



Reduced grazing impacts on vegetation communities in southern Siberian taiga
by Temuulen Tsagaan

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Land Resources and Environmental Sciences

Montana State University

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Abstract:

Dukha people, the reindeer herders in northern Mongolia, on the southern edge of the Siberian taiga, are natives of Tuva, a former Soviet Republic. They used to freely migrate across the Russian-Mongolian border, but were no longer allowed to migrate across the border after they were accepted as Mongolian citizens in the 1950s. Since Mongolia's livestock privatization in the 1990s, they now own their herds and have had no more access to social and financial support, which has further reduced the migrating distances. Only a few campsites from where they can easily access urban areas and other income resources have been used. Increased consumption of reindeer meat and hunting pressure has also decreased both the domestic reindeer and wild ungulate populations. Consequently, this region of the West Taiga has lacked grazing and browsing impact. Ground cover of shrubs has increased while percent cover of graminoids, forbs and lichens has decreased.

To effectively detect changes in the vegetation, two sites that have been grazed for 15 and 28 years and two sites that have not been grazed for 17 and 25 years were * selected. Transects were established starting at the campcenters and extending in the directions of reindeer grazing. Up to four sampling zones (valley bottom, hillside or terrace, forested upper sideslope, and ridgeline) were established within each transect. One large rope hoop (size 13.45 m²) with a small hoop (size 0.08 m²) nested inside was placed every 300 paces to document total number of species present, percent ground cover of shrubs, forbs, graminoids, lichens, bare ground and litter, shrub height, percent leaves on shrubs and green biomass. A simplified soil profile was described in each hoop. An apparent trend survey sheet was completed for each hoop.

Valley bottoms, hillsides and ridgelines at grazed sites had less ground cover of shrubs than at ungrazed sites. Ungrazed sites had taller, but less vigorous shrubs with less green biomass compared to grazed sites. Grazed sites also had more plant species than ungrazed sites. Increased percent shrub cover at ungrazed sites reduced percent cover and accessibility of graminoids, forbs and lichens.

Reindeer grazing and browsing need to be more evenly distributed throughout the taiga. Currently grazed sites need to be rested to recover their lichen mats, while ungrazed sites should be utilized to improve plant vigor and better balance the species in the plant communities.

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APPROVAL

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This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency and is ready for submission to the College of Graduate Studies.

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Abstract

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INTRODUCTION

Mongolia is a landlocked country in north central Asia. It borders Russia (the Siberian Republics of Tuva and Buriatia) on the north, Khazakhstan on the west and China on the south (Figure 1). The northernmost point is at 52°6' and the southernmost at 41°31' Northern Latitude (Hilbig, 1995). Mongolia's territory covers 1,565,000 sq. kilometers with a population density of approximately 1 sq. kilometer per capita, which is not evenly distributed. More than one third of the population of 2.3 million live in Ulaanbaatar, the capital city.

Mongolia has 21 provinces, called aimags. The capital, Ulaanbaatar, and other major cities each form their own aimag. Each aimag consists of 12 to 24 smaller administrative units, called soums (Hilbig, 1995). Each soum encompasses a large land area, but each has a central economic and administrative urban center. In addition, there are small sub-units of the soums, called baags.

Ecologically, Mongolia is divided into six basic natural zones, differing in climate, landscape, soil, flora and fauna. They are high mountain, taiga forest, mountain forest steppe, steppe, desert steppe and desert zones (Finch, 1996). Mongolia has a sharply continental climate, with long, cold, dry winters and brief, mild and relatively wet summers. When Arctic air masses dominate in mid-winter, temperatures average -20 to -35°C. In the coldest part of the country, the lowest temperature recorded was -58°C. By contrast, summer temperatures in the Gobi Desert climb as high as 40°C. Annual

precipitation ranges from 600 mm in the northern mountain regions to less than 100 mm in the Gobi (Finch, 1996).

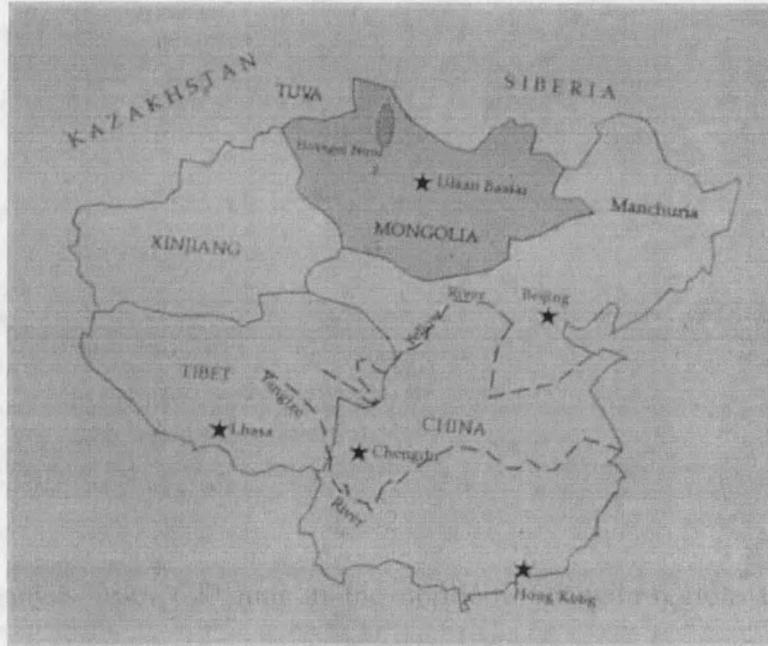


Figure 1. Central Asia

Mongolia's taiga zone, where this study was conducted, includes the southern edge of Siberia's vast taiga forest, the largest continuous forest system on earth. Taiga is a boreal coniferous forest, comprised in Mongolia primarily, of Siberian larch (*Larix sibirica*) (70%), and at higher elevations, Siberian pine (*Pinus sibirica*). The forests are rich in mosses and lichens. The taiga zone occurs only in northern Mongolia and covers about 5% of Mongolia's territory. It experiences more precipitation (300-400 mm annually) and lower temperatures than most of Mongolia, with cold, snowy winters and cool, rainy summers (Finch, 1996).

Mongolia was a socialist country with a centrally planned economy from the 1920s until the early 1990s. In 1990, Mongolia began its conversion to a democratic government and market economy and is still undergoing major political, social and economic change. At the start of the transition, all manufacturing plants and factories were privatized along with all domestic animals. However, all natural resources, including land and land resources, have remained as public property with an exception of homesites. There is no private land ownership, which allows all herders to practice their traditional nomadic herding lifestyle. They herd sheep, goats, camels, horses, cattle and yaks.

In the northern tip of Mongolia, where it reaches furthest into the Siberian taiga, there are approximately 30 households (Wheeler 1999) who herd domestic reindeer (*Rangifer tarandus*). They are called Tsaatan or "reindeer herder" in Mongolian, or Dukha as the people refer to themselves. They live in teepees and are the most nomadic of all herders in Mongolia. Because their nomadic movements are largely determined by the need to pasture the reindeer in specific areas with sufficient lichens and by the availability of wild game to hunt, they have been known to travel great distances, often without concern for the borders of a particular soum or nation (Wheeler, 1999). They are natives of Tuva, a republic of the Russian Federation in south-central Siberia, which borders Mongolia to the north (Figure 1). Tuva "was incorporated into the Soviet Union in 1944, the final addition to the Soviet territory. Prior to that, Tuva was, nominally, an independent state, the Tuva People's Republic (1921-1944). This state, however, was

...controlled by the Soviet Union with the intention of separating the Tuvan territory from Mongolia so that it could be more easily absorbed by the Soviet Union later on, which is exactly what happened in 1944" (Donahoe, 1998). The Tuvans have a long history as nomadic pastoralists. Many scholars have hypothesized that reindeer were first domesticated in this area of southern Siberia, and that this may have been the earliest domestication of livestock anywhere in the world (Donahoe, 1998). Currently, Tuva has a territory of 170,500 sq. kilometers and a population of 308,000.

Until 1911, "Tuva was considered a part of Outer Mongolia. During this time, the Tsaatan had the freedom to migrate within the area which is now divided by the international border of Russia and Mongolia. So, before the various revolutions, the reindeer people were more appropriately citizens of the taiga. In 1926-27, however, the border was more firmly established, marking the beginning of several attempts by the Mongolian Government to relocate the Tsaatan to their "home" in Tuva, where they waited for a season or two and then moved back to northern Mongolia. ...In 1956, after finally realizing that the Tsaatan considered Mongolia their home, the Mongolian Government granted the Tsaatan Mongolian citizenship and gave them citizen passports" (Wheeler, 1999). In northern Mongolia, the reindeer herders historically lived their nomadic lifestyle in Ulaan Uul and Renchinlumbe Souns of Khuvsgul Aimag. In 1985, the Mongolian parliament resolved to consolidate all Tsaatan and their reindeer both from Ulaan Uul and Renchinlumbe Souns into one new soum, called Tsagaan Nuur (Wheeler, 1999). Although the 30 reindeer-herding families present a fairly homogeneous group, they are divided into two different groups by location, history and dialect

(Wheeler, 1999). Fourteen of the households live in the East Taiga to the north of Shishkhed River and 16 households live in the West Taiga to the south of this river, but both are within the Tsagaan Nuur Soum. This study covered areas of the West Taiga only.

The reindeer population in Renchinlumbe and Ulaan-Uul Soums remained at about 1000 in the 1960s and 1970s. However, by the time "Tsagaan Nuur Hunting and Reindeer Breeding State Farm" was established in the following decade to promote hunting and herding for the Tsaatan, the population had declined to 594 owing to inadequate number of herders, low price for reindeer products, and the poor health due to inbreeding. In 1991, due to better veterinary care and herding staff support by the government, the population increased 170%, peaking at around 1030 (Dashdorj, 1992). This population growth continued until 1992 when the herd size reached 1200. During these decades, reindeer were, and still are, used for transportation, milk and meat, but the velvet antler harvest has been the major use since 1978 (Dashdorj, 1996).

During Mongolia's transition into a market economy, the state farm was decollectivized and reindeer were privatized like all other livestock species in the country. With the private ownership of reindeer, everything changed for the Tsaatan. The government subsidies were no longer available for the herders or the herd. The herders now have neither salaries nor other income sources, except for the velvet antlers. The once-a-year velvet antler harvest has not been enough to pay for household expenses. Owing to this reduced income, their food resources have become extremely limited. Consequently, they have been consuming their reindeer. This increased consumption,

coupled with poor veterinary care, has led to a sharp decline in the herd size. The current reindeer population fluctuates around 300 and is in poor health. The closure of the international border has eliminated access to new animals. This has resulted in inbreeding, which is one of the causes of the herd's poor health. Cutting the velvet antlers has also contributed to decreased health by making the animals more susceptible to infections, diseases and parasites (Wheeler, 1999. Personal communication, 1999 and 2000).

As the herd size declines, the population of active reindeer herders is also decreasing. When a household consumes all of their reindeer, their only income resource besides relatively small and sporadic income from selling and trading handicrafts and from occasional outright gifts, they have to move down to lower elevations to herd other animals or to urban towns to find jobs. Harsh climate and poorly drained, rugged topography in the taiga do not allow herders to have other species of domestic animals, such as cattle or sheep. Preferred reindeer rangelands are often in the remote, high mountains that are at least a day or two horseback ride from any urban centers. The only means of arriving at these camps is by horseback or on foot, rigorous by both means. These factors provide limited options of livelihood for the herders. The number of households is decreasing every year. If this situation remains the same, the reindeer-herding culture of the Tsaatan, the world's southern most nomadic reindeer herders, will likely disappear. This extinction would be a loss to the diversity of world culture. There are some Mongolian and international organizations, such as the Mongolian Reindeer

Fund and the Red Cross, which are working to save this unique culture by bringing in new reindeer herds from Tuva to refresh the genetic pool.

Reindeer herders have, historically, been hunters and gatherers (Wheeler, 1999). The Siberian taiga ecosystem sustains wildlife populations of roe deer (*Capreolus pygargus*), moose (*Alces alces*), musk deer (*Moschus moschiferus*), caribou¹ (*Rangifer tarandus*), ibex (*Capra sibirica*), brown bear (*Ursus arctos*), wolf (*Canis lupus*), sable (*Martes zibellina*), Eurasian river otter (*Lutra lutra*), and others (Dashdondov, 1990). However, to reduce reindeer consumption, the reindeer people have heavily hunted the wild animals in this region. As a result, most of the wild ungulates have left this area and migrated to Russia (Personal interviews, 1998, 1999, 2000). Now few wild animals or game species are found in this region (personal interviews and observation, Appendix A).

Due to decreased populations of domestic reindeer and wild ungulates, a majority of this vast mountain range has lacked grazing and browsing² utilization for at least the past decade. The remaining few herders have been using a few preferred campsites more often and for longer periods of time. These campsites are relatively close to urban towns, providing opportunity for trade and income from tourism. While these few areas are being heavily grazed and browsed, the rest of the region has been rested.

¹ Caribou are wild, whereas reindeer refers to domestic animals, even though they are the same species.

² Grazing refers to graminoids and forbs, while browsing refers to shrubs.

Problem Statement

According to some reindeer herders, most mountain valleys and campsites were previously dominated by grasses and forbs (personal interviews, 1998-2000). However, they now are largely covered with shrubs, which has caused problems: 1) some of the old campsites are now not utilized because the camping space is covered with shrubs, which makes them even less desirable, and 2) some of the other desirable forage species, such as lichens and forbs, have been replaced by shrubs.

Literature Review

Mongolia's vegetation includes more than 3000 species of vascular plants, 927 lichens, 437 mosses, 875 fungi and numerous algae (Finch, 1996). Common tree species in the taiga zone of Mongolia include *Larix sibirica*, *Pinus sibirica*, *Picea ovobata* and *Pinus sylvestris*, although *Larix sibirica* dominates. Dominant shrub species are *Juniperus pseudosabina*, *Betula platyphylla*, *Betula rotundifolia*, *Betula berberis*, *Salix glauca* and *Salix divaricata* with understories of *Vaccinium vitis-idaea*, *Rhododendron ledebouri*, *Pedicularis flava*, *Ranunculus altaicus*, *Potentilla gelida*, *Bergenia crassifolia*, *Pyrola rotundifolia* and *Cladonia rangiferena* (Finch, 1996).

Caribou/reindeer consume lichens throughout the year, although this forage loses its importance in summer, when dwarf birch represents the key summer food (Crete and Doucet, 1998). Willows and various forbs also are prominent in reindeer diets in the spring and early summer (personal interviews, 1999).

Many studies have simulated browsing on deciduous shrubs. Crete and Doucet (1998) studied the effects of heavy browsing by caribou on deciduous shrubs. They surveyed and compared five heavily browsed and two lightly browsed birch stands. The leaf/wood ratio and the percent dry weight of leaves were higher in lightly browsed than in heavily browsed stands. Leaf biomass was twice as high in lightly browsed versus heavily browsed areas.

Manseau et al. (1996) also studied effects of summer grazing by caribou during the grazing season on vegetation composition and productivity. In stands of dwarf birch repeatedly used by caribou, leaf biomass and ground cover were significantly lower than in unused sites. Leaf biomass in used sites was 20.5 g/m² compared to 57.2 g/m² in unused sites. They concluded that heavy browsing reduced annual forage productivity by more than 50%.

Leaf stripping and bud ablation in summer negatively affect most deciduous shrubs (Crete and Doucet, 1998). Ouellet et al. (1994) showed that *Salix* also represents an important component of caribou summer diets and is negatively affected by clipping. Intense ungulate herbivory can lead to willow decline in which suppressed willows produce one-third to one-fourth the aboveground biomass than taller willows (Singer et al., 1994). Heavy browsing impacted seed production, because catkins are produced only on shoots that were not browsed the previous year (Singer et al., 1994). Moreover, Kay and Chadde (1997) measured seed production inside and outside willow exclosures and found that protected willows produced, on average, 306,000 seeds per sq. meter, while

plants outside produced none (Kay, 1997). Given the browsing impact on biomass and seed production, willows are expected to decrease in abundance as the caribou population increases.

Archer and Tieszen (1980) and Chapin (1980) analyzed the impact of browsing and grazing on some plant species in Alaska. Both of these studies concluded that plants grazed and browsed by caribou in Alaska had increased nutrient concentrations. Stark et al. (2000) studied reindeer grazing effects in Finnish Lapland and found that net nitrogen of plants was increased by grazing.

Ouellet et al. (1994) also simulated grazing and browsing of vegetation available to caribou in the Arctic. Their study showed that grazing generally reduced plant net production. However, it positively modified chemical composition of shrubs and sedges and enhanced forage quality. They found that willows and sedges had lower levels of cellulose and lignin and higher concentrations of nitrogen, potassium and phosphorus than control plants. Enhancement of forage quality by browsing and grazing may favor herbivores that reselect these plants later in the summer (Ouellet et al., 1994).

Plant quality is likely to have a major effect on the diet of caribou (Ouellet et al., 1994). A winter diet high in lichens puts caribou in a negative phosphorus balance. It may also create a negative nitrogen balance in these animals. Caribou have to replenish phosphorus and nitrogen during the growing season. Therefore, preference and digestibility of caribou summer foods are positively correlated with nitrogen and phosphorus levels and negatively with fiber content (Chapin et al., 1986).

If plants respond to grazing and browsing by compensatory growth or by positive changes in nutrient levels, caribou may adopt a strategy of returning to plants that have been browsed previously (Ouellet et al., 1994). This is consistent with Singer et al.'s (1994) conclusion that heavily browsed willows produced lower amounts of chemical defense compounds, resulting in a higher preference by ungulates. This may suggest that previously used sites can be preferred over rested areas.

Although rest may improve plant vigor, it decreases forage palatability, intake, digestibility and digestion rate due to increased ADF (acid detergent fiber residue) and NDF (neutral detergent fiber residue) (Launchbaugh et al., 1978). Chapin et al. (1986) examined seasonal patterns of carbohydrate, lipid, cellulose, hemicellulose and lignin in deciduous shrubs, tussock graminoids, mosses and lichens. They found that cellulose content of deciduous shrub leaves and stems increased with age. They also had less ADF and NDF early in the season. This is possibly why wild ungulates migrate from low elevations to higher elevations as the growing season progresses (Albon and Langvatn, 1992). Migrating animals prolong their access to preferred high protein and low fiber species by travelling to higher elevations or latitudes, where the same plant species are in their earlier phenological stages due to later snow melt. This may mean that moving the camp more often during the growing season would benefit the herd.

Chapin (1986) studied nutrient allocation in tundra growth forms, deciduous shrubs, graminoids, and herbivory impact on these nutrients. He suggested that tundra plants invest a large proportion of their total nutrient capital in leaves. His results showed

that deciduous shrubs, willows and birch, have high nutrient concentrations in their leaves following snowmelt and can rapidly translocate nutrients into new growth. They are most vulnerable to herbivores at this time.

Graminoids, in contrast, possess large below ground nutrient reserves and are able to rapidly produce new shoots in response to repeated defoliation (Chapin, 1986). Graminoids in the tundra have their tillers in the lichen and moss layer, so that they do not require apical meristem regrowth after defoliation (Chapin et al., 1986, Bell and Bliss, 1980). This makes them tolerant of grazing throughout the growing season, unless defoliation is so severe and/or too frequent that it removes the tillers or the lichen layer is overgrazed.

Heavy grazing by reindeer reduces the lichen mat (Ouellet et al., 1994). Manseau et al. (1996) showed that annual productivity of lichens at heavily grazed sites was only 6% of that of ungrazed sites. The lichen mat was also absent in grazed sites. Ground that was previously lichen-covered was either bare or covered with fragments of dead lichens, mosses or early successional lichens.

Grazers in tundra plant communities maintain relatively high plant species diversity and prevent any of the plant species from gaining a high dominance (Virtanen, 2000). However, because individual plants are not completely consumed when grazed, differences among species in their response to herbivory in terms of survivorship, growth, reproduction and competitive ability can be a critical determinant of community changes (Augustine and McNaughton, 1998). Encroachment of shrub species is expected to decrease ground cover of lichens due to their low shade tolerance (Topham, 1974).

Foraging selectivity can be another important driver of community change in all systems (Augustine and McNaughton, 1998). Preferred species have to cope with a much more competitive environment and recover more slowly, when surrounding plants are not grazed (Caldwell, 1984). Changes in tundra species composition due to intensive herbivory by caribou appear to be the result of differential tolerances to tissue loss among species. Therefore, slow growing lichens decline dramatically with caribou grazing (Augustine and McNaughton, 1998).

Proposed Hypothesis

The objectives of this study are to: 1) characterize current plant communities, species diversity, and plant vigor at different campsites, 2) identify differences in vegetation cover associated with varying grazing regimes, and 3) characterize the effects of nongrazing on plant communities. This will provide information for local herders, local and regional governments and other institutions, such as non-governmental organizations interested in the management of this area, to determine if lower ungulate numbers and potentially fewer predators are causing changes in the vegetation composition and vigor. The information can be used in determining policies for hunting and reindeer management including potential increases in numbers. It can also provide a basis for recommendations regarding herd sizes, length of grazing and rest periods, spatial and temporal distribution of grazing and optimal campsite locations.

This study proposes a hypothesis that the reduced number of wild ungulates and reindeer has resulted in: 1) increased percent cover of deciduous shrubs due to reduced

browsing impact 2) decreased presence and percent cover of other functional vegetation groups, some of which include desirable forage species such as lichen, and 3) decreased species diversity and plant vigor.

METHODS AND MATERIALS

Study Design

To determine the effects of grazing on vegetation communities, four summer campsites were selected for study. Campsites of the same seasonal (summer) use were chosen because reindeer forage habits vary from season to season. Two of the campsites, Urtun Khyarkh and Joshim, were selected to represent "grazed" campsites. They have been used for the past 15 and 28 years, respectively (personal interviews, 1999-2000). The other two, Terturag and Dood Saalig, were chosen to represent "ungrazed" campsites. They have not been used for the past 17 and 25 years, respectively, with the exception of 1996, 1999 and 2000 regarding Dood Saalig (personal interviews, 1999-2000).

All four campsites are located 17-30 km from each other on tributaries of the Tenggis Gol (river) which eventually flows into the Enisey River (Figure 2). Joshim is west of the Tenggis Gol in the Ikh Agaya Mountain Range whose summits are at 2400-2800 meters elevation. The other three campsites, Terturag, Urtun Khyarkh and Dood Saalig, are in the Saalig Mountain Range east of the Tenggis Gol. The average elevation of the Saalig Range summits is approximately 2500 meters (Tsogt, 1992). All four campsites are located in glaciated valleys below mountains that rise above the tree line. Campsite elevations range between 1835 and 1895 meters. All four valleys share

