Mongolian gazelle and Marmot. Reduction of habitat is believed to be a low threat to Mongolian gazelles. Mining, degradation of water sources, poor spring grazing, and reduced mobility of herders were believed to be medium to low threats to Mongolian gazelles. A reduction in marmot numbers is considered a threat to wolves as a loss of prey species.

Image 5. A freshwater wetland provides a critical refuge for a variety of wetland birds.

Image 6. A lookout tower at Kherlen Bars Khot, a 9th century Kitan period city.

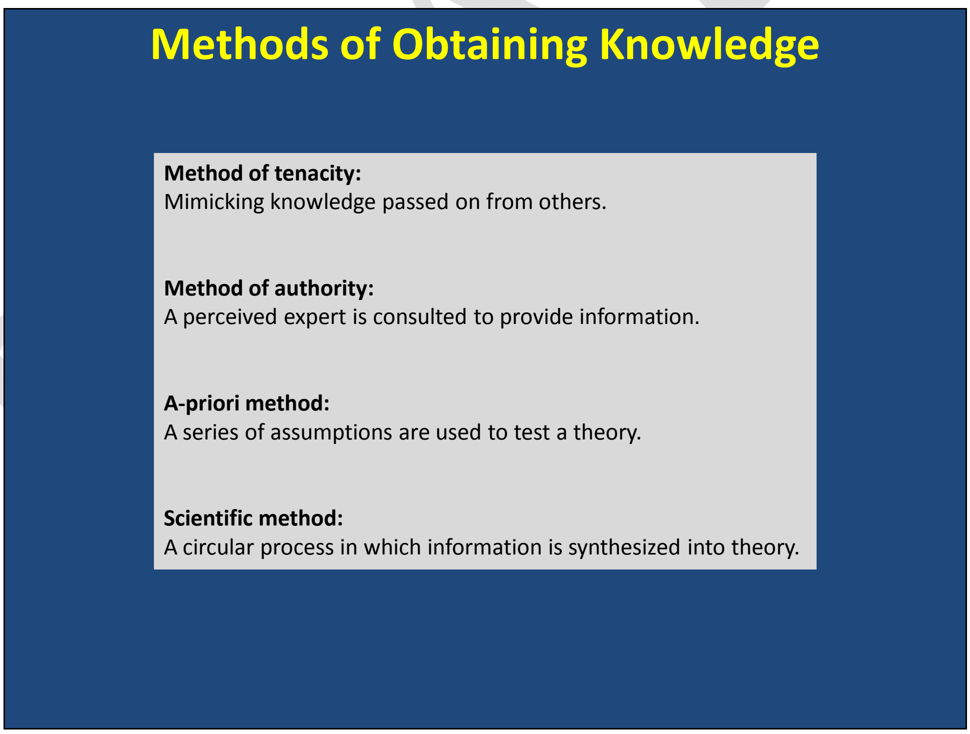
TRAINING AND RANGER MONITORING

Introduction to basic statistics and field methodology

The terms of reference called for Tosonkhulstai rangers to be included in a training course for field methodologies. As the purpose of this summer's field work was to develop and test various methodologies for a long term monitoring program it seemed premature to develop a training program when we have yet worked out the methodologies and protocol. Many of the rangers have previously benefited from a variety of training courses over the years. For example in April 2010 a WCS training course was held in Tosonkhulstai with the purpose of training rangers and community members on Distance sampling protocol and scan sampling to estimate marmot population size (Winters, 2010).

In the future, as a long term monitoring program is developed and protocol guidelines are established it will be a more productive and meaningful exercise to train rangers to assist in the collection of data. This will allow the training to be more focused on a definite purpose and a clear understanding of the need to implement the acquired skills in practice. Additionally, the TNC assistant field biologist will have a greater capacity to act as a mentor and trainer rather than as a participant in the training.

Image 7. An introductory slide used during the classroom training in statistics and field methodology.



Prior to developing the field methodologies and initiation of the field work, classroom training was conducted for the TNC assistant field biologist. The following subjects were presented over the course of 5 days:

- The role of science and scientific methodology
- Hypothesis development
- Experimental design
- Data presentation
- Concepts of probability
- Descriptive statistics
- Statistical analysis
- Survey methodologies

The purpose of this short introduction to research methodologies and data analysis was to familiarize the TNC staff biologist with concepts important in designing and implementing field studies (Appendix I). This introductory course should be seen as a very brief introduction to the concepts and not taken as a comprehensive treatment of these concepts and methodologies. Topics covered were chosen to build towards thinking and discussion of how to prepare and conduct a study to monitor chosen target species in Tosonkhulstai NR. A more in depth examination of these topics are found in: Quinn & Keough (2002), Braun (2005), Gotteli & Ellison (2004).

In the field the TNC assistant field biologist was exposed to 2 different methodologies for sampling marmots (line transects and two-stage sampling using area fixed size quadrats). Track scent stations were used for assessing carnivore presence/absence. Additional valuable experience was gained in planning and preparation for field studies and further development of professional field craft skills.

Image 8. *Limonium bicolor* in bloom.

Ranger patrols

There has been considerable training provided to the rangers and community groups working and living within the reserve. However, there still appears to be a wide disconnect between training provided and incorporation into mandatory field protocol by the Eastern Mongolian Protected Area Administration (EMPAA) supervisors. Training without endorsement and acceptance of the new skills and concepts by the supervisors into work plans becomes meaningless. Ranger presence within the reserve (with the exception of one dedicated ranger) appears to be minimal at best. We encountered people carrying out illegal activities more frequently than we encountered rangers (marmot hunters, gazelle poachers, ninja miners washing tailings). Providing rangers with additional monitoring duties in addition to their duties as enforcers of the rules and regulations that apply within the boundaries of Tosonkhulstai in hopes they will in turn have a greater presence within the reserve will only be successful without a mandate to carry this out from their supervisors.

In addition to a recently acquired mobile ranger station, ranger monitoring routes have been suggested by the TNC assistant field biologist (Appendix II). In addition, the use of a 4-wheel drive vehicle is provided by TNC during the winter to make winter patrols more feasible. The mobile ranger station was provided to help facilitate and encourage rangers to take extended trips to the reserve thereby increasing their presence. Routes were designed to accommodate the district from which the soum rangers are responsible for and to take advantage of vantage points by travelling to high points. During the time of our field work the mobile station had yet to arrive and there was no obvious sign that ranger routes were being followed.

There appears to be several obstacles needed to overcome in order to increase the effectiveness and presence of the rangers Monitoring routes. Ranger responsibilities need to be expanded to the entire reserve, not simply the area in which their respective soum boundary falls under. This effectively fragments the reserve into 5 separate smaller reserves.

There is no senior ranger responsible for the activities and professionalism of the reserve rangers. Currently all the rangers have equal status and there is little supervision from the ESPAA office, therefore there is no chain of command and there is no clear mandate to carry out tasks. It would seem logical to have a senior ranger appointed whose duties in addition to carrying patrols as defined by his/her job description is also responsible for assigning monitoring and responsibilities and monitoring the level of effort of other rangers. This senior ranger could then report to the ESPAA director and/or reserve conservation council.

Patrol routes need to vary in location, timing, duration, and intent. Following the same route by the same ranger at the same times of the day will lead to boredom for the rangers and decreased vigilance and interest in continuing patrolling efforts and will allow poachers to more easily carry out activities once it is known when and where patrols takes place. Likewise in addition to patrolling the region within their soum jurisdiction, rangers should work in teams at times covering other areas of the reserve. In addition to the suggested route from the TNC assistant field biologist and the use of the mobile ranger station, patrol routes could be increased to incorporate the following tactics:

- Patrolling the boundary of the reserve. With the exception of a few metal signs on main tracks at the reserve boundary, the current boundaries of Tosonkhulstai are poorly delineated.   A motorcycle track could easily be established that outlines the boundary of the reserve. This would provide rangers with better perspective of the area under their watch and to observe activity at the reserves edges. Additionally it would facilitate a better understanding of the reserve boundaries by those living on the outside edges.

- Road patrols. There are numerous actively used tracks criss-crossing the reserve connecting soum centers with the aimag capital, the main road between Ondorkhaan and Choibalsan or other soum centers. At times vehicles travelling these roads encounter gazelle herds and give chase hoping to opportunistically shoot one. Mapping roads within the reserve and patrolling these roads periodically would help reduce opportunistic poaching occurrences and will provide better public awareness about the reserve and the presence of rangers on patrol enforcing the law.

- Household visitations. Periodically (2 times/year?) all households living within the reserve and within 3 km's of the reserve boundaries should be visited by a ranger to simply provide an update as to what type of activities are planned within the park by the ESPAA or conservation NGO's. Many families still have only a vague idea about the purpose and activities within the reserve and ask who is supposed to benefit the reserve, why are outsiders trying to limit the way we live, and what is the purpose of the reserve. Every household within and in the vicinity of the reserve should be aware of the purpose, history, and current status of Tosonkhulstai.

- Patrols to random locations. Perhaps twice/month each ranger should travel a route connecting randomly selected points. This will facilitate discovery of new things off the normal track and help uncover any illegal activity that may be taking place outside of view from the main roads and high points.

- High points route. The greatest length of Tosonkhulstai follows an east-west axis. If one were to drive along this axis connecting prominent hill points the majority of the route would allow a ranger to view a large proportion of the reserve. By carefully examining a detailed topographic map (1:100,000) and by experimentation a route could be created.

Image 9. Sunset in Tosonkhulstai.

At this point, focusing on increasing law enforcement efforts should be a priority. Incorporating rangers into monitoring of biological data should proceed as the methods are developed and a protocol established. At that point, a short training course introducing monitoring protocols for target species (or others as needed) followed by implementation and analysis would be appropriate. While on patrol observations and information collected should be recorded in a systematic manner in field notebooks. Such observations should include:

- Name of ranger,
- Date and time (Start/Stop) of patrol,
- Patrol route name, or if different GPS locations at turning points,
- Time and GPS location of observations that generate interest by the ranger,
- Time, GPS location of people encountered as well as the nature of their presence in the reserve,
- Time, GPS, numbers, of wildlife species of interest (large mammals, rare birds, etc.).

The routes need to be entered into a GIS database and used to help visualize regions which may still be underrepresented or to identify areas where monitoring efforts should be increased.

Image 10. Hay bales stacked and ready for transport.

BASELINE STUDIES

Survey for carnivores using scented track stations

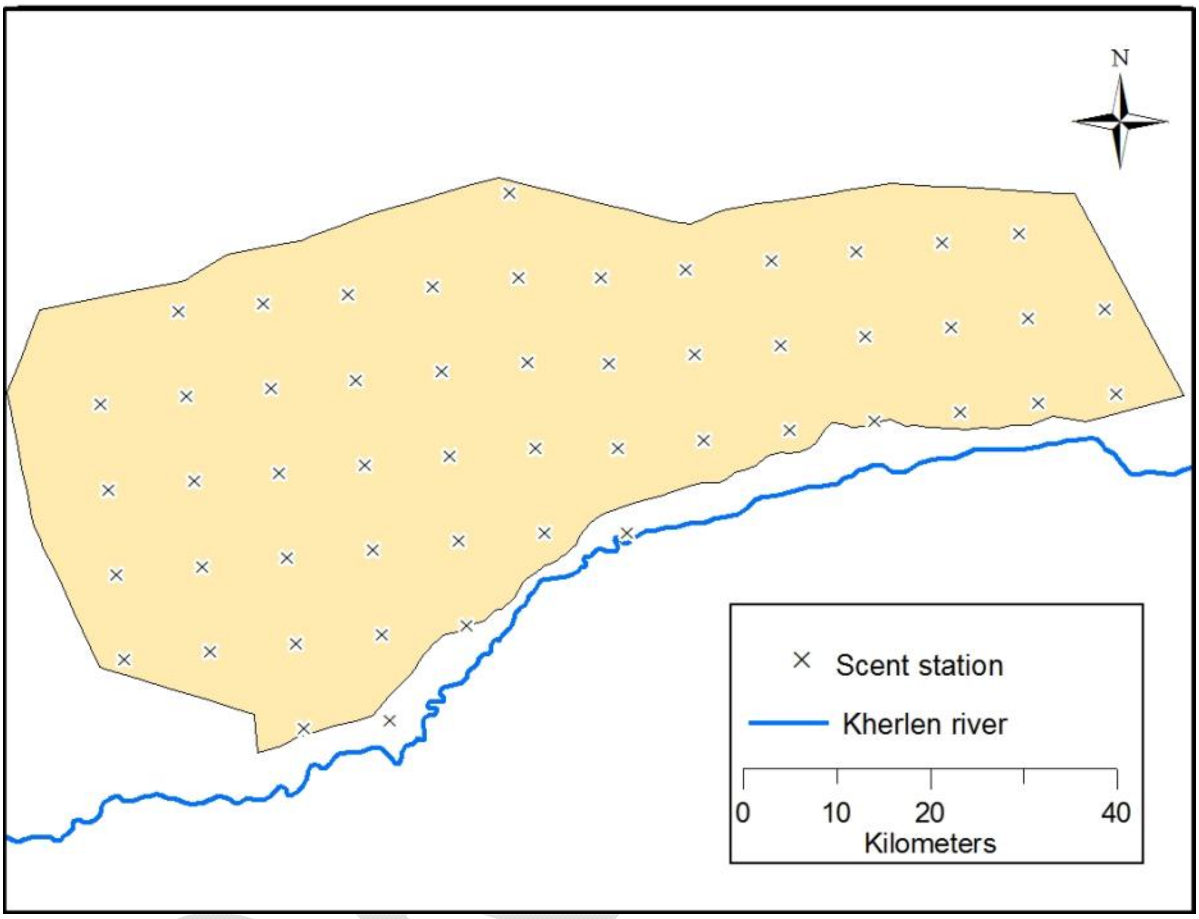
Medium and small carnivores are inherently elusive, making direct observational survey methods a near impossible task. As a result a variety of indirect methods have been developed to better determine carnivore distribution and abundance such as using hair snags to collect genetic material, scent stations with or without attractants to record tracks and other sign, and finally an increasingly common methodology is the use of remotely triggered cameras to record the presence of individual animals. These are expanded on greatly in Long et al., (2008).

The guidelines for developing a monitoring program for Tosonkhulstai carnivores were to develop a program that is inexpensive and easy to implement. Given this, we chose to evaluate the use of baited track stations to assess occupancy of carnivores within Tosonkhulstai. We also wanted to test whether it was feasible to use unscented mineral oil as a moistener to help maintain quality track impressions.

After estimating logistical considerations, scent station preparation times and considering other efforts to undertake during the monitoring training it was decided that setting up track stations at approximately 50 locations would be a reasonable number to complete. This corresponded to a scent station for every 90 km^2. This worked out so that station sites were systematically spaced at approximately 9.5 km's intervals (Figure 2). Treated and untreated stations were located 100 meters apart. To create a track bed, we cleared vegetation and stones from and smoothed off a 0.9m diameter plot and added a fine layer of sifted soil obtained at the site (Image 2). We added a layer of finely sifted topsoil mixed with mineral oil to help maintain the integrity of track impressions.

Image 11. An evening cumulonimbus cloud over Tosonkhulstai.

Figure 2. Location of scent stations for baseline surveys for carnivore occupancy in Tosonkhulstai Nature Reserve. Stations are approximately 9.5km's apart.



Plaster scent disks were prepared (approximately 2 cm's thick and 5 cm's in diameter) and soaked in a solution of rotten egg and fish (100 raw eggs and 5 kg of boneless raw fish were placed in plastic air-tight containers and left in the sun for approximately one month) were placed in the center of each station (Image 3). We elevated the scent disk using either a small stone or horse scat to deter burying beetles from consuming the bait, however this had little effect. At each site, we created two track stations separated by 100 meters, one with and one without a moistening agent (unscented mineral oil).

In order to prevent wind from deteriorating track integrity, scent stations were prepared usually in the afternoon hours and checked the following morning. Given logistical and time constraints scent stations were only left out for one night.

Image 12. Preparing a track bed using mineral oil as a moistening agent.

Image 13. Adding a scent plaster disk as an attractant.

Assumptions

It is important to understand what assumptions were made to ensure that the data collected are truly representative of the population of interest throughout the reserve. Equally important is to understand and discuss what assumptions may have been violated and how this may affect the survey results.

The scent stations are randomly located throughout the reserve. The location of the first station was randomly selected and then each station after was systematically spaced at 9.5 kilometer intervals.   This ensures that the data is reflective of what the situation is within the entire reserve. If scent stations were chosen such that they were placed near known fox dens, or along trails with fresh fox tracks, then visitation rates would be high and thus biased. We elected to not deploy scent stations that were within close proximity to households in order to save time and to avoid being accused of suspicious activity near households. This biases the samples in that the assumption is that there is likely to not be wildlife in close proximity to households and therefore no need to put out a station. This also creates a bias in the data point (percentage of stations visited will be higher) if in the future scent stations are placed in close proximity to households next time. Future surveys should incorporate these locations into the sample and the distance from the household recorded in order to better understand what the distance of influence households are having on wildlife in the surrounding area.

All stations have an equal probability of detection. We made all attempts to create and apply the bait to the disc equally. Smoking was not permitted while creating the station, gloves were worn when handling the bait, and we did not wash our hands, eat food, or urinate within 2 km's of the scent stations. We assume that while building the station that the disturbance was not such that it would cause an animal to avoid the station rather than investigate. Additionally we made a conscious effort to return to stations and to make track observations at the same time the following day to ensure all stations were out for a similar time period. In the case where either the disc was removed by an animal or carrion beetles ate all the bait, we can only assume that the residual stench of the bait was still strong enough to attract curiosity by the species of interest (future scent discs need to be raised off the ground by a nail or wooden stake and fixed to the location so it can only be removed with effort). Weather also plays a key role in the activity of animals. Stations that were deployed in inclement weather may have not been visited due to the animal remaining in a sheltered location. Our stations that were rained out were not included in the analysis but wind, clouds, temperature, and moon phase is all known to influence animal activity. We attempted to minimize the biases caused from violating this assumption by putting out all the stations in as brief a time span as possible.

The bait used was a suitable attractant to the species of concern. This is a difficult assumption to verify. We assume that the strong scent of the bait would arouse curiosity in carnivores and at least make an investigation. However, species such as a manul may not be attracted to this type of bait.

Image 14. A corsac fox (*Vulpes corsac*).
Image courtesy of: Thomas Mueller

Track station results

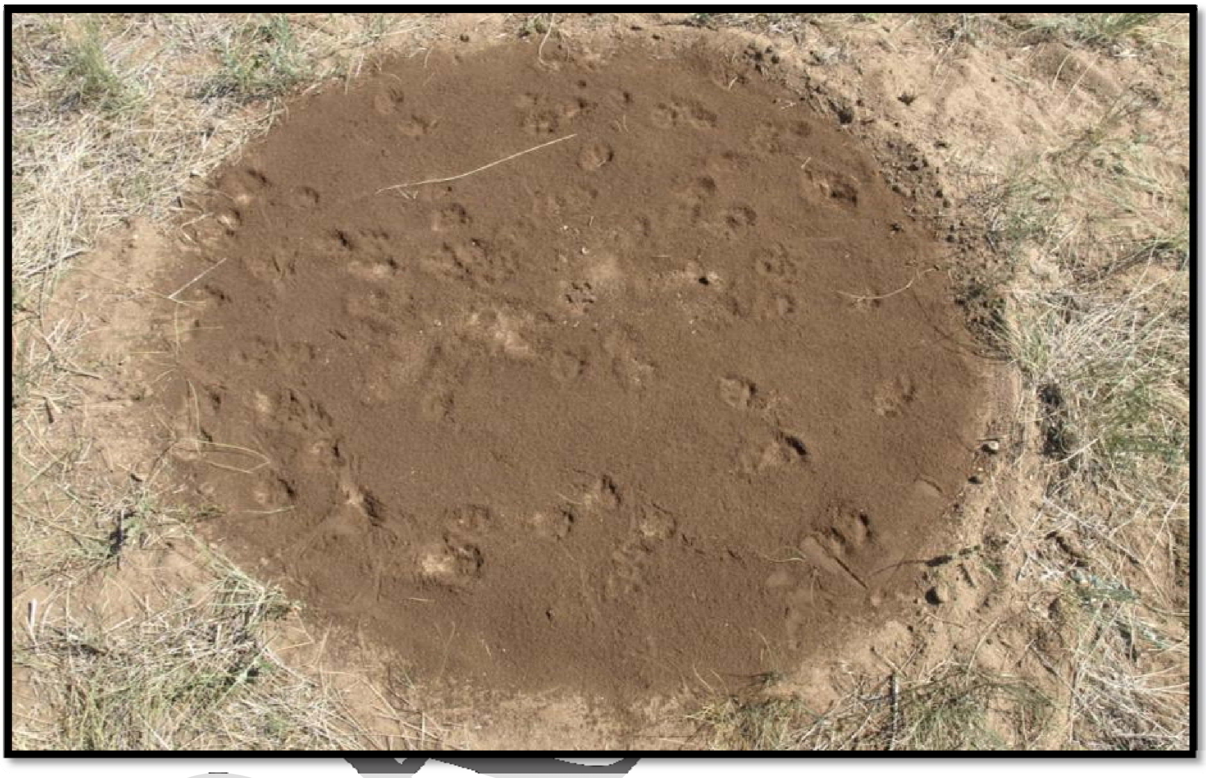
Of a total of 52 pre-determined scent station locations, 45 were successfully monitored over as close to a 24 hour period as possible (mean = 19.6 hours). Of the stations that we did not record data from; two were within 200 meters of a household and the main UB-Choibalsan road and we elected to not put out a scent disc and 5 of the stations were created but washed out by heavy rain (4 on 3 separate occasions). Tracks from at least four species (*Mustela eversmanni, Mesichinus dauuricus, Vulpes vulpes, and Vulpes corsac*) were identified while incidental tracks were recorded from common raven (*Corvus corax*), a gull (*Larus sp*.), and a Mongolian gazelle (*Procapra gutturosa*). Due to windy and dry conditions, track impressions were not as well defined as desired, this resulte in a number of impressions by corsac and red foxes indistinguishable and subsequently pooled as the detection of fox.

In total 24% (11 of 45) of untreated track stations had medium sized mammal sign while mineral oil treated stations had sign present at 31% (14 of 45). Sign attributed to 'Vulpes' was present at 22% of treated stations (10 of 45 stations) and 16% of untreated stations (7 of 45); indicating that the presence of mineral oil was not likely deterring animals from investigating the scented tablet. Only 3 sites had both treated and untreated stations visited by what we identified as either a red or corsac fox. Fox might not be interested in visiting a second station after discovering that the scent is not associated with a food source and no longer worthy of investigating. Steppe polecat was detected at 3 of 45 untreated stations (07%) and at 4 of 45 (09%) at treated stations. Hedgehogs visited 2 of 45 dry sites and none of the treated sites. No wolf sign was detected. A complete photo record of track impressions can be found in Appendix III.

Identifying tracks of individual species provided a greater challenge than anticipated due to a variety of factors. Conditions for preservation of tracks were not favorable and as a result many of the impressions were not identifiable. In clearing the vegetation from the sites, we often created deep soft pits that had to be filled using dry soil. This created a much deeper and softer layer than desired and some stations had impressions that filled in with sand. Additionally, under breezy conditions, the soft sandy soil easily eroded into the impressions. We hoped that a layer of mineral oil would help stabilize tracks and this improved conditions somewhat but not completely. A combination of imported sand/clay would improve conditions and this would be a practical solution if stations are to be permanent.

A more reliable solution would be the use of camera traps to positively identify animals visiting each station which would lead to positive identification and greater confidence in identifying the type of tracks and other sign. An additional advantage is that camera trap stations can be deployed for multiple days without the need to return minimizing the influence of things such as weather and detection of human presence from the building of the station.

Image 15. A track station with numerous fox tracks.



Marmot surveys

We conducted surveys for marmots using two separate methodologies, 1) driving north-south line transects following distance sampling protocol 2) quadrat sampling at systematically located 50 x 50 meter quadrats (coinciding with placement of the scent stations) and 3) a more intensive area sampling effort (75 x 75 meter plots at 2 km intervals) within areas believed to have a high density of marmots determined from driving line transects. Line transect data was analyzed using the program Distance 5.0 (Thomas et al. 2006). Quadrat samples were analyzed following analysis guidelines described by Norton-Griffiths (1973).

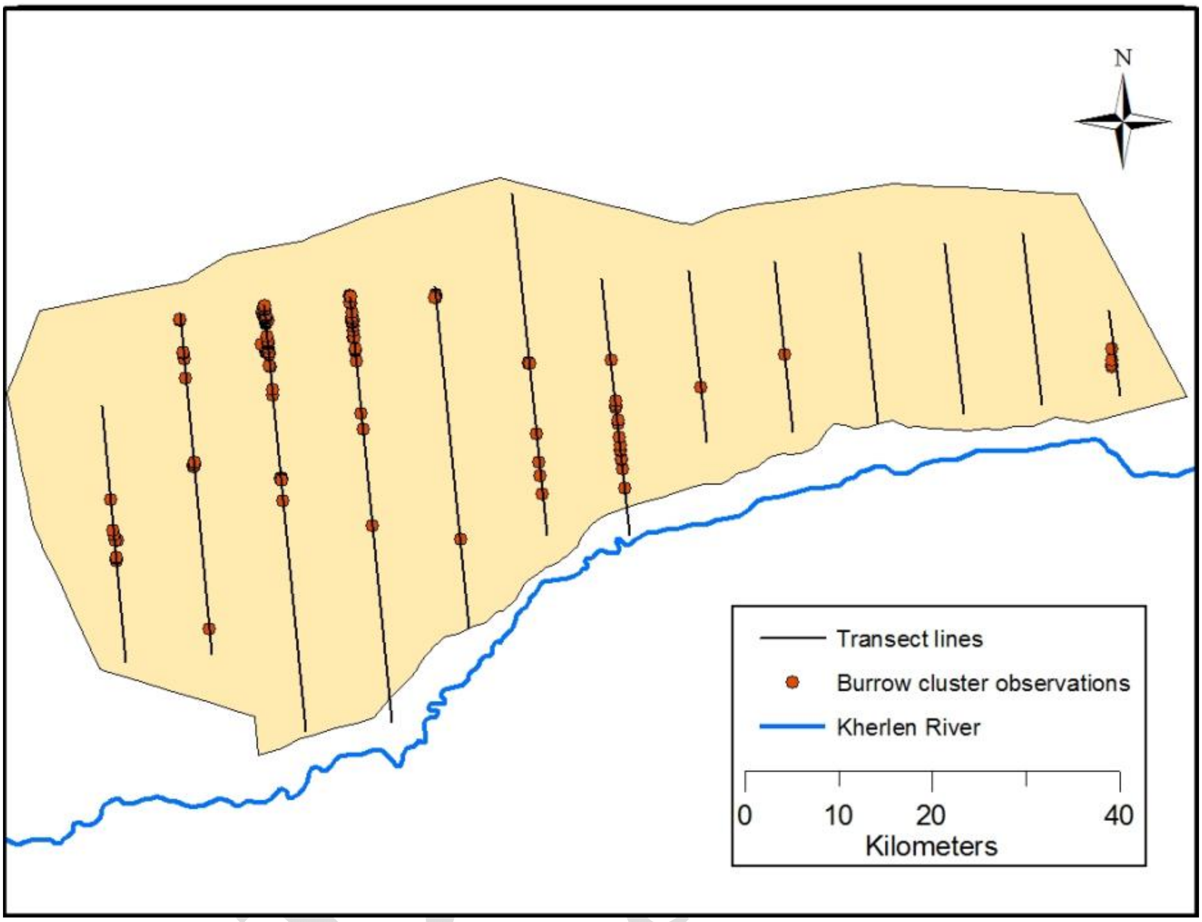
Distance sampling with line transects

Distance sampling using line transects to estimate marmot density has been conducted using vehicles and walking (Townsend & Zahler, 2006, Winters, 2010). Due to the absence of reliable spatial data on the current distribution of marmots we elected to follow evenly spaced north south line transects across the entire reserve. The alternative would be to stratify our efforts and concentrate a larger number of transects in known marmot areas, which would result in less variation around the mean of our estimate. This can be done in future efforts, but only after the distribution of marmots within the park is more accurately mapped.

We divided the reserve into 13 north south line transects spaced approximately 9.5 km's apart (Figure1). Start and stop locations coincided with the locations of scent station sampling stations. We choose these transects based on the available knowledge of the reserve boundaries and used a 1:100,000 scale map to plot points and record into a GPS.

The survey team consisted of a driver and two observers. Driving speeds were maintained between 20 and 30 km's/hour or slower when conditions dictated. Distances were measured using a laser rangefinder (Bushnell Elite 1500) and sighting angles to the nearest degree were taken using a sighting compass (Suunto Visat KB-20). We took care to measure the angle outside of the vehicle to prevent the magnetic properties of the body from distorting compass bearings.

Figure 3. Location of line transects for estimation of burrow cluster density and locations of active burrow cluster observations.



If a potentially active burrow cluster was detected we stopped the vehicle and on foot walked to the burrow and examined it for signs of activity and to determine which species may be using the burrow. We followed criteria suggested by Townsend (2006) to positively determine whether a burrow was active or inactive were the presence of fresh scat, fresh diggings, observations of runways, grazed grass around the burrow, and resting beds. Often times we observed that many burrows were connected with runways greater than the 15 meter criteria recommended by Townsend (2006) for defining a burrow cluster and made adjustments in defining the size of a burrow cluster accordingly.

We attempted to define a burrow cluster based on the connectedness of active burrows by runways. We estimated the distance from the transect line based on the distance from the geometric center of the burrow cluster (defined by first establishing a line between the two burrows furthest apart, the burrow cluster center is then the point at which the two widest space burrows along a line perpendicular to the first line intersect). Within an active burrow cluster we counted the number of active and inactive burrows. Inactive burrows detected within the active burrows were counted only if there were evidence of an open burrow. Burrows whose entrance had been filled with soil as a result of long period of inactivity were not considered.

Analysis was conducted using Distance 5.0 (Thomas et al., 2006) with the conventional distance sampling (CDS) engine. Data analysis proceeded in the following order:

1. Enter data into an Excel spreadsheet and calculating perpendicular distances of the burrow clusters to the center line using the sighting angle and the measured distance from the cluster. This consisted of first determining the sighting angle from the measured compass bearing taken in the field. By trigonometry the sighting distance can be calculated prior to entry of the data into Distance software (Distance also calculates these distances automatically).

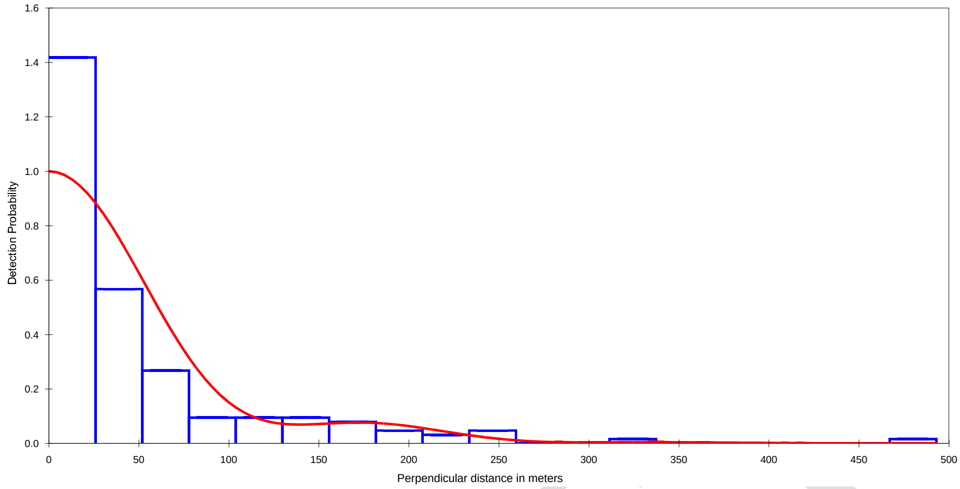
2. Creating a project in Distance following the steps in the distance project setup wizard.

3. Examining histograms using a variety of cutoff criteria to determine appropriate cutoff point to determine a final model which best fits the collected data; ie. both model and data closely fit 100% sighting probability on the transect center line (see Buckland et al., 2001). We first examined all data (max sighting distance was 493 meters) and noted a distinct break at 250 meters (only 3 sightings were beyond this point) (Figure 2a). We again examined histogram at 250 meters (Figure 2b), and settling on a final truncation at 75 meters (Figure 2c) as this provided a good fit at g(0) and g(75) was approximately 0.15% at which point Buckland et al. (2001) suggest truncation of observations below this value.

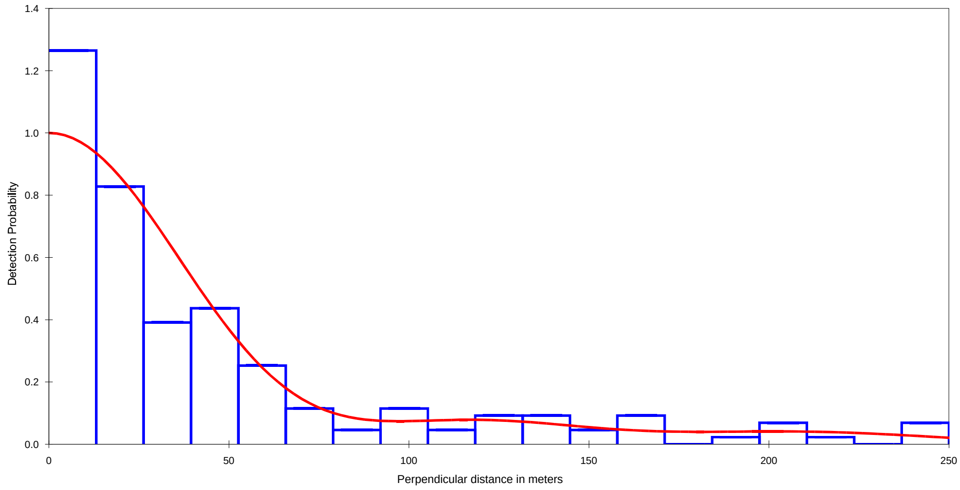
Image 16. A marmot concealed in tall grass.

Figure 4. Histogram of sighting data.

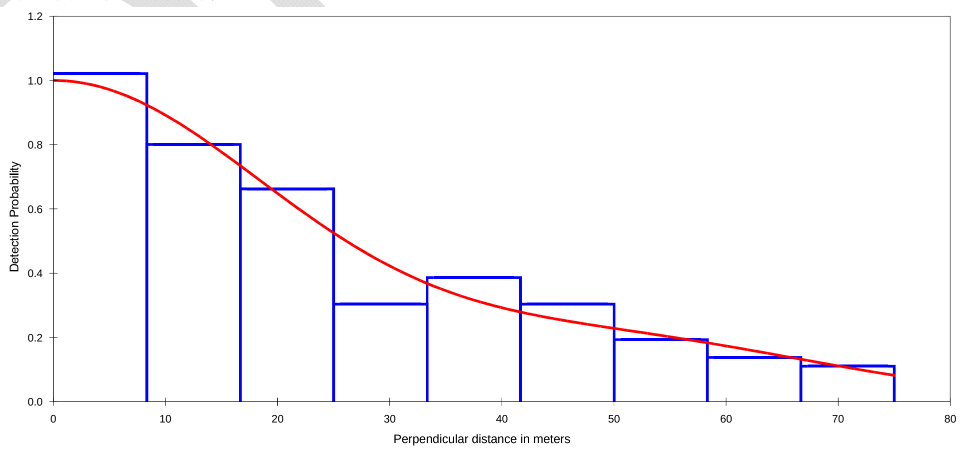
a. No truncation of the data.



b. Truncation at 250 meters.



c. Truncation at 75 meters.



4. After determining a suitable truncation point the data were then examined to determine if grouping the data into intervals provided a better model fit to the data (9 equal intervals were used). At this point all model definitions were evaluated and a final model was selected using Akaikes Information Criterion (AIC).

Assumptions for line transect surveys

It is important to review and understand the assumptions necessary in order to obtain an unbiased estimate of the true population size. Ensuring that all members of the monitoring effort are aware of and understand the assumptions is a critical but often overlooked exercise. This is particularly important when a question or an uncertainty arises while in the field and a decision for how to proceed is needed; if the field team understands the assumptions, it is more likely that a solution can be found that does not compromise these assumptions. The assumptions for line transects using distance sampling methodology are outlined as follows (further details can be found in Buckland et al. [2001]).

The lines are located in a random fashion relative to the objects of interest within the study area. Within the study area, transects must be randomly placed. Lines cannot be located to ensure that a marmot colony is counted or that a transect is placed within an area known to have lots of marmots. If the distribution of marmots is known to be clumped then the survey design can be stratified to more intensively sample high density regions, but this requires that the distribution of marmots be well mapped.

All measurements are recorded with accuracy and not influenced by observer or equipment bias. All observations must be recorded in the same fashion, estimation of distances, or using paces instead of a rangefinder could result in erroneous measurements and bias the result. Compass measurements must be taken so that metal is not influencing the needle (proximity to vehicles, binoculars hanging from ones neck etc…).

The sample area is representative of the population of interest.

All objects of interest are correctly identified. Identifying an active burrow cluster from an inactive cluster can be difficult, even when using qualified criteria. For example, field observers must be able to distinguish an active marmot burrow cluster from a badger or corsac fox den.

All objects on the line are detected accurately. This is a critical assumption that MUST be met. Failure to detect objects on the line will result in a modeled density at g(0) that is biased low and falsely recording objects that appear to be on the center line will result in a modeled g(0) that is too high. This may be obvious and seemingly easy assumption to meet, but when carrying out surveys from a vehicle there may be a tendency to focus on the path in front of the observer to be ready for a jolting bump or to look out the side window nearly perpendicular to the vehicle. Observers must consistently scan the path of the vehicle from side to side.

Objects are detected at their initial observation. For burrow clusters, this is a relatively easy assumption to meet. However care must be taken to ensure that the center of the burrow cluster is properly identified.

If the assumptions are met then the detection model will resemble the true conditions and an accurate estimate can be assumed. However, conditions in the field may be such that assumptions cannot be met or observer behavior may change during the course of a survey. For example observer fatigue may influence detection of burrow cluster at the end of a long transect, an observer may not be fully engaged in observation at the start of a transect, or anticipate burrow clusters due to prior knowledge and thus focus more closely during certain times of the field work. It must be noted that there will be no perfect data set but with care and attention to the assumptions, it can be assumed that the results will produce a best estimate of reality.

Image 17. An active burrow cluster with a clear trail connecting two burrows.

Line transect sampling results

From 12 to 25 July we drove along 13 transects totaling 356 km's recording 176 active burrow clusters (Figure 1). Prior to truncation for distance analysis, active burrow clusters had a mean of 2.5±1.9 SD active burrows (Max = 11) and 0.5±1.0 SD inactive burrows (Max = 6). A total of 142 burrow cluster observations were used in the final model development (80% of all observations).

Burrow cluster encounter rate (burrow clusters observed per kilometer driven or [n/L]) was 0.399±0.23% CV. Winters (2010) recorded encounter rates of 2.2 active colonies (ie. burrow clusters) per kilometer in a region of Tosonkhulstai considered to have high marmot densities. The density of active burrow clusters for Tosonkhulstai was 6.1 burrow clusters/km^2 and extrapolating to a total population of 28,041 (95% CI 16,549 – 47,349) active burrow clusters (Table 1). Using Winters (2010) results of 1.71 marmots/burrow cluster the population size of marmots in Tosonkhulstai is around 48,000 individuals.

Image 18. A young marmot at its burrow entrance, on the lookout for danger.

Table 1. Population statistics estimated from line transect surveys and extrapolation to the number of marmots from scan sampling results reported by Winters (2010).

Parameter	Point Estimate	SE	% CV	95% Conf. Interval
DS	6.1	1.5	25	3.6 – 10.3
E(S)	2.32	0.15	6	2.04 – 2.63
D (S)	14.1	3.7	26	8.3 – 24.1
N (Burrow clusters)	28,041			16,549 – 47,349
N (Marmots)*	47,951			28,298 – 80,966

DS: Estimate of density of burrow clusters/km
E(S) Average number of active burrows/burrow cluster
D(S) Estimate total number of active marmot burrows
* Derived from Winters (2010) estimation of 1.71 marmots/cluster

A 26% CV is large, thus it will be difficult to detect population changes. Based on this first survey the encounter rate (n/L) can be used to estimate the length of transect that would be necessary for an estimate with 10% CV (Buckland et al. 2001). For planning purposes it is recommended that the value of 'b' be 3 and thus the formula is as follows:

$$\mathrm{L} = \left(\frac{b}{(CV_i\,(\hat{D}))^2)}\right)\left(\frac{L_0}{n_0}\right)$$

Thus based on an L_0= 356 km's driven and a total of n_0 = 142 observations in order for an estimate of burrow clusters to have a 10% CV future surveys would have to have at least L = 752 km's of transects driven. This is roughly two times the length of the current survey and a realistic survey effort to undertake. This would be equivalent to driving a transect every 4.25 kilometers rather than the 9.5 kilometers widths for this survey. As a better understanding of how marmots are distributed throughout Tosonkhulstai, effort can be stratified to survey high and low density marmot regions.

Image 19. An active and easy to detect marmot burrow.

Surveys in 2011 should focus on expanding the 2010 survey by doubling the effort and drive transects at 4.5 km intervals and extending the endpoints to the boundaries of the reserve. Additionally, at least one survey should be conducted along an east-west axis at 4.5 km intervals to better define the distribution of marmots for area sampling. These three surveys should all have similar results, with the % CV reduced. At that point, survey frequency can be decided upon based on the level/proportion of change TNC and ESPAA are interested in detecting.   Additionally, once marmot distribution is better mapped, it will be possible to re-evaluate the placement of the transect lines to place more effort in high marmot abundance regions.

As the TNC assistant field biologist is more comfortable with the survey methodology and assumptions employing rangers to assist in data collection is one option. One issue to overcome is whether a ranger can follow the assumptions in line transect sampling while attempting to ride a motorcycle and stay on the transect centerline. At this point, it may be more feasible to use rangers to assist in gathering data related to marmot distribution. One possibility is that while a team is conducting line transects for distance sampling by vehicle the rangers can be driving parallel but randomly located line transects to record marmot burrow cluster locations.

Image 20. A male Mongolian gazelle (*Procapra gutturosa*) carcass contributing to the nutrient cycle.

Quadrat sampling

Sampling in 75 x 75 meter plots.

Quadrat sampling for marmot burrow clusters with 75 x 75 meter plots was conducted in areas where concentrations of marmots was believed to be high. After completion of the line transect surveys we deliniated regions where burrow clusters were frequently observed and sampled burrow clusters in 75 x 75 meter plots.

Using a sighting compass (Suunto Vista KB-20) and a laser rangefinder (Bushnell Elite 1500) a spotter directed two observers to the remaining three corners of the qudrat. After each corner was marked with flagging, the spotters walked through the quadrat searching for burrows. Active burrows were determined by looking for features associated with marmot presence such as scat, tracks, fresh digging, live marmot; and inactivity such as spider webs over the entrance, eroded soil, or clogged with old vegetation.

The analysis presented here closely follows the steps outlined by Norton-Griffiths (1973) and Norton-Griffiths (1978). The sample design and application differs in that the data is derived from sub-sampled quadrats along systematically spaced ground transects rather than randomly selected transects flown over a concentration of animals whose location was determined a-priori. Here we replace systematic aerial photos along the transects with equal sized quadrats with burrow clusters counted by walking through the plot.

We assessed active burrows as to whether they were part of a larger burrow cluster. We located the geographic center of the burrow cluster by locating the intersection of the midpoint of the two furthest burrows and again the two furthest burrows along perpendicular to this axis. If the geometric center of the burrow cluster was inside the quadrat, it was counted. Once an active burrow cluster was identified, both active and inactive burrows within the cluster were counted as such.

Image 21. Camping while conducting quadrat surveys.

After driving line transects, we identified a total of 665 square kilometers for more intensive 75 x 75 meter quadrat sampling at 2 km intervals (Figure 2). Developing a population estimate is outlined below.

The north south length of each sampled quadrat is calculated and divided by the length of each quadrat (75 meters) to give the total number quadrats that could potentially be sampled (z_t) (Future efforts should sample along randomly selected transects withing marmot areas, however marmot distribution needs to be better developed before this is practical). To calculate the total number of transects that could be possibly driven (N) divide the length of the sample area by 75 meters. This resulted in a total of 746 transects of which we selected quadrats along systematically spaced transects at 2 km intervals for a total of n = 31 (Z_t). Along the sampled transects, a total of 245 quadrats ($\bar{z}_t$) were sub-sampled.

Following the procedure for drawing the quadrat boundaries and then counting burrow clusters outlined above, we tallied 23 active burrow clusters (Y_t), (Table 2) within these plots.

Figure 5. Location of 75 x 75 meter quadrat sampling.

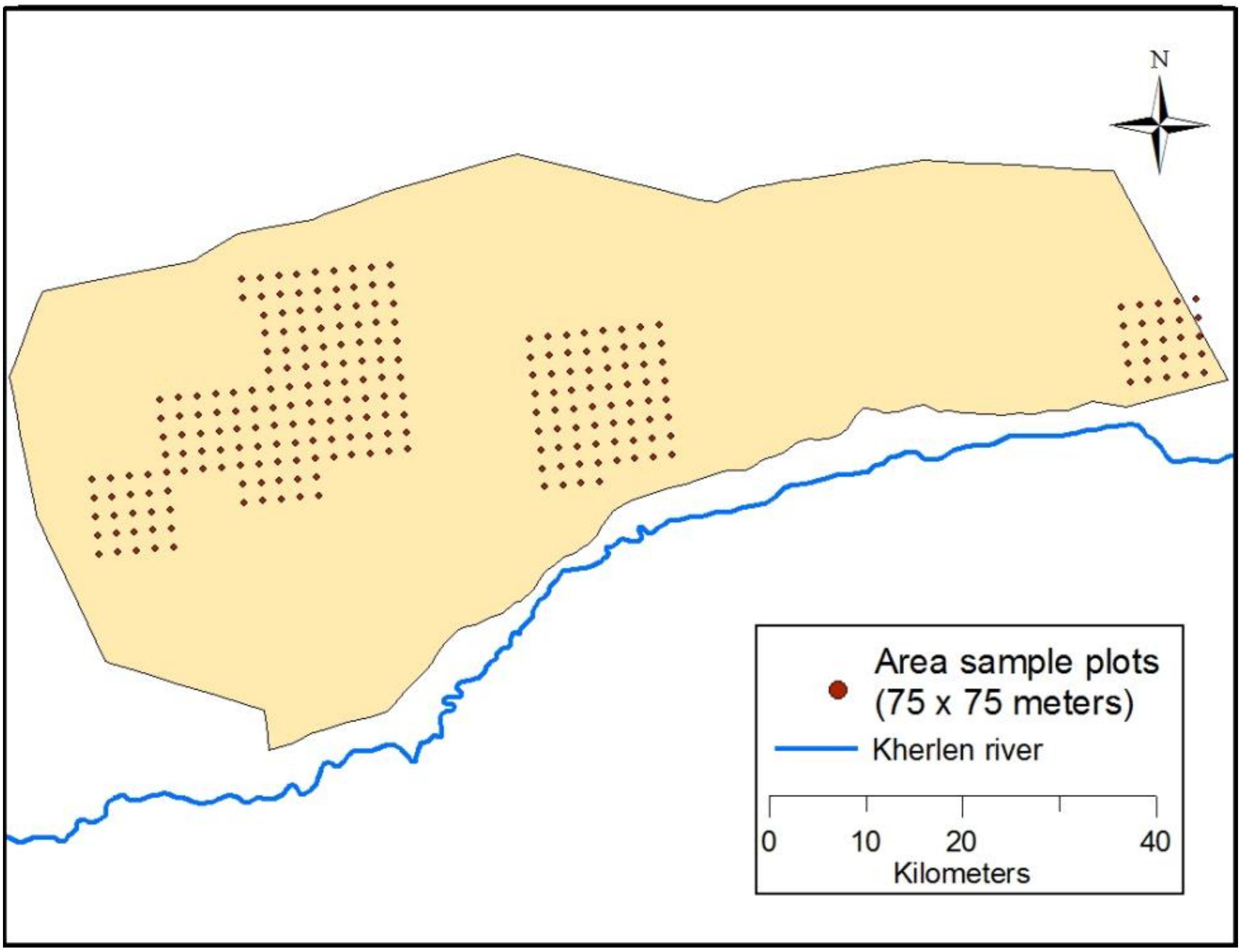


Table 3. Quadrat data from 75 x 75 meter quadrat sampling in known marmot areas.

Transect No.	Plots Z_t	Burrow clusters counted y_t	Possible No. plots $\bar{Z}_t$	Transect estimate $\underline{Y}_t$	Burrow density per plot $\bar{d}_t$
1	3	0	53	0	0
2	5	1	107	21	0.2
3	5	0	107	0	0
4	5	0	107	0	0
5	5	0	107	0	0
6	8	0	187	0	0
7	8	3	187	70	0.38
8	8	1	187	23	0.13
9	8	0	187	0	0
10	9	0	213	0	0
11	9	1	213	24	0.11
12	9	2	213	47	0.22
13	9	0	213	0	0
14	11	0	267	0	0
15	11	0	267	0	0
16	11	2	267	49	0.18
17	11	4	267	97	0.36
18	11	2	267	49	0.18
19	12	0	320	0	0
20	12	6	320	160	0.5
21	12	0	320	0	0
22	8	0	187	0	0
23	6	0	160	0	0
24	5	0	107	0	0
25	5	0	107	0	0
26	5	0	107	0	0
27	9	0	213	0	0
28	5	1	107	21	0.2
29	5	0	107	0	0
30	5	0	107	0	0
31	5	0	107	0	0

The average number of burrow clusters per quadrat (d_t) is simply calculated by dividing the number of plots surveyed in each transect by the total number of clusters identified. The number of marmots estimated for each transect is calculated by multiplying the average number of burrow clusters/quadrat by the total number of quadrats that could be sampled (Y_t).

$$(\mathbf{Z_t} * \bar{d}_t = \mathbf{Y_t})$$

A population total can then be calculated using this equation (Table 3):

$$\mathbf{Y = N} * \bar{y}_t$$

Where $\bar{y}_t$ represents the average of the transect estimates.

$$(\bar{y}_t = \frac{\sum \mathbf{Yt}}{\boldsymbol{n}})$$

Population variance can then calculated by: $\mathbf{Var\ (Y)} = \frac{\mathbf{N(N-n)}}{\mathbf{n}} * \boldsymbol{s}^2\mathbf{Y_t}$

where: $$\boldsymbol{s}^2\mathbf{Y_t} = \frac{\mathbf{1}}{\mathbf{n-1}}\left(\sum \mathbf{Y_t}^2 - \frac{(\sum \mathbf{Y_t})^2}{\mathbf{n}}\right)$$

Population standard error is: $\mathbf{SE(Y)} = \sqrt{\mathbf{Var\ (Y)}}$

and 95% confidence limits of $\mathbf{Y = Y \pm 1.96 * SE(Y)}$

Table 4. Results from quadrat sampling in areas in Tosonkhulstai Nature Reserve believed to have high concentrations of marmot burrow clusters. Population total here refers to estimate number of active burrow clusters.

Population total	Y	13,428
Population variance	Var(Y)	1,279
Standard error	SE(Y)	4,691
95% Confidence limits of	(Y)	±9,195
95% Confidence limits as % of (Y)		±68%
Density (burrow clusters/km^2)		20

The area sampling survey results are comparable to Winters (2010) density estimates of 24 burrow clusters/km^2 for an overlapping region of these surveys. The estimate of 13,428 burrow clusters comprises slightly less than half the overall estimate of 28,041 from line transect surveys throughout the entire reserve.

Our survey region was a rough estimate from observations during line transects and a large proportion of our quadrats had no burrow clusters. This is why there are wide confidence intervals. Increasing the area sampled at each quadrat will have the effect of reducing the variation in the estimate. However this needs to be carefully assessed as to the ability of the observers to accurately detect all burrow clusters in this area. A larger area will require more time to walk through and the chance of missing a burrow cluster will increase. The frequency at which quadrats are sampled would also help minimize variation. Likely the best way to reduce variation is to limit the sample area to known marmot distribution areas. Development of a better understanding of how marmots are distributed throughout Tosonkhulstai is necessary to do this. Future quadrat surveys should be able to incorporate some aspect of the three suggestions.

Comparison between quadrat sampling and line transect sampling results.

There was consistency between the assignment of active burrows to a single burrow cluster between both line transect survey and quadrat sampling ($P = 0.49$), and likewise for the number of inactive burrows assigned to active burrow clusters during each survey ($P = 0.29$) (Table 4). The mean number of active burrows/cluster was slightly higher than Winters (2010) and likely due to our modification of the criteria by Townsend (2006) in which we included active burrows greater than 15 meters apart if there was direct evidence of a runway between the two. It may simply be the result of the timing of the survey conducted by Winters (2010) and this survey in that regular maintenance of and creation of new burrows as young marmots mature may have been taking place between April and July.

Table 5. Composition of active burrow clusters (N = 23) observed within 75x75 meter plots sampled in a 665 square kilometer area in Tosonkhulstai NR.

	Quadrat		Line Transects	
	Active	Inactive	Active	Inactive
Mean	2.26	0.74	2.32	0.46
SD	1.63	0.96	1.89	0.95
SE	0.34	0.20	0.15	0.08
Range	1 – 6	0 – 3	1 – 11	0 – 6

Burrow cluster density estimates from quadrat sampling (20/km) are comparable with Winters (2010) estimates (24.4/km). The mean number of burrows per cluster was slightly higher for both line transects and quadrat sampling compared to Winters (2010); while our survey area was approximately twice the size for quadrat sampling and our rough estimation of marmot regions included broad regions where there were no marmot burrow clusters.

Quadrat sampling is not an efficient method for estimating the population size of marmots for the entire reserve and may be a more practical and simpler way to estimate burrow cluster numbers once the distribution of marmot clusters is better known from other methods such as driving line transects. However quadrat sampling offers simplicity in design, conduct, and analysis which may be a more attractive option when using rangers or other field observers. Additionally, quadrats with active burrow clusters can be monitored for burrow cluster longevity.

Using rangers to help conduct quadrat sampling would be easy to implement and practical use of their time. Quadrat locations can be pre-determined and teams of rangers can visit a number of quadrats simultaneously and record the number of burrow clusters within the particular quadrat. This method is technically easier to implement than a distance sampling protocol. However, training is still an important activity and care must be taken to ensure that the rangers are provided training so that the data can be collected consistently.

A combination of using line transect burrow cluster locations and rangers charged with recording active marmot burrow cluster locations within their region of responsibility would help better refine marmot range within the reserve and make area sampling more efficient.

Image 22. Carrion beetles (*Nicrophorus sp*.) consuming the mixture of rotted eggs and fish used as bait. The American burrying beetle (*Nicrophorus americanus*) is endangered, partly due to habitat fragmentation.

FUTURE CONSIDERATIONS

The cooperation between Tosonkhulstai rangers and conservation NGO's creates numerous opportunities to better protect wildlife and to better understand the effectiveness of that effort. There are numerous considerations and challenges that need to be addressed before a fully functional monitoring program can be achieved but this initial effort is a step in the right direction.

Greater attention to cataloguing and mapping how biodiversity is distributed within Tosonkhulstai would help improve the overall importance of Tosonkhulstai as a biological refugia for the entire Eastern Steppe Ecosystem. It would be important to know if the species richness of Tosonkhulstai is greater than other similar sized area of the steppe. Monitoring the occurrence of these species could be used as a gauge for the overall health of the reserve.

The importance of monitoring of the threats to Tosonkhulstai must not be overlooked. There are a number of illegal activities ongoing inside the borders. Most of these are visually recorded and passed along as verbal complaints about the difficulties of protecting the reserve. This information would help justify further conservation efforts and perhaps provide arguments for additional support to eliminate these activities. For example, in the northwest region of Tosonkhulstai, ninja gold miners dump and wash tailings into the alkaline ponds, recording which ponds have been contaminated needs to take place. Other activities taking place within the reserve that are not appropriate such as industrial hay cutting for profit and its use as a race horse grazing area.

Tosonkhulstai has many small isolated pockets of freshwater habitat important for a number of species. These locations are generally known to exist, but they are not well documented. Many of these experience some level of livestock grazing and this threatens to reduce their effectiveness as a reserve for the species that depend on their existence.

If there is a desire to compare the effectiveness of the protected areas concept using these monitoring guidelines, regions outside of Tosonkhulstai can be monitored as well. This would simply require selecting a similar sized (or several smaller regions, but with a total similar area) region as Tosonkhulstai that is not included under any protected area status other than Mongolian laws on wildlife and environment. A protected area of similar size that is not receiving outside funding assistance for conservation efforts could be evaluated to assess need in other regions. The comparison between the three regions would be interesting.

Most of the analysis used for this work was carried out using the software program Distance and Microsoft Excel. However basic descriptive statics were created using the statistical software Minitab ver 15. The TNC assistant field biologist does not have access to statistical software. Distance software is freely available and has been installed on one office computer. It would be a worthwhile investment for TNC to obtain a software package that is easy to use and cost effective for TNC reporting activities.

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Appendices

Appendix I. Training course in statistics and field methodology

Appendix II. Track impression photos

Appencix III. Presntation of findings