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Argali Ecology in Ikh Nartyn Chuluu Nature Reserve: Preliminary Findings

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Abstract

Little is known about the ecology of argali (*Ovis ammon*), a species listed as threatened in Mongolia and internationally. We initiated research to better understand the species' ecology and develop a conservation plan for the species. Here we report on preliminary finding from a radio telemetry study of argali ecology. We captured and radio collared 22 argali, using drive nets, lamb captures, and darting from 2000-2003. Eight collared animals have died: 2 due to capture techniques, 4 from predation, 1 from starvation and exposure, and 1 of unknown (not predation) causes. We collected 633 locations on the 22 argali through September 2003, but acquired sufficient data for analyses for only 12 animals thus far. Animals primarily restricted their movements to the northern portion of Ikh Nartyn Chuluu Nature Reserve, and have not exhibited seasonal movement patterns. Mean home ranges were 47.46 ±4.21 km^2 (Range = 29.96 – 75.00 km^2) using the 100% minimum convex polygon method, with smaller areas of predicted occurrence (62.03 ±4.84 km^2 for 95% kernel, 23.76 ±3.96 km^2 for 75% kernel and 9.36 ±1.61 km^2 for 50% kernel home ranges). Predation by domestic dogs, previously unrecorded was an important early finding of our work.

Key words: Argali, conservation, Gobi, home range, Mongolia, *Ovis ammon*

Introduction

Argali sheep (*Ovis ammon*) are the largest mountain sheep in the world, with some males in Mongolia weighing over 200 kg and sporting impressive, spiraling horns that reach over 165 cm long (Schaller, 1977, 1998; Valdez, 1982; Mallon *et al.,* 1997). Little is known about the ecology of the species, although argali are declining throughout their range and the species is listed as threatened in Mongolia and internationally (Shiirevdamba *et al.,* 1997; Amgalanbaatar & Reading, 2000; Hilton-Taylor, 2000; Johnson, 2002). We initiated an interdisciplinary research project in an attempt to better understand the species' taxonomy, ecology, and population dynamics. The results of this work will hopefully enable us to better conserve these magnificent animals. In this paper we report on some of the ecological results we have obtained from one aspect of our work; a radio telemetry study.

Argali inhabit the cold, arid grasslands of mountains, steppe-covered valleys, and areas with rocky outcrops in Central Asia, including portions of Mongolia (Shackleton, 1997). Currently, their populations are patchily distributed in the northwestern and western Altai Mountains, the central Khangai Mountains, the Trans-Altai Mountains and the mountain massifs and rocky outcrops of the Gobi Desert in southern Mongolia (Reading *et al.,* 1998; Schaller, 1998). A few argali survive in the mountains near Lake Khovsgol in the north.

Although argali appear to be declining, accurate population estimates are difficult. Most biologists agree that the species is experiencing marked population declines and fragmentation (Mallon *et al.,* 1997; Amgalanbaatar *et al.,* In press). As such, argali are listed as Threatened in the Mongolian Red Book and as "Rare" by the country's newly enacted Law on Fauna (Shiirevdamba *et al.,* 1997; Wingard & Odgerel, 2001). Argali population declines appear to be primarily a result of poaching and conflicts with domestic livestock production, although the extent and impact of each is poorly understood (Mallon *et al.,* 1997; Reading *et al.,* 1997, 1998, 1999; Amgalanbaatar *et al.,* in press). Traditionally, most poaching was subsistence hunting (shooting animals illegally for food), but increasingly people poach commercially to supply an increasing demand for argali horns to be used in traditional Chinese medicine (Amgalanbaatar *et al*., in press). In addition, livestock numbers increased dramatically following privatization of herds from 26 million head in 1992 to 33 million head in 1998 (Amgalanbaatar & Reading, 2000). As the nation's human and livestock numbers increase, over-grazing and displacement by livestock reduces and degrades argali habitat (Sheehy, 1996; MNE, 1996; Reading *et al.,* 1999). Solutions are difficult, as many nomadic herders live a marginal existence, barely able to feed and clothe their families. On a more positive note, most Mongolians want to conserve nature and wildlife, which they view as part of their cultural heritage (Myagmarsuren, 2000).

We initiated an argali research project to help us understand argali sheep ecology well enough to develop a long-term conservation management plan for the species. Our project encompasses several aspects of argali biology, ecology, and conservation, including capture techniques, population genetics, niche overlap with domestic livestock, and population ecology. Here we report on preliminary results from a radio telemetry study designed to explore sources and rates of mortality, home range size, habitat use, movement patterns, behavior, and reproductive rates.

Study Site

We conducted our study in Ikh Nartyn Chuluu Nature Reserve (Ikh Nart) in northwestern of Province Dornogobi. Ikh Nart was established in 1996 to protect 43,740 ha of rocky outcrop habitat and its associated wildlife (Myagmarsuren, 2000). No permanent human settlements exist in or near (i.e., all > 30 km away) the protected area, although nomadic pastoralists use the area to for livestock grazing. The region is a high upland (~1,200 m) covered by semi-arid steppe vegetation. Permanent cold-water springs are available in some of the several, shallow valleys draining the reserve. Climate is strongly continental and arid, characterized by cold winters (to -40°C), dry, windy springs (to 25 mps), and relatively wet, hot summers (to 35°C). Precipitation is low and seasonal, with most precipitation falling in the summer. The flora and fauna are representative of the semi-arid regions of Central Asia, with a mix of desert and steppe species. Vegetation is sparse. Xerophytic and hyperxerophytic semi-shrubs, shrubs, scrub vegetation, and turfy grasses dominate, although different plant communities can be found around oases and streams, on rocky outcrops, and other localized areas. Other globally significant species occurring in Ikh Nart include ibex (*Capra sibirica*), goitered gazelle (*Gazella subgutturosa*), Mongolian gazelle (*Procapra gutturosa*), cinereous vultures (*Aegypius monachus*) and saker falcons (*Falco cherrug*).

Methods

Animal Capture and Handling

Drive Netting. In 2002, we employed 1 set of parallel, overlapping drive nets approximately 3 m high by 30 m long to create a barrier extending approximately 300 m in the bottom of a shallow, dry stream bed. Nets were 15 x 15 cm mesh and held up with 6 cm x 6 cm x 2.5 m poles on alternating sides. We laid approximately 30 cm of net on the ground to easily entangle argali and inhibit them from running under the net. In 2003, we extended the net barrier an additional 200 m using 2 parallel rows of nets with much smaller mesh (3 x 3 cm mesh). The double row of nets helped entangle animals in the finer mesh that otherwise enabled animals to pass directly through with ease.

We employed 3 - 6 local herders on horseback and part of our field team on horses or motorcycles or in vehicles to locate and drive adult argali sheep toward the nets. Hidden people and horseback riders extended past the ends of the net barrier to scare animals that tried to avoid the nets. Other team members hid near the nets to re-direct animals and more quickly reach and restrain netted animals. We equipped most people with hand-held two-way radios for communication. We stationed two central coordinators on a high point. After argali hit the nets, team members rushed to physically restrain and process captured animals (see below). The total elapsed time from capture to release was 10-25 minutes.

Lamb Capture. Researchers searched for newborn argali lambs during early spring (late March – early May). We used sightings of lambs at a distance or behavioral cues from ewes to identify areas with lambs. We searched likely locations carefully for the highly cryptic lambs. We circled located lambs with team members and, while one or more people kept the lamb's attention, another person approached slowly from behind, grabbing the lamb. After about two days, lambs easily outran us and evaded capture. We processed animals in 7-10 minutes following capture.

Darting. We darted argali using a remote delivery system developed by Pneu-Dart, Inc. We utilized Pneu-Dart® rifles with telescopic or red dot scopes and either 1 or 2 ml, 50 caliber type C Pneu-Dart darts with barbed needles. We prepared anesthetic darts and reversals in advance using the bighorn sheep as a model (Kreeger, 2002; Kreeger *et al.,* 2002). For anesthesia with a 2 ml dart, we mixed 4 mg of carfentanil citrate, 50 mg of xylazine, and 100 mg of ketamine. For a 1 ml dart we used 2 mg carfentanil, 25 mg xylazine, and 50 mg ketamine. The inconsistent ballistics of the darting equipment forced us to approach to within ~35 m of target animals. This required sneaking up on unsuspecting animals or waiting hidden in the path of slowly moving, grazing animal. To facilitate both, we used spotters with two-way radios. We ranged potential targets using laser rangefinders.

We monitored darted animals closely. We reversed carfentanil with 100 mg of naltrexone hydrochloride administered intravenously and 400 mg administered intramuscularly. We reversed xylazine with 15 mg of yohimbine hydrochloride administered intravenously. The recommended dose of naltrexone is 100 mg per 1 mg of carfentanil. We gave an additional 100 mg naltrexone to minimize the possibility of re-narcotization in a free-ranging animal. We gave yohimbine at a rate of 0.1 mg/kg body weight. For simplicity we were prepared to reverse the 1 ml darts with the same reversal protocol. The entire process of darting to reversal took about 10-20 minutes.

Animal Handling. We processed animals as quickly as possible. We repositioned darted and netted argali from lateral to sternal recumbency as soon as we reached the animal to avoid bloating and respiratory compromise. We held lambs during processing. We covered the eyes of all captured animals with a hood and kept all noise to a minimum. Processing included radio collaring and ear tagging animals, recording morphometric measurements, collecting biological samples (hair, blood, feces, and parasites), and monitoring temperatures, pulses, and respiration. All radio collars were equipped with mortality switches to enable us to locate animals quickly following their deaths. Lamb collars were expandable and designed to drop-off after 6-9 months (Diefenbach *et al.,* 2003).

Data Collection and Analyses

Radio Telemetry. We tracked collared argali throughout the year using a traditional receiver, antenna (hand-held yagi 3-element or simple H), and global positioning system (GPS). We collected location data as often as possible while in the field (min. of two weeks each month). We tried to sight animals at a distance using binoculars or spotting scopes, or by sneaking to avoid influencing argali movements. We stopped collecting location data for that day on animals that responded to trackers. We tried to locate as many animals as possible each day and conducted focal animal tracking, in which we tracked a single, randomly selected animal continuously for a full day (or as long as the observers went undetected). We used these opportunities to collect behavioral data for future analyses. After finding an animal, we waited until the animal moved off before approaching the location to collect the exact location using a global positioning system (GPS). Because lambs, especially newborns, remain near their mothers, our telemetry data on lambs also recorded locations for ewes.

Mortality switches permitted us to quickly locate dead animals in an attempt to determine the cause of death. If a veterinarian was present, we conducted necropsies on all collared animals that died to help us ascertain the cause of death. Otherwise, we looked for signs of death and took photographs for veterinarians to examine later.

Data Analyses. We incorporated telemetry data into a geographic information system (GIS) to help facilitate analyses. We used only the first location for each day during which we recorded multiple locations for a single animal to reduce possible bias due to 1) researchers inadvertently spooking animals and causing them to move and 2) autocorrelation between locations. Since argali could easily (and often did) cross their entire home ranges within 12 hours (longest straight line distance = 15.5 km), we used 1 location/day as the maximum sampling interval for our home range analyses (Swihart & Slade, 1985a, b). We used ArcView 3.2® to determine 100% minimum convex polygon (MCP) and 95%, 75%, and 50% adaptive kernel home ranges for all animals with >15 telemetry days (i.e., days during which we recorded at least 1 location for the animal) and >90 tracking days (i.e. days from the day the animal was first collared to the day we last recorded a location or the animal died).

We examined all variables for normality and homogeneity of group variance using Bartlett's test. We compared multiple means using simply t-tests, with corrections for separate variances where appropriate. Unless otherwise indicated, we present all means ±1 S.E. We set significance at $P < 0.05$.

Results

We captured and radio collared 22 argali sheep from 2000-2003 using drive nets, lamb captures, and darting (Table 1). The 9 animals captured using drive nets comprised 6 adult females, 1 adult male, 1 female lamb, and 1 male lamb. We hand captured 4 female and 4 male lambs. Finally, darting yielded 2 adult females, 1 yearling female and 2 male lambs. Therefore, overall we captured and collared 10 adult females, 1 adult male, 1 yearling female, 5 female lambs, and 6 male lambs.

Mortality

Since the beginning of our telemetry study (year 2000) 8 collared animals have died. These mortalities included 5 male lambs, 1 female lamb, 1 yearling female, and 1 adult ewe (Table 1). Two animals (1 male lamb and 1 ewe) likely died as a direct result of capture techniques. The lamb was the first lamb captured and died of maternal neglect. This lamb likely died because team members remained too close to the animal following release. The capture team wanted to make sure the mother would return to the lamb and so remained with him for over 8 hours after his release. We found him dead with no milk in his stomach 2 days later. The ewe died of peritonitis five days after being darted. She moved at the sound of the dart gun, causing

Table 1. Argali sheep (*Ovis ammon*) tracked using radio telemetry in Ikh Nartiin Chuluu Nature Reserve, Mongolia, 2000-2003. Study days refer to the number of the days from animal capture until death or last telemetry location. Telemetry days refer to the number of days for which we received at least one location on an animal. Note: DN = Drive Netting; HC = Hand Capture; and DG = Dart Gun.

Animal I.D.	Study Days	Telemetry Locations	Telemetry Days	Capture Method	Alive or Dead	Gender	Age
Jed	10	2	2	DN	Alive	Male	Adult
Ankhaa	3	3	2	HC	Dead	Male	Lamb
Amgaa	127	21	18	DG	Dead	Male	Lamb
Bor	153	29	23	DN	Dead	Male	Lamb
Bayanaa	159	34	30	HC	Dead	Male	Lamb
Namshir	164	40	32	HC	Alive	Male	Lamb
Davaa	167	33	24	DG	Dead	Male	Lamb
Batorshikh	174	27	25	HC	Alive	Male	Lamb
Naraa	4	2	2	DN	Alive	Female	Adult
Otgoo	6	2	2	DN	Alive	Female	Adult
Lauren	6	8	4	DG	Dead	Female	Adult
Choi	7	2	2	DN	Alive	Female	Adult
Batbold	9	2	2	DN	Alive	Female	Adult
Debmaa2*	93	59	34	DG	Alive	Female	Adult
Mandakh	368	130	87	DN	Alive	Female	Adult
Tuya	372	95	76	DN	Alive	Female	Adult
Ganaa	17	22	9	DG	Dead	Female	Yearling
Megmaa	4	3	3	HC	Dead	Female	Lamb
Dayan	7	2	2	DN	Alive	Female	Lamb
Zulaa	160	43	40	HC	Alive	Female	Lamb
Tonimaa	168	37	29	HC	Alive	Female	Lamb
Onon	171	37	31	HC	Alive	Female	Lamb

* Radio collar failed.

the dart to hit her in the abdomen region. A necropsy revealed a pinhole in her rumen.

Of the 6 argali that died of non-study related causes, 4 (66.7%) died due to predation. Our staff witnessed 2 domestic guard dogs (*Canis familiaris*) attacking and killing 2 10-month old male lambs in late winter (February). A third male lamb (9 mos.) died from predation by a large canid; likely a domestic dog, but possibly a wolf (*Canis lupus*). Finally, a red fox (*Vulpes vulpes*) killed a neonate female lamb (~4 days old). The lamb was also suffering from joint ill, a septic disease of the joints that probably contributed to her death.

One (16.7%) argali, a yearling female, died of starvation and exposure during the severe dzud (harsh winter conditions of deep snow, often with a hard crust of ice on the ground) of 2000-2001. Her body was emaciated and bone marrow liquid. Dozens of other argali and hundreds of livestock died in Ikh Nart during this severe winter. The cause of death for the last mortality, a male lamb, remains unknown (16.7%), but was not due to predation. We found his carcass >1 month after his last location. While the mummified skin and skeleton were intact, we were unable to determine the cause of death.

Home Range & Movement

As of early October, 2003, we have collected 633 locations on the 22 argali collared since 2000 (Fig. 1). We only recorded 1 animal leaving the boundaries of Ikh Nart (Fig. 1), and he did so for just a few days. As expected, collared animals restricted their movements to the area of rocky outcrops; we did not record any locations on the western flats (Fig. 1). Several (N = 6) animals were recently captured (Sept. 2003) and therefore, we have little data on them. Other animals died before we could accumulate much data (see above). As a result, we report on analyses from telemetry data collected for 12 argali: 9 lambs (6 male, 3 female) and 3 ewes (Table 2). We tracked these animals for an average of 189.67 ±25.18 days (i.e., tracking days) and collected data on an average of 37.42 ±6.20 days (i.e., telemetry days).

Animals primarily restricted their movements to the northern portion of Ikh Nart, basically north of our research camp (Figs. 1 and 2). We did not note any seasonal differences in movement patterns or home range use; telemetry locations were scattered throughout the home ranges of all animals during both winter (October – March) and summer (April – September). Similarly, animals regularly crossed their home ranges throughout the study. Since our study site only varies a couple hundred m in elevation, argali in Ikh Nart do not demonstrate any elevational migration, but used the entire range of elevations throughout the year.

Argali inhabited mean home ranges of 47.46 ±4.21 km^2 (Range = 29.96 – 75.00 km^2) using the 100% minimum convex polygon (MCP) method. Kernel home range sizes (i.e., area of predicted occurrence) were, not surprisingly, larger for 95% kernel ranges, but smaller for 75% and 50% ranges (Table 2). Mean home range sizes covered 62.03 ±4.84 km^2 for the 95% kernel home ranges, but

Table 2. Home range sizes (km^2) of argali sheep (*Ovis ammon*) in Ikh Nartiin Chuluu Nature Reserve, Mongolia, 2001-2003. Study days refer to the number of the days from animal capture until death or last telemetry location. Telemetry days refer to the number of days for which we received at least one location on an animal.

Animal I.D.	Study Days	Telemetry Days	100% Minimum Convex Polygon	Kernel Home Ranges 95%	75%	50%
Amgaa	127	18	26.96	45.35	16.70	4.00
Davaa	167	24	31.47	83.10	42.37	16.41
Batorshikh	174	25	34.30	68.89	37.60	15.13
Bayanaa	159	30	36.97	36.64	7.15	3.16
Bor	153	23	46.42	89.45	51.40	20.64
Debmaa2	93	34	46.56	43.56	12.03	4.07
Tonimaa	168	29	47.32	67.80	27.50	12.26
Onon	171	31	49.13	60.37	12.34	4.95
Zulaa	160	40	50.35	71.08	21.82	7.48
Namshir	164	32	60.02	43.26	14.21	7.87
Mandakh	368	87	68.56	62.19	16.01	7.95
Tuya	372	76	75.06	72.69	26.03	8.40
Mean	189.67	37.42	47.46	62.03	23.76	9.36
S.E.	25.18	6.20	4.21	4.84	3.96	1.61

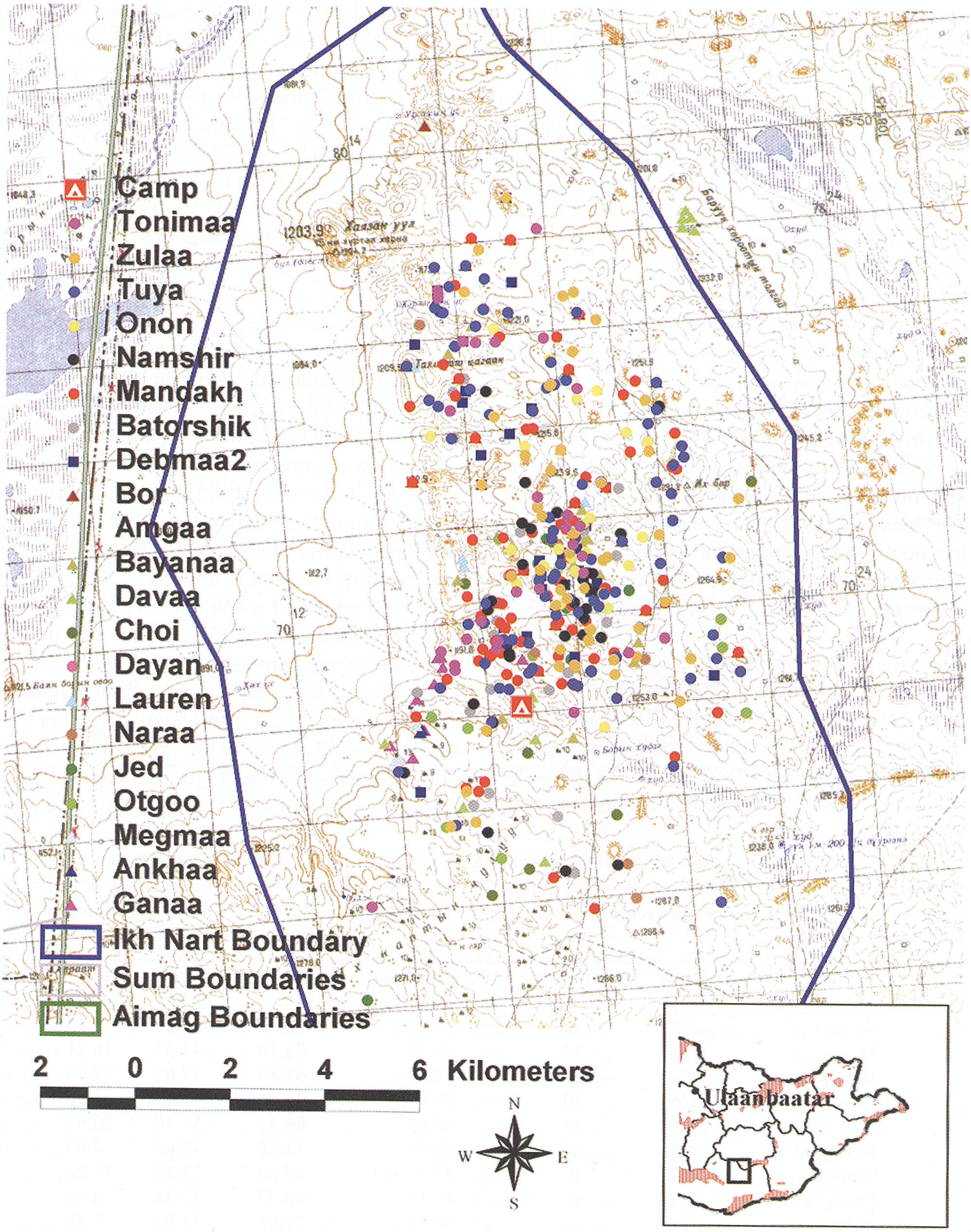

Figure 1. Locations Recorded for Radio Collared Argali (Ovis ammon) in Ikh Nartiin Chuluu Nature Reserve, Mongolia, 2000-2003. Only 1 location/day shown. Circles represent animals still alive, triangles represent animals that have died, and squares represent animals whose collars have failed.

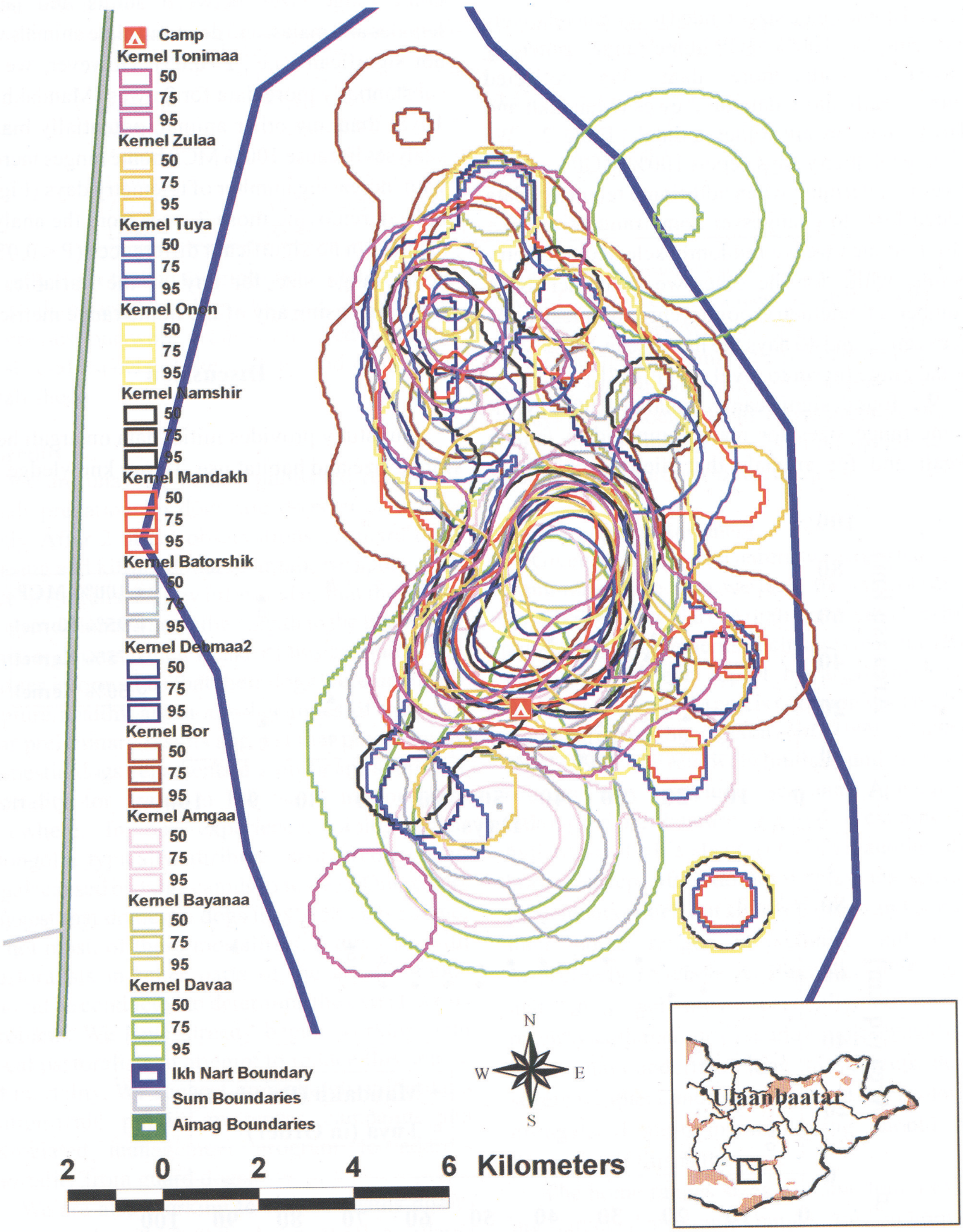

Figure 2. Kernel Home Ranges (95%, 75%, and 50%) for 12 Radio Collared Argali (*Ovis ammon*) in Ikh Nartiin Chuluu Nature Reserve, Mongolia, 2000-2003. Data based on 1 location/day only.

dropped off to only 23.76 ±3.96 km^2 for 75% and 9.36 ±1.63 km^2 for 50% kernel home ranges.

We plotted the total number of telemetry days versus home range area for all animals (Fig. 3a). Kernel home range sizes tended to remain relatively constant, but 100% MCP home ranges generally increased with more data. We collected substantially more data on 2 ewes (Mandakh and Tuya) than on any other animal (Table 2). We plotted telemetry days versus 100% MCP for these ewes to determine when additional telemetry data added little to changes in home range size (Fig. 3b). For one ewe we randomly selected telemetry points, while for the other we used increasing number of telemetry points chronologically. At between 25 and 40 days the increase in 100% MCP home range began to level off (Fig. 3b).

We found significantly smaller 100% MCP home range sizes for male compared to female argali and for animals that died compared to animals still alive (Table 3). We found similar 100% MCP home ranges for adults and juveniles (Table 3). Comparisons of 95%, 75%, and 50% kernel home range sizes between adults and lambs, females and males, and dead and alive animals were not significant (i.e., P>0.05). However, we had substantially more data for 2 ewes (Mandakh and Tuya) than any other animal, potentially biasing analyses because 100% MCP home ranges increase with increasing number of telemetry days (Fig. 3). Indeed, removing those 2 ewes from the analyses resulted in no significant differences (P < 0.05) in home range size for any of the variables we examined using any of the home range metrics.

Discussion

Our study provides initial data on argali home range size and habitat use. To our knowledge it is

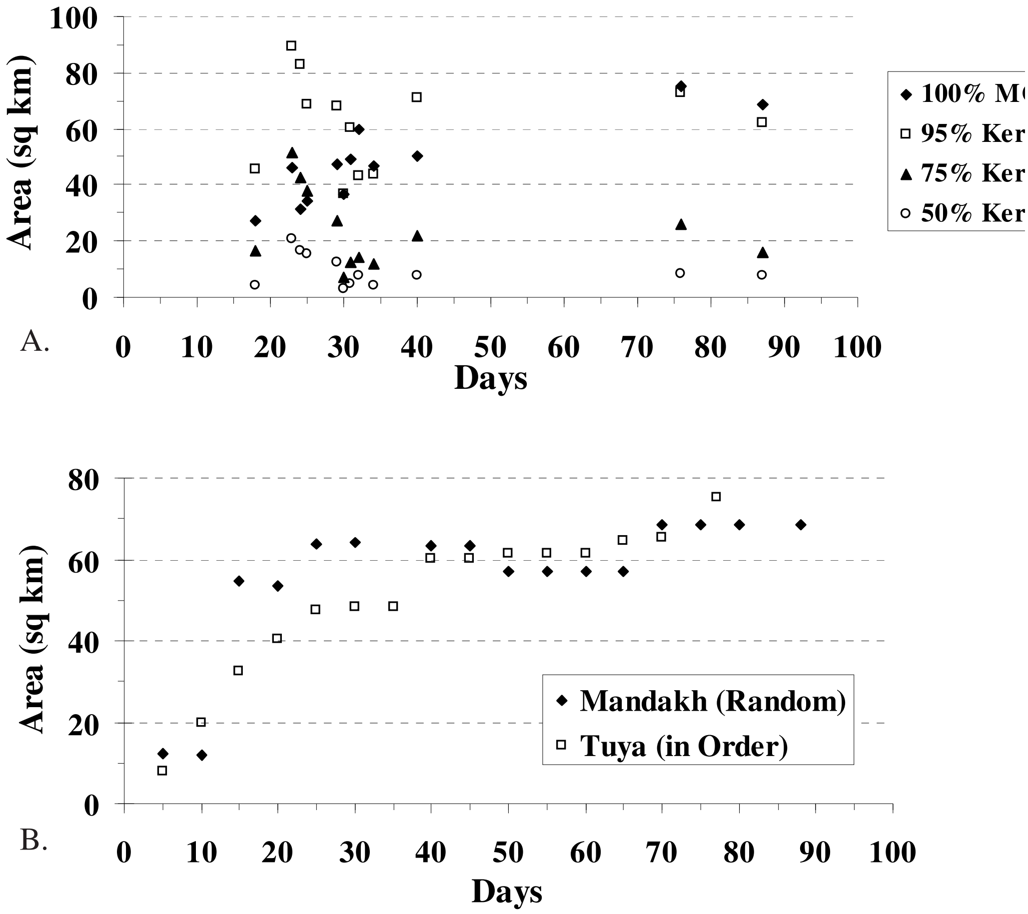

Figure3. Increase in Home Range Size as the Number of Telemetry Days Increases for Radio Collared Argali (*Ovis ammon*) in Ikh Nartiin Chuluu Nature Reserve, Mongolia, 2000-2003. A. 100% minimum convex polygon (MCP) and 95%, 75%, and 50% Kernel home ranges for 12 argali tracked for different lengths of time. B. Change in MCP home range size as additional data are included randomly and chronologically (in order).

Table 3. Comparison of mean (±S.E.) home range sizes (km^2) of argali sheep (*Ovis ammon*) by gender, age, and whether or not they are still alive. (Paired numbers that are significantly different using simple t-tests appear in bold).

Category	*100% Minimum Convex Polygon*	*Kernel Home Ranges* 95%	75%	50%
Female	**56.16 ±5.05**[1]	62.95 ±4.35	19.29 ±2.78	7.52 ±1.18
Male	**39.36 ±4.91**[1]	61.12 ±9.15	28.24 ±7.30	11.20 ±2.94
Adult	63.39 ±8.62	59.49 ±8.51	18.02 ±4.17	6.81 ±1.37
Lamb	42.55 ±3.56	62.88 ±6.04	25.68 ±5.05	10.21 ±2.06
Alive	**44.25 ±4.66**[2]	61.23 ±4.15	20.94 ±3.19	8.51 ±1.28
Dead	**35.46 ±4.19**[2]	63.64 ±13.26	29.41 ±10.44	11.05 ±4.40

the only study to date to employ radio telemetry in the study of argali ecology. As such, as the study progresses, our work promises to shed new light on several aspects of the biology and ecology of argali sheep.

Mortality

We are unaware of any published reports of argali predation by domestic dogs prior to this study. After 2 direct observations of guard dogs chasing and killing collared argali, we spoke with local pastoralists. They informed us that their dogs frequently hunted and killed argali in the late winter when argali are in their weakest physical state. They further informed us that their dogs were unable to capture healthy argali at other times of the year. Our preliminary results suggest that predation by domestic dogs represents a significant source of mortality for argali in Ikh Nart, and possibly elsewhere. In our experience, biologists in Mongolia typically attribute most predation on argali caused by large canids to wolves. Our results suggest that domestic dogs may well cause some, if not most, of these mortalities. Interviews with pastoralists in other parts of the argali's range should be conducted to determine the extent of this problem. We have already begun working with local pastoralists in attempt to reduce this source of mortality. We suggest immediately initiating a nation-wide public awareness campaign and associated management program to address mortality from guard dogs.

We are also working to reduce deaths due to our research methods. After losing our first collared lamb, we made a point of working as quickly as possible to collar and process neonate argali and then leave the area for at least 24 hours, preferably longer. This change in approached seemed to work, as we lost no other lambs due to maternal neglect after instituting this policy. Similarly, because chemical immobilization is inherently dangerous, we are shifting away from this method and moving toward the exclusive use of drive nets and breakaway collars. We may still be required to dart already collared animals to replace their collars with the breakaway models. Of course, there are always risks associated with capturing and collaring wild animals, but our goal is minimize these and continually improve our techniques.

Home Range & Movement

Given their cursorial nature, we expected larger home range size than we have thus far observed for argali in Ikh Nart. Argali have yet to exhibit any seasonal movements or changes in home range sizes, as has been report by argali in Russia (Heptner *et al.,* 1988) and is common with bighorn mountain sheep (Shackleton *et al.,* 1999; Krausman *et al.,* 1999). The relatively limited number of water sources may preclude seasonal movements, although more data are required to examine this hypothesis. Dall's sheep (*O. dalli*), another thin-horned sheep, often do not display any seasonal movements either, but simply expand and contract their home ranges in summer and winter respectively (Nichols & Bunnell, 1999). Adult males may well move seasonally, yet we only recently collared our first adult male. In addition, argali may undertake long movements during severe weather conditions like dzud and prolonged droughts. Long-term monitoring should help determine if this is the case.

The home ranges sizes we have found to date are larger than home ranges for bighorn (*O. canadensis*) sheep, as one would expect given the larger size of argali (Geist, 1999), although there was some overlap between home range sizes of the two species. Argali in Ikh Nart are possibly most comparable to desert bighorn sheep (*O. c. mexicana*). Reported home ranges for desert bighorn vary from 8.6 – 44.1 km^2 for ewes and 9.8

– 50.5 km^2 for rams using 95% MCP (Krausman *et al.,* 1989, 1999; Singer *et al.,* 2001). Rocky Mountain bighorns (*O. c. canadensis*) exhibit slighter smaller home range sizes of 3.2 – 35.3 km^2 for ewes, but similar home ranges of 14.0 – 54.7 km^2 for rams using 95% MCP (Singer *et al.* 2001).

Much of our data comes from male and female lambs. The movements of most of these animals reflect the movements of their mothers as well. Thus, we would expect no differences between home range sizes of lambs and adults and between males and females. Lamb and adult argali did exhibit similar home ranges; however, we did find significant differences between male and female 100% MCP home range sizes (Table 3). These differences appeared to result from the large home ranges of 2 ewes that we have been tracking for over 1 year. Since home range size continued to increase with additional data point, this result is not surprising. In addition, 2 lambs (Amgaa and Davaa) that appeared to be orphans, as we never observed them with a ewe, exhibited relatively small home range sizes (Table 2) and both were males. We suspect that these individuals moved less than other lambs because their mothers were not present to induce greater movement. Kernel home ranges probably provide a better comparison of habitat use between groups of animals because they indicate the area of important habitat; none of our kernel home range comparisons were significant.

Not surprisingly, all of our collared argali remained in the region of rocky outcrops and did not venture into the open habitat to the west. The cryptic coloration of argali blends in well with the rocky outcrops, which also conceal animals that flee from potential predators.

Kernel home ranges, based on probability of occurrence, indicate the most important habitat. Most argali spent most of their time in an area of ~28 km^2 just north of our research camp (Fig. 2). Future research will explore the reasons for this, including more detailed habitat assessments. Vegetative assessments are currently underway. In addition, the 95% kernel home ranges of all animals collared included the perennial spring and stream in the valley that includes our camp. Similarly, all but one animal's 100% MCP included the stream. The stream appears to represent an important water source for these animals. It also appears to function as the approximate southern boundary for most collared animals. These data suggest that argali in Ikh Nart may represent more than one subpopulation. We hope to collar animals from south of camp to better examine this possibility.

Future Conservation & Research

We are only beginning our research into argali biology and ecology, and hope to continue our project for several more years. Other aspects of research include genetic examination of putative subspecies in Mongolia (Tserenbataa *et al.,* in press), vegetative analyses, disease surveys, and a study of niche overlap between argali and domestic sheep and goats in Ikh Nart. We will also likely expand our work to include Siberian ibex in an attempt to better understand how argali and ibex partition resources. We currently have a single male ibex collared. Finally, we would eventually like to expand our work or collaborate with other researchers studying argali in other parts of Mongolia, especially including the Khangai and Altai Mountains.

Our overall goal is improving the conservation prospects for argali sheep in Mongolia. We plan to use the results from our research to develop sound conservation management plans for Ikh Nart and for Mongolia overall, something we have already begun (MNE & WWF-Mongolia, 2000). Only by better understanding the factors that influence argali ecology, especially mortality and reproduction, can we hope to reverse the current trend of declining and increasing fragmentation of argali populations in Mongolia.

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Хураангуй

Аргалийн тархалт, популяцийн бүтцийн судалгааг 2001 оны 11-р сарын 22-25-ны хооронд Сийлхэмийн Нурууны Байгалийн Цогцолбор газарт явуулж нийт 12 сүрэг 238 аргалийн бодгалийг тэмдэглэв. 225 бодгалийг тодорхойлсоны 29 нь бие гүйцсэн угалз, 138 нь бие гүйцсэн хомь, 58 нь хурга байлаа. Сүргийн дундаж хэмжээ 20.0 (сүргийн хэмжээ 1-119, стандарт хазайлт 34.0), хурга ба хомийн харьцаа 42:100, угалз ба хомийн харьцаа 21:100 байлаа. Аргалийн өвлийн бэлчээр нутгийг байгалийн цогцолбор газрын аргалийн менежментийн төлөвлөгөөнд онцлон оруулав. Сайлгэм, Чикачэва уулын хил дамнан нутагладаг аргалийн популяцийн удаан хугацааны мониторинг, менежментийн төлөвлөгөөг Монгол Улс болон Оросын Холбооны Улсын засгийн газар, тусгай хамгаалалттай газрын захиргаад нарийвчлан гаргах зайлшгүй шаардлагатай болохыг тэмдэглэв.

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