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SUMMER HABITAT SELECTION OF REINDEER (*Rangifer tarandus*) GOVERNS ON THE UNPROTECTED FOREST AND HUMAN INTERFACE IN CHINA

JING WANG[1,2], PENG WANG[1,2], ACHYUT ARYAL[3], XIUXIANG MENG[1, 2 *], ROBERT B. WELADJI[4]

[1]School of Environment and Natural Resources, Renmin University of China, 59 Zhongguancun Dajie, Beijing 100872, China; e-mail: meng2014@ruc.edu.cn
[2]College of Animal Science and Veterinary Medicine, Shanxi Agricultural University, Taigu 030801, China
[3]Institute of Natural and Mathematical Sciences, Massey University, Auckland, New Zealand.
[4]Department of Biology, Concordia University, 7141 Sherbrooke Street West, Montreal, QC, H4 B 1R6, Canada

* Author for correspondence

Abstract

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The habitat selection by animals depends on different environmental and anthropogenic factors such as the season, climate, and the life cycle stage. Here, we have presented the summer habitat selection strategy of reindeer (*Rangifer tarandus*) in the unprotected forest area from the northern arctic region of China. In summer 2012, we investigated a total of 72 used and 162 non-used plots in the reindeer habitat to record habitat variables. We found that the reindeer used significantly higher altitude, arbour availability, and vegetation cover area as compared to the non-used habitat variables. Principal component analysis (PCA) showed that six principal components (68.5%) were mainly responsible for the summer habitat selection of reindeer such as the slope position, concealment, anthropogenic dispersion, arbour species, distance from the anthropogenic disturbance area (> 1000 m) and water quality (Wilks' Lambda = 0.12; P = 0.0001). The local people are largely dependent on forest product resource in these regions, such as bees herding, collecting wild vegetables, hunting, poaching, and grazing. These activities highly influenced the reindeer habitat and its behaviours. This study thus confirmed that reindeers are forced to choose poor habitat in unprotected forest area with high human disturbance or interference. These factors should be considered by the concerned authority or agency to manage reindeer population in the wild.

Key words: reindeer (*Rangifer tarandus*), summer, habitat selection, effective factor.

Introduction

Habitat selection by animal is a process of long-term evolution and function adopted by the animal to survive in the existing environment, based on the natural selection theory (Manly et al., 2002; Boyce et al., 2002). Habitat selection of species is also dependent on habitats and

animal behaviour (Aryal et al., 2013a, 2014b) and the ongoing changes in the environment may also affect the habitat selection by an animal (Aryal et al., 2013b). Habitat selection by an animal differs with season, climate, and the animal life cycle (Jiang, 2004; Aryal et al., 2014a).

Reindeers (*Rangifer tarandus*) are least concerned species distributed in the northern arctic region of China (Ma, 1986; Henttonen, Tikhonov, 2008) as well as in Eurasia and North America (Banfield, 1961; Orians, Wittenberger, 1991). The reindeer population in China is of great interest with the Ewenki community in terms of promoting tourism, providing antler, and also as a food source (Ma, 1986); however, information on the impact of their use on their behaviour, distribution, and response to environmental stress is lacking (Yin et al., 1999; Tang, 2008; Wang, 1995; Li, 1988). The reindeer has seasonal migration in different habitat, and there are very few studies that have reported on the habitat selection of this animal in the other distribution ranges (O'Brian et al., 2006; Skarin et al., 2004). However, specifically, the Chinese reindeer population has not been uniformly managed, and studies on their seasonal habitat preference throughout the distribution range in China is lacking (Ma, 1986; Yin et al., 1999; Tang, 2008; Wang, 1995; Li, 1988). Reindeer in China are distributed outside the protected area, in the unprotected forest. Therefore, we have attempted to study the summer habitat selection strategy of reindeer in the unprotected forest area of the northern China.

Material and methods

Study area

The study was conducted in Aoluguya, Genhe, Inner Mongolia, China (52°10′E, 5′122°N) (Fig. 1). This region is located in northern China and in the western slope of the Great Khingan Range, which is a hilly terrain with plateau-dominated habitat (Ma, 1985). The study area had an altitude ranging from 700 to 1443 m (Fig. 1) and it was covered with larch tree forest including pine, birch, and red spruce trees (Chen, 1985; Feng, Bai, 2011). This forest area has a humid cold temperate climate, which is characterized by cold, wet winter; long, dry, and windy spring; cool short summer; and plunged autumn temperatures with early frost. The annual average temperature and precipitation here is 6.5 °C and 450 mm, respectively (Chen, 1985; Xiang, 2008). This area boasts of about 40 mammalian species including reindeer, musk deer (*Moschus moschiferus*), black brown bear (*Ursus arctos lasiotus*), bear (*Selenarctos thibetanus*), lynx (*Felis*

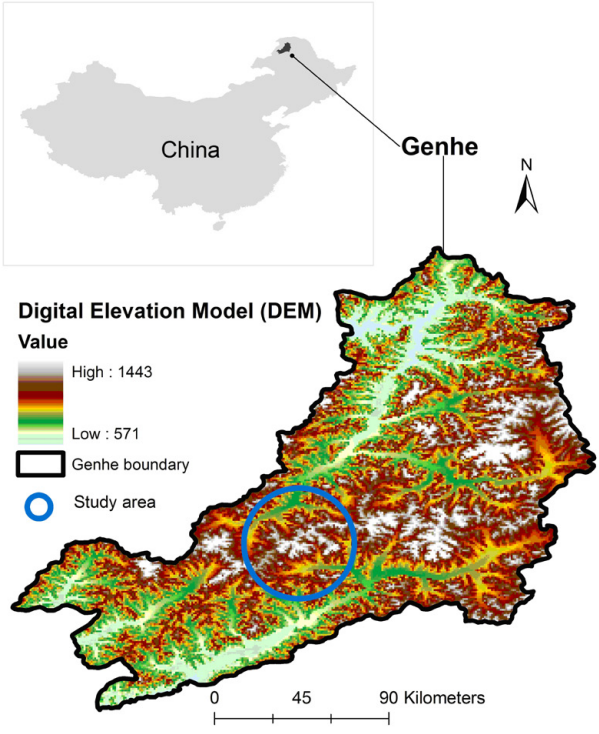

Fig. 1. Illustrated China and study area's digital elevation modelling (DEM) within Genhe district of China.

T a b l e 1. Definition and description of habitat variables of wild reindeer.

Variable	Ecological variables	Variable definition and description
Continuous variables	Altitude (m)	20×20 m altitude of the reindeer fresh activity trace centre within sample area ;
	Arbor canopy (%)	estimate 20×20 m sample centre four directions the upper canopy of vegetation cover on the ground percentage averaged;
	Arbor DBH	20×20 m sample arbour diameter the four directions from the nearest trees to centre sample averages (DBH, roughly 1.3 m height);
	Arbor height (m)	20×20 m sample the four directions from the nearest trees to centre sample height averages (conifers, DBH > 15 cm);
	Arbor density (stems)	20×20 m Arbor quantity (conifers, DBH > 15 cm);
	Shrub height (m)	average value of brush height of five 4×4 m sample area in the 20×20 m sample area;
	Shrub canopy (%)	20×20 m average of Shrub canopy of five 4×4 m sample area in the 20×20 m sample area;
	Ground-plant muscus-lichen cover (%)	the ratio of surface vegetation accounts for the acreage of sample area in the 20×20 m sample area;
	Muscus-lichen cover (%)	estimate the number of eatable plants for reindeer of five 4×4 m sample area in the 20×20 m sample area, average value;
	Stump quantity (stems)	20×20 m sample Stump quantity(conifers, DBH > 15 cm);
	Fallen wood quantity (stems)	20×20 m sample fallen wood quantity (conifers, DBH > 15 cm);
	Withered grass cover (%)	20×20 m sample hay ratio of the total sample area estimated in each 4x4 m quadrat dry plant total coverage;
Discrete Variables	Slope aspect	slope aspect in 20×20 m sample, divided into the east slope (45 ~ 135 °), the southern slope (135 ~ 225 °), the western slope (225 ~ 315 °) and the North slope (315 ~ 45 °);
	Slope gradient (°)	slope gradient in 20×20 m sample, divided into flat slope (≤ 30 °), middle slope (30 ~ 60 °) and steep slopes (≥ 60 °);
	Slope position	20×20 m sample slope position divided into: the lower slopes and valley, mesoslope /mountainside, upslope and ridge;
	Vegetation type	20×20 m sample area vegetation mainly type appearance, divided into conifer forest, conifer and shrub mixed forest, shrub, grassland;
	Concealment	at 1.3 m height (roughly the height of the reindeer head and eye when upright position), sample the average in four direction of the visual range, divided into 3 level, that is good (≤ 10), middle (10 ~ 20 m) and poor (≥ 20);
	Lee condition	sample area affected by the wind, the intrusive is divided into level 3, that is good, middle, bad;
	Water quantity assessment	the size of the bubble water in the sample area and around the sample area, divided into four grade: greatly (diameter of rivers or bubble ≥ 1500cm), big (diameter of river branches or bubbles is ≥ 1000cm), medium (diameter of river branches or bubbles is ≥ 500 cm), small (diameter of bubbles is < 100 cm);
	Soil moisture degree	divided into four grades: very wet (grip will make the water be out of), moist (grip will make dough), moist to some extent (grip will make dough, scattered if loosen the grip), dry;
	Water dispersion (m)	vertical dimension between sample area and source of water (springs and rivers and so on, do not contain snow), divided into three grade: near (≤ 500 m), medium (500 ~1 000 m) and far (≥ 1 000 m);
	Anthropogenic dispersion (m)	from sample area to human disturbance (such as tourism, transportation, agriculture, gathering, grazing and so on. divided into three grade: near (≤ 500 m), medium (500 ~1 000 m) and far (≥ 1 000 m);
	Hunters residential area dispersion (m)	vertical dimension between sample area and settlement, divided into three grade: near (≤ 500 m), medium (500 ~1 000 m) and far (≥ 1 000 m).

lynx), sable (*Martes zibellina*), and snowshoe hare (*Lepus timidus*) (Chen, 1985). The local people largely depend on the forest for their livelihood such as by collecting forest products, grazing, herding bees, collecting wild vegetables as well as by related activities such as tourism and hunting (Chen, 1985; Liao, Xie, 2011).

Data collection

We laid out eights transect lines in the reindeer habitat in summer 2012 (June–July). The transect line were laid from an elevation of 400 to 1400 m with a width of 1000 m between each transect. We walked in each transect line to search for reindeer signs (direct observation, pellets, footprints, resting site, urine deposition site, and mark). Once we encountered any sign, we laid out reindeer use plots of 20×20 m and recorded all habitat information (Table 1). At every 100 m stop, we laid out same-sized plots 50 step to the right and to the left of the transects and searched again for reindeer signs. In case we did not find any signs, we labelled the plot as non-use plot and collected same habitat variables. We used principal components analysis (PCA) and discriminate function analysis (DFA) to analyse the habitat selection function of reindeers in the study area based on the presence and absence of habitat data (Manly et al., 2002). We then performed our analysis by using SPSS (version 16.1) software.

Results

We measured a total of 72 use and 162 non-use sample plots in the reindeer habitat and recorded the habitat variables for summer season (Table 1). Continuous variables of habitat such as higher altitude, arbour availability, and ground cover were significantly different between use and non-use plots (Mann–Whitney U, $P < 0.005$); other continuous variables were not significantly different between the use and non-use plots (Mann–Whitney U, $P > 0.005$) (Table 2).

There was a significant difference in the discrete variables between use and non-use plots such as slope ($\chi 2 = 11.675$, df = 3, $P = 0.009$). Furthermore, the variables such as vegetation type, concealment, lee condition, water quantity assessment, soil moisture degree, water dispersion, and anthropogenic dispersion distance variables were also significantly different

T a b l e 2. Continuous summer habitat variable in use and non-use plots in the study area (Mean±S.E.).

Variables	**(n=72) Use plots**	**(n=162) Non- use plots**	**P Mann-Whitney U test**
Altitude	926.92 ±0.81	913.35 ±1.34	0.000**
Arbor canopy	17.86 ±2.40	9.42 ±1.46	0.000**
Arbor DBH	35.54 ±2.11	15.99 ±1.31	0.000**
Arbor density	8.21 ±0.46	4.30 ±0.37	0.000**
Arbor density	6.94 ±0.49	4.39 ±0.49	0.000**
Shrub canopy	59.38 ±2.38	57.35 ±1.90	0.794
Shrub height	54.16 ±1.98	121.61 ±7.04	0.000**
Ground-plant cover	90.50 ±0.73	91.31 ±0.57	0.023
muscus-lichen	19.37 ±1.69	15.34 ±0.97	0.849
Stump quantity	1.31 ±0.22	0.98 ±0.16	0.000**
fallen wood quantity	1.22 ±0.23	1.31 ±0.20	0.128
Grassland cover	2.57 ±0.36	5.11 ±0.34	0.013*

Notes: * Significant difference ($P<0.05$); **Most significant difference ($P<0.01$).

T a b l e 3. Discrete summer habitat variable in use and non-use plots in the study area.

Factor	Item	Frequency		Percentage (%)	
		Random plots (n=162)	Used sites (n=72)	Random plots (n=162)	Used sites (n=72)
Slope aspect	East	76	39	46.9	54.2
	West	2	0	1.2	0
	South	26	1	16	1.4
	North	58	32	35.8	44.4
	χ^2=11.675 df =3 P=0.009				
Slope gradient	Flat slope (0-20)	108	16	66.7	22.2
	Gentle slope (20-40)	39	32	24.1	44.4
	Steep gradient (>40)	15	24	9.3	33.3
	χ^2=42.731 d*f* =2 P=0.000				
Slope position	Upslope	0	1	0	1.4
	Middle slope	0	59	0	81.9
	down the slope	162	12	100	16.7
	χ^2=181.552 d*f* =2 P=0.000				
Vegetation type	Needle leaved forest	49	17	30.3	23.6
	Mixed forest	77	47	47.5	65.3
	Brush	24	0	14.8	0.00
	Meadow	12	8	7.4	11.1
	χ^2=15.207 d*f* =3 P=0.002				
Concealment	Good	24	0	14.8	0
	Fair	25	3	15.4	4.2
	Poor	113	69	69.8	95.8
	χ^2=20.313 d*f* =2 P=0.000				
Lee condition	Excellent	39	1	24.1	1.4
	Good	38	6	23.5	8.3
	Fair	67	29	41.4	40.3
	Poor	18	36	11.1	50
	χ^2=53.750 d*f* =3 P=0.000				
water quantity assessment	Large	90	70	55.6	97.2
	Quite large	20	2	12.3	2.8
	Middle	11	0	6.8	0
	Small	41	0	25.3	0
	χ^2=40.621 d*f* =3 P=0.000				
Soil moisture degree	Extremely moist	48	0	29.6	0.0
	Moist	81	33	50.0	45.8
	Dry	21	39	13.0	54.2
	Extremely dry	12	0	7.4	0.0
	χ^2=59.848 d*f* =3 P=0.000				
Water dispersion	Far	117	51	72.2	70.8
	Middle	32	21	19.8	29.2
	Near	13	0	8	0
	χ^2=7.741 d*f* =2 P=0.021				
Anthropogenic dispersion	Far	162	43	100	59.7
	Middle	0	29	0	40.3
	Near	0	0	0	0
	χ^2=74.480 d*f* =1 P=0.000				
Hunters residential area dispersion	Far	62	18	38.3	25
	Middle	71	51	43.8	70.8
	Near	29	3	17.9	4.2
	χ^2=16.417 d*f* =2 P=0.000				

Notes: * Significant difference (P<0.05); ** Highly significant difference (P<0.01).

between the use and non-use plots (Table 3, $P < 0.05$). In the summer, the reindeers used more mixed-shrub vegetation type area (65.3%; $\chi 2 = 15.207$, df = 3, $P = 0.002$), concealment (95.8%; $P = 0.001$), lee condition (50%; $P = 0.001$), large amount of water (97.2%; $P = 0.021$), soil moisture partial drying (54.2%), distance from the nearest water source (≥1000 m, 70.8%; $P = 0.001$), human disturbance distance (≥1000 m, 59.7%; $P = 0.001$), distance from the hunter's residential area dispersion (≥500 m, 95.8%; $P = 0.001$) habitats (Table 3).

Principal component analysis (PCA) revealed that 6 principal components could explain 68.5% of the total variance among all habitat variables (variables in 6 metrics; Table 4). First line of PCA represented arbour (eigen values cumulative 21%); second line represented lichen cover, shrubs height, and canopy (eigen values cumulative 36%); third line represented water quality; and the fourth and fifth lines represented the stump quality and fallen trees (eigen values cumulative 68%) (Table 4).

T a b l e 4. Principal component analysis (PCA) coefficients of 23 reindeer habitat variables in the study area (Variability explained 68.5%).

Variable	Component					
	PC1	PC 2	PC 3	PC 4	PC 5	PC 6
Altitude	-.171	.414	.240	-.284	-.267	.116
Arbor canopy	.771	.178	.369	-.110	.020	.095
Arbor DBH	.809	.036	.387	.020	.085	-.029
Arbor height	.666	.077	.402	.027	-.091	.023
Arbor density	.829	.145	.376	.058	.023	.030
Shrub canopy	-.499	.248	.140	.175	-.154	-.192
Shrub height	-.523	.270	.414	.267	.285	-.075
Ground-plantmuscus-lichen cover	-.108	.673	.249	.077	-.261	.081
muscus-lichen cover	.138	-.544	.053	.287	-.144	.476
Slope gradient	.361	-.125	-.025	-.354	.401	.311
Water dispersion	.396	.332	-.489	.633	-.133	.078
Anthropogenic dispersion	.214	.597	-.424	-.338	.237	.164
Hunters residential area dispersion	.361	.431	-.460	.608	-.021	.143
Concealment	.293	-.481	-.240	-.414	-.397	-.036
Slope aspect	-.210	-.185	-.060	.239	.510	.452
Vegetation type	-.577	-.168	-.342	-.108	-.072	.160
water quantity assessment	-.344	-.382	.671	.074	-.062	.146
Lee condition	.325	-.368	-.286	-.119	-.460	.242
Stump quantity	.470	-.254	-.179	.371	.059	-.461
fallen wood quantity	.278	-.700	-.168	.001	.331	-.316

Our result suggested that 6 variables, namely, the slope position, concealment, anthropogenic dispersion, arbour species, hunter distribution area, and water quality, were significantly responsible for summer habitat selection of reindeer in the unprotected forest habitat (Wilks' Lambda = 0.12; $P = 0.0001$; Tables 5, 6).

T a b l e 5. Variables in the analysis summer habitat selection model.

Model		Tolerance	F to Remove	Wilks' Lambda
1	Slope position	.993	559.373	.719
	Concealment	.993	33.085	.240
2	Slope position	.955	231.486	.373
	Concealment	.930	45.978	.223
	Anthropogenic dispersion	.894	30.192	.210
3	Slope position	.954	132.159	.223
	Concealment	.914	48.345	.171
	Anthropogenic dispersion	.625	83.337	.193
4	Slope position	.951	129.303	.212
	Concealment	.891	36.075	.156
	Anthropogenic dispersion	.625	79.919	.182
	Arbor DBH	.966	10.908	.141
5	Slope position	.949	111.162	.191
	Concealment	.869	25.964	.143
	Anthropogenic dispersion	.524	95.802	.182
	Arbor DBH	.948	13.510	.136
	Hunters residential area dispersion	.777	12.032	.135
6	Slope position	.947	105.198	.176
	Concealment	.815	13.515	.127
	Anthropogenic dispersion	.524	84.306	.165
	Arbor DBH	.945	14.247	.128
	Hunters residential area dispersion	.580	24.622	.133
	water quantity assessment	.609	15.065	.128

T a b l e 6. Wilk's lambda of governing factors for habitat selection of reindeers.

Model	Number of Variables	Lambda	df1	df2	df3	Exact F			
						Statistic	df1	df2	Sig.
1	2	.210	2	1	232	433.907	2	231.000	.000
2	3	.186	3	1	232	335.891	3	230.000	.000
3	4	.141	4	1	232	347.515	4	229.000	.000
4	5	.135	5	1	232	292.223	5	228.000	.000
5	6	.128	6	1	232	257.307	6	227.000	.000
6	7	.120	7	1	232	236.366	7	226.000	.000

Discussion

Our result habitat features such as the slope position, concealment, and anthropogenic factors mainly influenced the reindeers in selection of their habitat in the summer season in the unprotected forest habitat of the study area (Fig. 2). The animal habitat selection is a compre-

Fig. 2. Showing reindeer and its habitat at study area a) reindeer herd, b) male reindeer in habitat, c) female and newborn, d) female reindeer in habitat (© author: Prof. Xiuxiang Meng, 2013).

hensive countermeasure of animals adapting to the environment. The genetic characteristic and physiological property of an animal, climate, habitat properties, food, shelter, bunker, pressure of predation, and competition, all affect the habitat selection function of animals (Noel et al., 1998; Chu et al., 2009; Aryal et al., 2010, 2013, 2014a). Reindeers avoid the anthropogenic-affected areas, and similar results have been reported in other studies (Nellemann, Cameron, 1996; Vistnes, Nellemann, 2001; Pharo, Vitt, 2000). The study area (i.e., Aoluguya) is a famous tourist attraction, with summer (from June to October) being the peak tourist season with high level of tourism-related activities (Helle, Särkelä, 1993; Nelleman, Cameron, 1996; Dyer et al., 2001; Vistnes et al., 2001). The local people of this area largely depend on the forest product resources such as bee herding, collecting wild vegetables, hunting, poaching, and grazing; these activities highly influence the reindeer habitat and its behaviours, and the reindeers try to avoid such anthropogenic-affected areas.

The availability of feeding species of reindeer such as lichen as the main food source and the rising temperature of this region has largely influenced the forest production and lichen production, as lichen growth is dependent on low temperature and forest canopy (Frid, Dill, 2002). Our study suggested that food availability and canopy cover were significantly greater

in the use area as compared to that in the non-use area; therefore, these factors are also responsible for habitat selection of reindeer. Therefore, this study has confirmed that reindeers are forced to choose poor habitat because of their distribution in unprotected areas has high human interference or disturbance. These factors should be considered by the concerned authority or agency to manage the reindeer population in the wild.

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References

Aryal, A., Raubenheimer, D., Subedi, S. & Kattel B. (2010). Spatial habitat overlap & habitat preference of Himalayan musk deer 'Moschus chrysogaster' in Sagarmatha (Mt. Everest) National Park, Nepal. *Current Research Journal of Biological Sciences*, 2(3), 217–225.

Aryal, A., Raubenheimer, D. & Brunton D. (2013). Habitat assessment for the translocation of blue sheep to maintains a viable snow leopard population in the Mt Everest Region, Nepal. *Zoology and Ecology*, 23(1), 66–82. DOI: 10.1080/21658005.2013.765634.

Aryal, A., Brunton, D. & Raubenheimer D. (2014a). Impacts of climate change on human-wildlife- ecosystem interactions in the Trans-Himalayan region of Nepal. *Theor. Appl. Clim*., 115(3–4), 517–529. DOI: 10.1007/s00704-013-0902-4.

Aryal, A., Raubenheimer, D., Ji, W. & Brunton D. (2014b). Blue sheep in the Annapurna Conservation Area, Nepal: habitat use, population biomass and their contribution to the carrying capacity of snow leopards. *Integrative Zoology*, 9, 34–45, DOI: 10.1111/1749-4877.12004.

Banfield, A.W.F. (1961). A revision of the reindeer and caribou genus rangifer. *Bulletin of National Museum of Canada,* 177, 1–137. https://lib.ugent.be/catalog/rug01:000836936

Boyce, M.S., Vernierb, P.R., Nielsena, S.E. & Schmiegelow F.K.A. (2002). Evaluating resource selection functions. *Ecol. Model*., 157, 281–300. DOI: 10.1016/S0304-3800(02)00200-4.

Chen, Z.J. (1985). Protection and utilization of wildlife resources in GenHe (in Chinese). *Natural Resources Study*, 4, 35–40.

Chu, H.J., Jiang, Z.G., Jiang, F., Ge, Y., Tao, Y.S. & Li B. (2009). Summer and winter bed-site selection by Goitred Gazelle (*Gazella subgutturosa sairensis*) (in Chinese). *Zool. Res*., 30(3), 311–318. DOI: 10.3724/SP.J.1141.2009.03311.

Dyer, S.J., O'Neill, J.P., Wasel, S.M. & Boutin S. (2001). Avoidance of industrial development by woodland caribou. *J. Wildl. Manag*., 65, 531–542. DOI: 10.2307/i293832.

Feng, C. & Bai X.L. (2011). The bryophyte consumed by reindeers and species diversity of bryophyte in reindeer habitats (in Chinese). *Acta Ecologica Sinica*, 31(13), 3830–3838.

Frid, A. & Dill L. (2002). Human-caused disturbance stimuli as a form of predation risk. *Conserv. Ecol*., 6(1), 11.

Helle, T. & Särkelä M. (1993). The effect of outdoor recreation on range use by semidomesticated reindeer. *Scand. J. For. Res*., 8, 123–133. DOI: 10.1080/02827589309382761.

Henttonen, H. & Tikhonov A. (2008). *Rangifer tarandus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>.

Jiang, Z.G. (2004). *Principles of animal behavior and species protection methods (in Chinese)*. Beijing: Science Press.

Li, Y.Z. (1988). Reindeers are hard to find in vast Xing'anling mountains (in Chinese). *Chinese Wildlife*, 1, 35–37.

Liao, Z.M. & Xie Y.X. (2011). The economic reasons and difficulties of the Institutional change (in Chinese). *Journal of China Agricultural University,* 28(3), 58–65.

Ma, Y.C. (1986). The management and utilization of reindeer in China. *Rangifer*, 1, 345–346.

Manly, B.F.J., McDonald, L.L., Thomas, D.L., McDonald, T.L. & Erickson W.P. (2002). *Resource selection by animals, statistical design and analysis for field studies*. Dordercht: Kluwer Academic Publication.

Nelleman, C. & Cameron R. (1996). Effects of petroleum development on terrain preferences of calving caribou.

Arctic, 49, 23–28.
Noel, L.E., Pollard, R.H., Ballard, W.B. & Cronin M.A. (1998). Activity and use of active gravel pads and tundra by caribou, Rangifer tarandus granti, within the Prudhoe Bay oil field, Alaska. *Can. Field-Nat*., 112, 400–409.
O'Brien, D., Manseau, M., Fall, A. & Fortin M.-J. (2006). Testing the importance of spatial configuration of winter habitat for woodland caribou: an application of graph theory. *Biol. Conserv*., 130, 70–83. DOI: 10.1016/j.biocon.2005.12.014.
Orians, G.H. & Wittenberger J.F. (1991). Spatial and temporal scales in habitat selection. *Am. Nat*., 137, s29–s49.
Pharo, E. & Vitt D. (2000). Local variation in bryophyte and macro-lichen cover and diversity in montane forests of wesern Canada. *American Bryological and Lichenological Society*, 103, 455–466. DOI: 10.1639/0007-2745(2000)103[0455:LVIBAM]2.0.CO;2.
Skarin, A., Danell, Ö., Bergström, R. & Moen J. (2004). Insect avoidance may override human disturbances in reindeer habitat selection. *Rangifer*, 24, 95–103. DOI: 10.7557/2.24.2.306.
Tang, G. (2008). The plight and countermeasures for Ewenki's reindeer breeding (in Chinese). *Heilongjiang National Series*, 6, 129–134.
Vistnes, I. & Nellemann C. (2001). Avoidance of cabins, roads, and power lines by reindeer during calving. *J. Wildl. Manag*., 65, 915–925.
Vistnes, I., Nellemann, C., Jordhøy, P. & Strand O. (2001). Wild reindeer: Impacts of progressive infrastructure development on distribution and range use. *Polar Biol*., 24, 531–537. DOI: 10.1007/s003000100253.
Wang, Y.Y. (1995). The reindeers and breeding of Ewenki people in the northeast China (in Chinese). *Heilongjiang National Series*, 4, 95–97.
Xiang, H. (2008). The status, confusion, thinking: the investigation and reflection about the existence and development of economy of Aoluguya Ewenki people (in Chinese). *Heilongjiang National Series*, 3, 155–159.
Yin, R.X., Wu, J.P., Wang, J. & Liu S.W. (1999). The reindeer in China (in Chinese). *Chinese Wildlife*, 20(4), 34–34.