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Burrow Cluster as a Sampling Unit: An Approach to Estimate Marmot Activity in the Eastern Steppe of Mongolia

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Abstract

In order to describe current marmot distribution and establish a baseline density for the Eastern Steppe of Mongolia (Dornod, Sukhbaatar, and Khenti aimags), we conducted line transects during pup emergence from June through July 2005. For these distance sampling surveys, we counted and measured active and inactive marmot burrow clusters. We define a sampling unit (= burrow cluster) as a surrogate for active and inactive colonies to estimate marmot density. We measured different characteristics of burrows and burrow clusters in order to estimate the probability of occupancy for future research. We also present various measures such as area (size) and average burrow number for active and inactive burrow clusters.

Key words: burrows, distance sampling, *Marmota sibirica*, Mongolia, sampling unit

Introduction

We conducted a survey in the Eastern Steppe in the summer of 2005 to establish baseline estimates of marmot distribution and abundance. Due to perceived recent dramatic declines in marmot abundance (Reading *et al*., 1998; Zahler *et al*., 2004; Wingard & Zahler, 2006), a 2-year marmot hunting ban was established throughout Mongolia (2005 and 2006).

Generally, steppe marmots (*Marmota sibirica*) are found in family groups (clans) or colonies (multiple clans; Barash, 1989; Adiya, 2000). Marmots are diurnal but spend a considerable time underground. We therefore needed to determine presence or absence even if no marmots were observed. We identified burrows as an indirect measure of marmot presence but did not want to overestimate marmot abundance by using burrows alone as a surrogate for marmot presence. Indeed, marmot burrows can persist long after marmots have been removed or are no longer present. Therefore, we were faced with 1) accurately determining marmot presence, and 2) defining a unit of measure while conducting transects in a timely fashion.

Burrows and burrow activity for semi-fossorial mammals have been used to determine relative density and presence (Lord *et al*., 1970; Schmutz & Hungle 1989; Boonstra *et al*., 1992; Hubbs *et al*., 2000). In addition, using animal sign (scat, tracks, for example) along transects are often used to determine species presence and relative abundance (Thompson *et al*., 1989; Ballard *et al*., 1995; Becker *et al*., 2004). We could detect burrows from a slowly moving vehicle, and we identified characteristics associated with active and inactive burrow clusters, that are parameters that could potentially indicate presence or absence. We also developed a way to rapidly assess these parameters.

Methods

Surveys were conducted from 10 June to 31 July 2005 in the ~250,000 km^2 study area of the Eastern Steppe (the three eastern aimags of Khentii, Dornod and Sukhbaatar in Mongolia). North-south line transects were located randomly at ~50 km apart.

Distance sampling along line transects was conducted to sample active and inactive burrow clusters, marmots and other wildlife (Buckland *et al*., 2001, see Townsend and Zahler, this volume, for full explanation of methods). We detected marmot burrows from our slowly moving vehicle and noted burrows tended to occur in clusters. The "burrow cluster" (burrows within 15 m) was our sampling unit; we made a determination of "active" based on the presence of 1) fresh scat and/or 2) a marmot. Burrow clusters were defined as a group of burrows >10.2 to 30.5 cm in diameter that

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were within 15.2 m of one another. The size (area) of these burrow clusters was measured (m^2), and location was collected from a center point. We recorded the number of burrows, size class of each burrow, burrow variables [digging, tracks (consistent in size and shape with marmot), marmot scat (old or fresh), debris (in entrance), alarm call, latrine, other animal sign (types and amount)] for each burrow cluster. We completed a binary logistic regression on four characteristics (digging, old scat, tracks and debris) to identify which characteristics were positively and negatively correlated with active burrow clusters (Minitab Statistical Software, Release 13.32).

When a burrow or burrow cluster was detected, the vehicle was stopped; the observer exited the vehicle to determine if the burrow was within the target size class. If it was, the observer took all appropriate measurements for that burrow cluster.

If during one moving hour no burrows were detected, we stopped and two observers conducted 150 m walking transects perpendicular to the transect in order to verify that no burrows were missed. We recorded sign and burrows detected along these transects as well as location, start and end time. We filled out habitat and weather logs every hour while on transect and noted significant changes in weather in our daily transect log.

Results

We completed 10 transects (2 through 11; 1,966 km) where burrow cluster data were collected (Figure 1).

We detected and measured 2,018 burrow clusters; of these, 123 (6%) were active, and 1,890 (94%) were inactive. We considered "active" only those burrow clusters that either had fresh scat (soft to touch, dark in color, generally green or greenish hue) and/or we observed a marmot or marmots at the burrow entrance. Digging, alarm, old scat, and tracks were more prevalent at the active burrow clusters, and, as expected, debris was more often encountered at the inactive burrow clusters (Table 1).

The results from the binary logistic regression on active burrow clusters (N = 124; binary logistic regression: G = 174.395, df = 4, P = <0.005) indicated that all characteristics were positively (digging, old scat and tracks) or negatively correlated (debris) with active burrow clusters (Table 2). For active burrow clusters, mean number of burrows

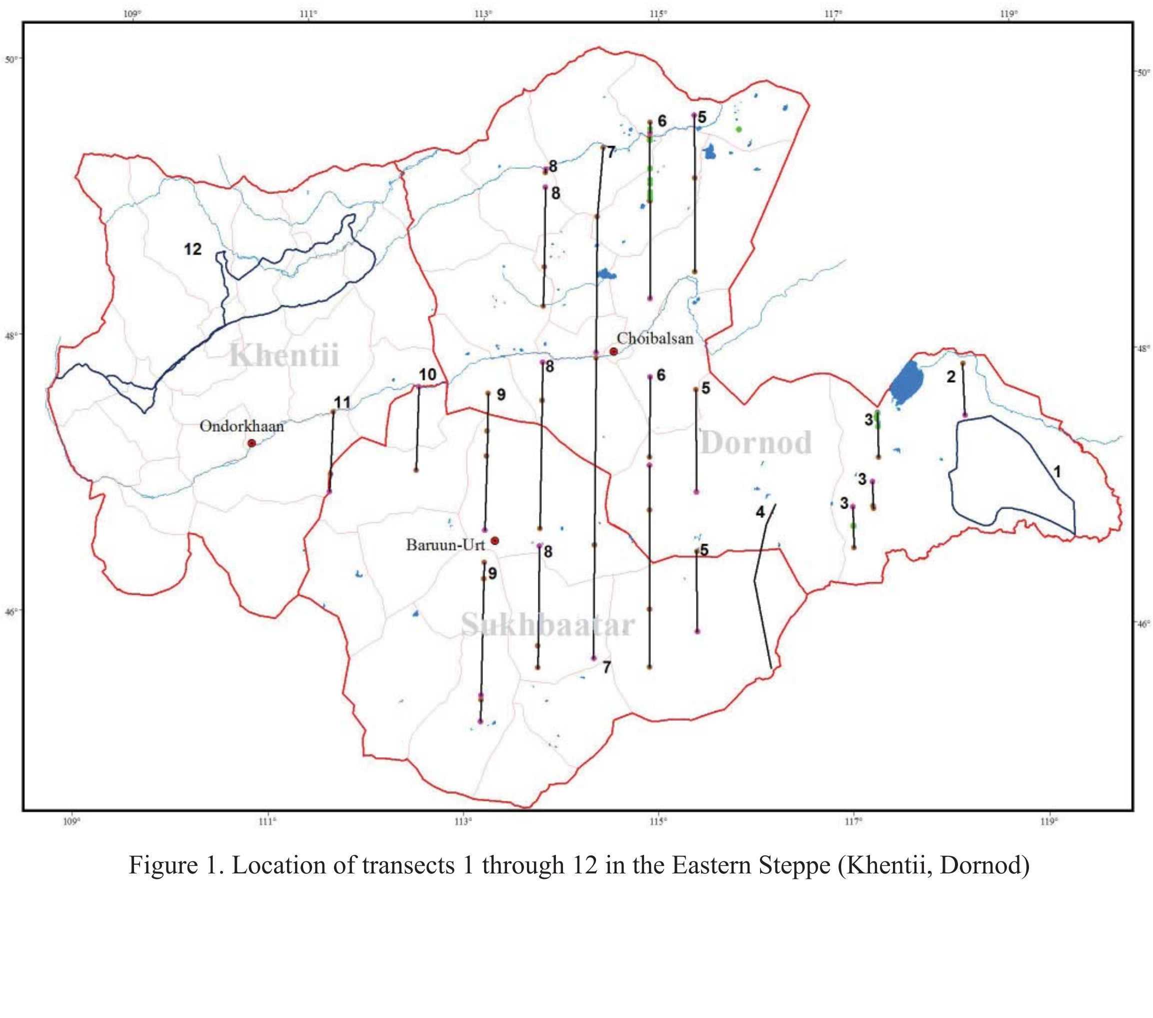

Figure 1. Location of transects 1 through 12 in the Eastern Steppe (Khentii, Dornod)

Table 1. Characteristics (number and proportion of total) for active and inactive burrow clusters.

Burrow cluster	N	Fresh scat*	Individ-ual*	Latrine	Digging	Old scat	Tracks	Debris	Alarm
Active	123	102	33	9	81	118	45	43	14
(prop)		0.829	0.268	0.073	0.659	0.959	0.366	0.350	0.114
Inactive	1890	0	0	8	546	801	194	1050	13
(prop)		0.000	0.000	0.004	0.289	0.424	0.103	0.556	0.007
Total	2013	102	33	17	627	919	239	1093	27
(prop)		0.051	0.016	0.008	0.311	0.457	0.119	0.543	0.013

*Presence of fresh scat and individual by definition were considered "active"

Table 2. Results from binary logistic regression with predictors, coefficient, standard error of the coefficient, z-statistic, probability, odds ratio and 95% confidence interval for 4 burrow characteristics.

Predictor	Coefficient (R^2)	SE Coefficient	Z	P	Odds Ratio	95% CI	
						lower	upper
Constant	-4.5470	0.3317	-13.71	0.000			
Digging	0.7320	0.2250	3.25	0.001	2.08	1.34	3.23
Old scat	2.3651	0.3409	6.94	0.000	10.65	5.46	20.77
Tracks	0.6214	0.2305	2.70	0.007	1.86	1.18	2.92
Debris	-0.8064	0.2035	-3.96	0.000	0.45	0.30	0.67

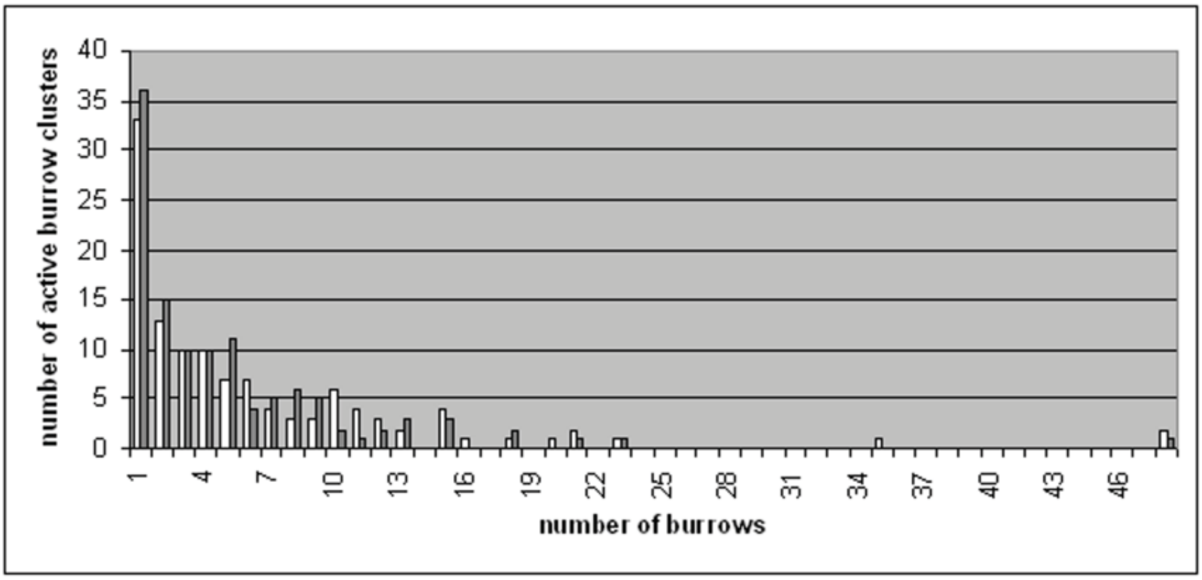

Figure 2a. Frequency distribution of number of burrows per active burrow cluster [total number of burrows (open) and number of marmot sized burrows (filled)] found on transects 2 through 11 in the Eastern Steppe, Mongolia (June and July 2005).

[all size classes (<5.1 cm, >5.1 to 10.2, >10.2 to 20.3 cm, >20.3 to 30.5 cm, and >30.5 cm)] per burrow cluster was 6.9 (N = 118, range 1 - 94), and for marmot-sized burrows per burrow cluster, the mean number was 5.5 (N = 118, range 1 – 86, Fig. 2a). For inactive burrow clusters, the mean number of burrows (all size classes) was 2.6 (N = 1871, range = 1 - 45), and for marmot-sized burrows, the mean number was 2.1 (N = 1871, range = 1 – 30, Fig. 2b). Because both data sets failed normality tests, we compared medians using Mann-Whitney Rank sum (U) test. The median values for "all burrows" and "marmot burrows" per active and inactive burrow clusters differed

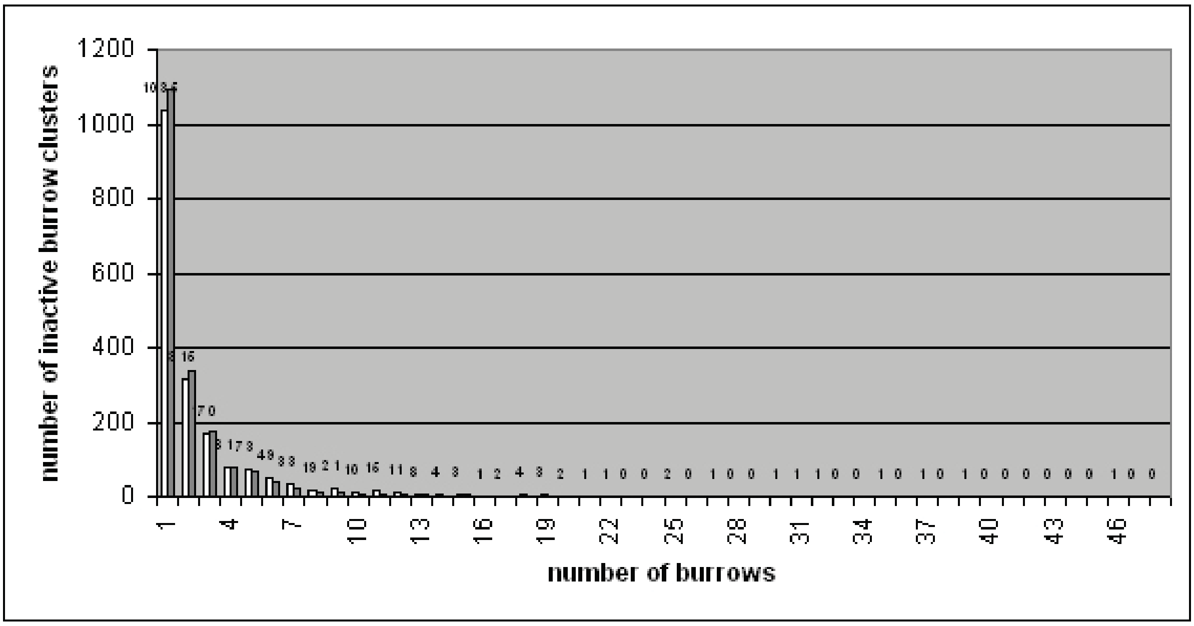

Figure 2b. Frequency distribution of number of burrows per inactive burrow cluster [total number of burrows (open) and number of marmot sized burrows (filled)] found on transects 2 through 11 in the Eastern Steppe, Mongolia (June and July 2005).

(Mann-Whitney U: T_{122} = 160973.0, $p \leq 0.0001$ and T_{122} = 161061.0, $p \leq 0.0001$; SigmaStat for Windows v. 1.0, 1992 - 1994).

A greater frequency of more burrows per burrow cluster for active burrow clusters was evident when compared to inactive burrow clusters (Figs 2a and 2b). In other words, active burrow clusters have a greater number of burrows, in general, than the inactive burrow clusters.

For active burrow clusters, the mean area was 1,056.6 m^2 (N = 122, range = 1.13 – 27,512.1 m^2) and, for inactive burrow clusters, mean area was 168.1 m^2 (N = 1,829, range = 0.14 – 24,566.2 m^2). The mean area of active burrow clusters was larger than for inactive burrow clusters (two-sample t-test: t_{1949} = 174,734.5, $p \leq 0.0001$). A greater frequency of larger size classes for active burrow clusters was evident when compared to inactive burrow clusters (Fig. 3). We detected only one target-sized burrow from our 150-m transects.

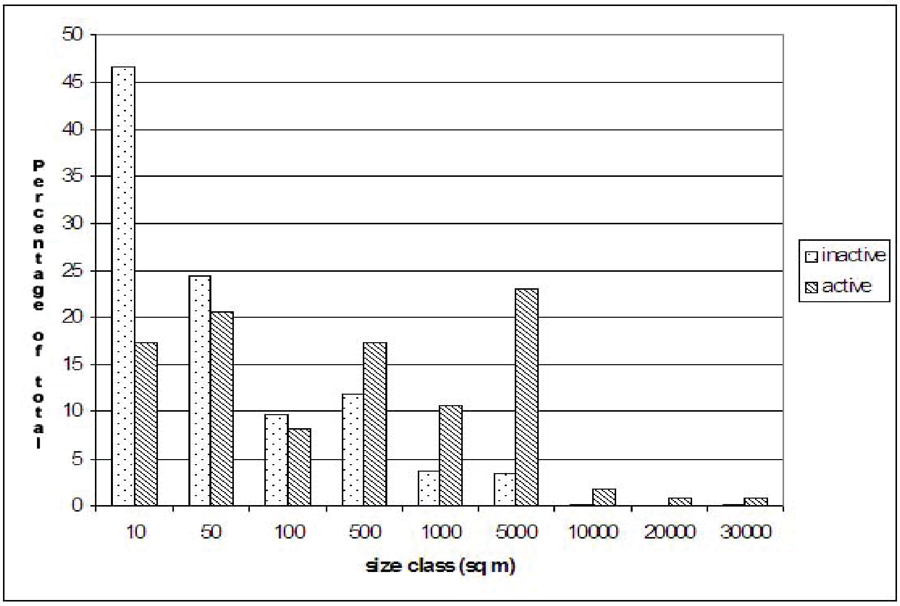

Figure 3. Percentage of total of occurrence for each size class for a) inactive burrow clusters (spotted) and b) active burrow clusters (hatched) found on transects 2 through 11 in the Eastern Steppe, Mongolia (June and July 2005).

Conclusions

We consider our approach to measuring burrow clusters an effective way to gauge relative density of marmot occupancy along transects. The parameters we used give a high degree of confidence in our assessment of "active" and "inactive." The parameters (old scat, digging, tracks, and debris) may be used in future studies to increase the number of categories assessing occupancy; in other words, they could be used to assess "probable active" and "probable inactive." The use of these parameters to assess activity is not new (Lord *et al*., 1970; Boonstra *et al*., 1992); however, our approach using distance analysis for marmot burrow cluster activity may be useful for covering large geographic areas.

The larger on average burrow number (per active burrow cluster) and area for active burrow clusters is likely due to the on-going maintenance and creation of new burrows by the resident marmots. More burrows (of all size classes) associated with the active burrow clusters could indicate that marmots may play a role in increasing other burrowing species; another potentially positive association of marmot presence on biodiversity, supporting the notion that marmots may play a role as a keystone species (Smith & Foggin, 1999; Soule *et al*., 2003). We might have expected fewer "non-marmot" sized burrows in active burrow clusters due to interspecific competition for resources (space and forage).

The results of our study indicate that activity is quite low in our study area (<6%; see Townsend & Zahler, this volume). Understanding how prevalent activity is in a healthy marmot population would give us a better understanding of the significance of this seemingly low occupancy. The low densities of marmots we recorded in some areas could result in effective isolation. This fragmentation could lead to serious problems associated with small population sizes, such as loss of heterozygosity (increased vulnerability to diseases, for example), inbreeding depression, and an increased likelihood of local extirpation. Understanding space use could provide insight into 1) how many animals are likely to be present in active areas, and 2) how close breeding groups need to be in order to constitute an effective population size (i.e. characteristics of metapopulations).

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Хураангуй

Монгол орны дорнод хэсгийн (Дорнод, Хэнтийн, Сүхбаатар аймаг) хээрийн бүсийн тарваганы тархалт, нягтшилыг тогтоох зорилгоор бид 2005 оны 06 ба 07 дугаар саруудад шугаман трансектийн аргаар судалгаа хийсэн болно. Түүнчлэн дээрх бүс нутагт тохиолдох тарваганы эзэмшилтэй ба эзэнгүй дошны тооллого, хэмжилтийг хийсэн юм. Тарваганы тоо толгойн нягтшилыг гаргах зорилгоор дээжийн нэгж буюу нүхний бүлгийг тодорхойлсон ба үүнд эзэнтэй ба эзэнгүй дошны нүхний тоог ашиглав. Түүнчлэн цаашдын судалгаанд тарваганы нүхний эзэмшилтэй болох магадлалыг тодорхойлох зорилгоор энэ удаад нүх болон түүний салаануудын янз бүрийн хэмжилтийг хийв. Мөн эзэнтэй ба эзэнгүй дошны нүхний дундаж тоо, эзлэх талбайн хэмжээ зэргийг хэмжиж тодорхойлсон болно.

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