MOOSE CONSERVATION IN CHINA: CHALLENGES FOR THE 21ST CENTURY

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ABSTRACT: Studies of Manchurian moose (*Alces alces cameloides*), one of China's species of deer, are scant. Available data indicate that moose numbers and distribution in China are declining. Population estimates in the 1980's is half of that in the 1970's, with an average annual decline of 6.3%. In the Greater Khingan mountain range, moose are relatively abundant and account for 70% of the total. In the Lesser Khingan mountain range however, moose seem to be isolated into 3 local populations, each with an effective population size of less than 500 individuals. Viewed in the long term, moose in Lesser Khingan will have difficulties increasing densities, and may become more isolated by increasing human disturbance. One hundred years ago, the forested moose range of Manchuria covered more than 70% of the land mass, but by the 1980's this forest cover was reduced to only 35%. In the 21st century, the human population in China is predicted to peak between the years 2030 - 2040 resulting in a continued deterioration in the natural environment. Thus, during the next 40 years, conservation and management of moose in China will be under severe pressure. As far back as the 1960's, the Chinese government realized this problem and made efforts to protect moose, both through legislation and management of forests for moose habitat. Ten natural reserves were established on moose range, and four others are in the planning stages. The objectives of forestry have been changed from timber production to sustained development which includes improvement of the environment, wise use of resources, extensive reforestation, forest protection, intensive management, and better living standards for local people. Undoubtedly some of these measures will benefit moose and their habitat. However, the primary problems for moose conservation in China continue to be lack of funding, weak public awareness, and little international involvement.

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China has a rich abundance of deer species, 21 species (40% of the world) belonging to 3 families and 11 different genera. Of these, 15 species, including Manchurian moose (*Alces alces cameloides*), have been designated for protection (Table 1).

Currently, there are no specialized measures or plans focused on moose conservation in China. The substantive protection began in 1962, when the moose was designated as a Protection Class II species which allows for tightly regulated hunting quotas that must be approved by provincial governments. In contrast, species listed on Class I are regulated by the central government.

The objective of this paper is to describe the current level of moose conservation in China and to identify the challenges for moose conservation in the decades ahead.

POPULATION SIZE AND DISTRIBUTION

Historically, moose were widely distributed throughout the Sungari Valley. During the 1700's, moose occupied the Ussuri River Valley (Ma 1992), and by the beginning of the 20th century moose were documented in the WanTa Mountain range (Kaplanov

Table 1. Population size, distribution status, and protection class for deer species in China (from Sheng 1992).

Species	Estimated Population number	Distribution status[1]	Protection class[2]
Tragulidae			
Lesser mouse deer (*Tragulus javanicus*)	<100	L	I
Moschidae			
Siberian musk deer (*Moschus moschiferus*)	>500,000	W	II
Alpine musk deer (*Moschus chrysogaster*)	>500,000	W	II
Himalayan musk deer (*Moschus leucogaster*)	1,000-10,000	N	II
Black musk deer (*Moschus fuscus*)	1,000-10,000	N	II
Cervidae			
Chinese water deer (*Hydropotes inermis*)	10,000-30,000	I	II
Tufted deer (*Elaphadus cephalophus*)	>5000,000	W	
Reeves'muntjac (*Muntiacus reevesi*)	>500,000	W	
Black muntjac (*Muntiacus crinifrons*)	1,000-10,000	L	I
Fea's muntjac (*Muntiacus feae*)	1,000-10,000	L	
Indian muntjac (*Muntiacus muntjak*)	>500,000	W	
Hog deer (*Axis porcinus*)	<100	L	I
Sambar (*Cervus unicolor*)	10,000-30,000	I	II
Eld's deer (*Cervus eldi*)	1,000-10,000	L	I
White-lipped deer (*Cervus albirostris*)	50,000-100,000	I	I
Sika deer (*Cervus nippon*)	1,000-10,000	I	I
Red deer (*Cervus elaphus*)	>500,000	I	II
Pere David's deer (*Elaphurus davidianus*)	<1,000	I	I
Roe deer (*Capreolus capreolus*)	>500,000	W	
Manchurian moose (*Alces alces cameloides*)	10,000-30,000	L	II
Forest reindeer (*Rangifer tarandus*)	<1,000	L	

[1]Distribution W:wide; I:isolated; N:narrow; L:limited
[2]Protection I:first class; II:second class

1948). Presently, moose are primarily distributed throughout the Greater and Lesser Khingan Mountain ranges (Jia 1992, Jia *et al.* 1994, Jia and Faber 1995).

Since the beginning of the 20th century, moose distribution in China has receded northward by 3 degrees of latitude (Jia *et al.* 1994). During the 1970's the moose population in China was estimated at 18,600 animals (Wang 1983). Moose densities were likely higher in previous decades but declined during 10 years of turmoil associated with the Cultural Revolution within China. In the 1980's, moose numbers appeared to further decline to approximately 10,000 animals with the exception of some local increases (Piao *et al.* 1993a). The moose population survival rate during the 1980's was only 53.4%, with an average annual decline of 6.3% (Piao *et al.* 1993a).

The Greater Khingan region is on the southern edge of Eurasian boreal forests and represents the principle moose range in Manchuria. The moose population was estimated at 13,700 in the 1970's (Wang 1983) and continued to decline to approximately 7,000 animals a decade later (Piao *et al.* 1993a). Moose populations are currently isolated in the southern and extreme northern regions of Greater Khingan possibly owing to low human disturbance in both regions.

Table 2. Decline in forest cover, Heilongjiang, Manchuria (EBFH 1993, Chen 1995).

	Year								
	1896	1932	1940	1945	1949	1962	1985	1986	2000
FCR[1]	73	53	55	42	36	40	36	35	51[2]
FA[3]	3310		2582		1670	1808	1238		

[1]FCR: Forest cover rate (%).
[2]Estimated value
[3]FA: Forest area (x 100 km^2).

Moose range in the Lesser Khingan consists mostly of mixed forest habitats (Jia and Faber 1995). Here moose populations numbered 5,000 during the 1970's (Wang 1983) but declined to less than 3,000 individuals by the 1980's (Piao *et al.* 1993a). According to Gao and Jin (1995), moose in Lesser Khingan are isolated, having been separated into 3 local populations at the beginning of the 1990's. One population of approximately 1,400 moose is found near Zhanhe, another is near Yichun (about 600), and the third in the Hebei region is comprised of approximately 1,000 animals.

It is known that moose in China usually produce a single calf (Wang 1981, Piao *et al.* 1993b), and that the adult sex ratio is approximate 1:1 (Piao *et al.* 1993a). If every cow had a successful reproduction, say 1 calf per year, the population should be composed of every adult female with 1 adult male, and 1 calf. The number of adults in a population, therefore, might be composed of 50-70% of the population. Actually, not every cow can give birth in a year (Piao *et al.* 1993b). Thus, the adult numbers in the 3 local populations might be in a range of 700-980, 300-420, and 500-700 respectively, and the effective population size less than 490, 210, and 350 animals respectively, if calculating by half of adult numbers (Nunney and Elam 1994). Since all sub-populations are below 500, then in the long-term, gene-drift could occur (Soule and Wilcox 1980) and populations may experience further declines.

Currently, there are few moose kept in captivity. In total about 6 individuals can be found, 5 in zoos (Beijing 1 M, 1 F; Harbin 1 F; Baicheng 1 M; Jixi 1 M) (Tian, *pers. comm.*), and one in the Songling Deer Farm in the Greater Khingan region (1 F).

HUMAN IMPACT ON HABITAT

Forests are the primary habitat for moose in China. Before the 17th century, human densities in Manchuria were low and the land was completely covered by virgin forests. During the period 1668 - 1840, there were four prohibitions (no cutting, no mining, no fishing/hunting, and no herding) implemented throughout Manchuria under the order of the Qing Dynasty. Forests were well conserved until the end of the 19th century. In Heilongjiang (a part of Manchuria), the area of forest cover was estimated to be 73% in 1896 (ie., EBFH 1993). Since then the land in this region has experienced a rapid decline in forest cover area (Table 2).

Human settlement in Manchuria was relatively late compared to other parts of China. At least 4 immigrations have been documented in Manchuria. In the period 1115 - 1234, about 200,000 southern people moved into Manchuria. A second migration of about 1 million people to Manchuria occurred in the period 1635 - 1643 (Chen 1995). In 1734, the population of Heilongjiang totaled only about 26,000 people. In 1841, after the period of 4 prohibitions, more than 100,000 people per year moved into Heilongjiang from south China. However,

Table 3. Human population increase in the Heilongjiang region of Manchuria (Chen 1995).

Year	1734	1812	1900	1912	1923	1931	1949	1986
People (Million)	0.026	0.444	3.00	2.17	3.60	6.00	10.14	33.85

the bulk of extensive immigration has occurred since 1923 (Table 3).

Between 1732 and 1734, a post road was built from Qiqihar to Hailar (covering the entire northern Heilongjiang) which brought an influx of economic activities. Forests at this time were minimally affected because of low human populations. It wasn't until the late 19th and early 20th centuries that widespread forest removal occurred during 3 discrete phases (EBFH 1993, Chen 1995). Phase I began in 1858 when Russians occupied the far east region. In a period of 27 years (1896 - 1923), a railway was built in Heilongjiang that used 2.5 million ha of land, and tremendous numbers of trees were removed along the railway right-of-way. The railway also resulted in attracting people who exploited the wild land and converted forests into farmlands. Phase II occurred between 1911 - 1921 when mass immigration was out of control. People cut trees for fuel wood, and to build houses and furniture, all causing considerable forest destruction. Phase III lasted from 1922 - 1945, when the Japanese controlled Manchuria. During this 23 year period, about 4 million ha of forests were cut in all of Manchuria, 2 million ha of which were in the Heilongjiang area. In the years 1931 - 1935, the Japanese carried out a policy of Village Emergence that led to forest destruction in remote mountain areas because many people were migrating and there were frequent forest fires along railways. From 1896 to 1949, the area of forest cover in Heilongjiang declined 51%, i.e. half of the original forests were lost within 50 years.

In the years 1949 - 1986, tree harvesting continued in Heilongjiang, although there was some planting, with the amount of forest consumption 2 to 2.5 times that of the forest growth due to the timber industry. The forest quality decreased. In the decade 1976 - 1986, forest area continued to decline by an average of 85,000 ha annually. Approximately half the Heilongjiang forests in the late 1980's had no timber for harvest (Chen 1995).

The diminishing of forests obviously affects the local climate, water, and soil. Air humidity has decreased 1.3%, precipitation has declined by 10%, and soil fertility has dropped (Chen 1995). At the same time, increases in evaporation (9%), temperature (0.5 C), windy (> 11 m/s) day, soil erosion, and desertification have occurred (Chen 1995). Throughout China, deserts expanded an average of 1,560 km^2 annually from the 1950's to the 1970's, and increased to 2,100 km^2 in the 1980's. The organic matter in soil also has declined 0.05% - 0.1% annually, especially in the eastern mountains where 7.64 million ha of soil has eroded. One third of the agriculture lands in Heilongjiang suffered various effects every year (EBFH 1993). In Sunglen Plain, the affected area enlarged 4 times within 3 decades. In the 3-Rivers Plain, the area of flooding has increased 1.85 times, up to 1.27 million ha, including 60% of the farmlands. In some rivers such as Muling, the amount of washed soil has increased 39% from 1962 to 1975. This resulted in a 1.5 m rising of the river bed and a 3 m widening of the river body (EBFH 1993).

Intensive cutting also has resulted in changes to forest structure in Heilongjiang. In several areas, forests regenerated to oak (*Quercus mongolica*) of early succession with tree ages now in the 30 - 60 year range.

In the 1960's, oak forests covered up to 75.2% in some areas such as Lenjiang at the southern edge of Greater Khingan. However, oak is a non-preferred food for moose in Manchuria, comprising only about 4% of food in winter (Yu *et al.* 1992). Coniferous trees comprised 63% of Heilongjiang forests in the 1950's, but dropped to 33% by the 1980's, a reduction of 47% within 40 years (Chen 1995).

The area of original forests in Heilongjiang continues to decrease, to 46.5% in the decade 1975-1985 (Yan and Chen 1995). However, due to forest silviculture during the period 1950 to 1986, 8.74 million ha of lands were planted, of which 3.39 million ha or 39% have been successful. These plantations contain 1.63 million ha of mature forests and 1.62 million ha of young trees (Table 4).

Forest fires have had a negative effect on the current state of forests, primarily in the regions of Greater Khingan and Heihe (Table 4). However, regeneration from fires has provided a greater quantity of food for moose (Ma *et al.* 1993).

The 3-River Plain, one of the largest wetlands in China and with a historical presence of moose, encompasses an area of approximately 110,000 km^2. Up until 1949, only 6,200 km^2 had been converted to agriculture. Beginning in 1958, development of the plain was accelerated and by 1983 approximately 38,000 km^2 (34.1%) of the area was in agriculture. The area of wetland has continued to decrease, and by the 1990's only 45% remained. Forest cover rate in the plain decreased by 23% by 1983 (Li 1996).

Natural predators of moose are believed to have played little or no role in moose population regulation. Siberian tigers (*Panthera tigris*) were regarded as a moose predator before the 1960's. Tigers were once distributed along the upper reaches of Huma River, Greater Khingan, but disappeared in the 1970's (Ma 1979). In the late 1980's, tigers became extinct in the Lesser Khingan (Wu *et al.* 1994), and at present, they can only be found in the Eastern Mountain regions (Gao and Ma 1996). Black bears (*Selenarctos thibetanus*) live only in parts of the Lesser Khingan, but remain at low densities (average 7 ind./1,000 km^2) (Zou and Ma 1997). Brown bears (*Ursus arctos lasiotus*) inhabit both the Greater and Lesser Khingans, at even lower densities (3 ind./1,000 km^2) (Zou and Ma 1997). Neither bear species have been recorded killing moose.

CONSERVATION AND MANAGEMENT

In recent decades, the Chinese government has made great strides in wildlife conservation. For example, 7 programs have been developed and implemented to save

Table 4. Forest structures in 5 moose ranges of Heilongjiang, Manchuria (EBFH 1993)

	Moose Range[1]				
	GK	YC	HJ	SH	HH
Area of young plantation (thousand ha)	780	710	340	460	1110
Area of mature plantation (thousand ha)	730	1340	530	1020	560
Young : Mature plantation	2:2:6	3:6:1	3:5:2	3:6:1	5:3:2
Yearly average fire area (thousand ha)	73.6	0.73	12.9	1.2	55.5
Average annual no. of forest fires	42	35	52	44	52

[1]GK:Greater Khingan, YC:Yichun, HJ:Hejiang, SH:Songhuajiang, HH:Heihe

endangered species, which include the Giant Panda (*Ailuropoda melanoleuca*), Japanese Crested Ibis (*Nipponia nippon*), Yangtzi Alligator (*Alligator sinensis*), Eldi Deer (*Cervus eldi*), Wild Horse (*Equus przewalskii*), David Deer (*Elaphurus davidianus*), and Saiga (*Saiga tatarica*). Seven ecological forestry programs have been implemented since 1970, including 3-North Protective Forests (42.4% of China's area), Protective Forest in the middle-upper Yangtzi River (20 million ha), Coastal Protective Forest (3.55 million ha), Agriculture Protective Forests in the North-China Plain (29 million ha), Taihang Mountains Reforestation, Desert Reforestation, and Plantation of Fast Growth Trees in 16 provinces (Yan 1995). Artificial breeding and *ex situ* preservation of endangered species began in the 1950's, and now includes 171 zoos and 110 botanical gardens. In 1994, China adopted the China Agenda 21 following the UN Environment and Development Conference of 1992. A Plan for Biodiversity Conservation was completed in 1994 and the Forestry Action Plan of China Agenda 21 in 1995. An office of Wetlands International China Program was opened in 1996. In addition, a comprehensive project of Wildlife Inventory (1996-1999) is currently being carried out throughout China (Chen and Guan 1997).

China has a long history of moose exploitation (Jia 1992). Although no specific conservation programs are in place, since the 1960's moose have been listed in the second class of nationally protected animals. In Heilongjiang, the provincial government closed moose hunting except for a few low quotas for minority people. During the Cultural Revolution (1966-1974), this restriction was ignored due to the turmoil in China. Since 1974, this hunting regulation has been re-established. In Heilongjiang, legal moose hunting is currently forbidden for most people, however fewer than 20 moose per year are set aside for minorities to harvest. In 1989, China published the Wildlife Conservation Act and National List of Protected Animals, in which the moose are listed as "second class" and since then they have received legal protection. Beginning in 1993, China instituted a new policy charging 700 Chinese Yuan for a moose hunting permit (China Forestry Ministry 1994). Yet, poaching continues to be a chronic problem throughout China.

The construction of nature reserves in China started in 1953. In total, 766 reserves covering approximately 66.18 million ha have been established up to 1993, which is 6.8% of China's total land area. It is expected that by the year 2000 the number of reserves will reach 1,000. Of established reserves, 501 are designated for forest and wildlife, 284 for wild animals and plants, and 214 for wild animals only. A further, 90 are national controlled reserves, and 9 are MAB (Man And Biosphere) biosphere reserves. Of the wild animal reserves, 257 animal species/subspecies have been protected including the Giant Panda (16 reserves), the Golden monkey (*Rhinopithecus roxellanae*, 2 reserves), Siberian tiger (*Panthera tigris altaica*), Asian elephant (*Elephas maximus*), gibbons (*Hylobates* spp.), gazelles (*Gazella* spp.), and Eldi deer (*Cervus eldi*) (Xue and Jiang 1995). Moose are protected in the forest and wildlife reserves.

There are 10 nature reserves established in Manchurian moose range (Ma 1992), including the Huzhong, Hanma, Nuominhe, Shengshan, Heilonggou, Honghuaerji, Xinlin and Wudihe in the Greater Khingan, and Fenglin and Honghe in the Lesser Khingan. Of these, Huzhong Reserve (194,000 ha) is a typical boreal ecosystem within which the Xing'an Larch (*Larix dahurica*) composes 90% of forest cover and moose is the main mammalian species protected. This reserve was regarded by the World Wildlife Fund and

Chinese government as one of 40 reserves of international significance (A class) (Meng 1993). Four additional reserves (Humahe, Xinglong, Zhanheding, and Dapingtai) are scheduled to be established in the next few years.

CHALLENGES AND GOALS FOR THE 21ST CENTURY

The future of Manchurian moose in China is currently uncertain. Pressures will continue to come from the following 5 aspects:

1. The overall nature environment of China is growing worse, and its rich biodiversity is seriously threatened. One quarter (156 species) of the 640 endangered species listed on the CITES list are found in China. In the last 5 decades, more than 200 plant species have become extinct, and another 4,600 plant species and more than 400 animal species have become endangered/rare. These flora and fauna comprise 15-20% of species in the entire country (Yan and Chen 1995, Xu 1995). During the 20th century, 8 mammalian species/subspecies became extinct in China, and it is estimated that another 40 will probably become extinct in the 21st century (Yu and Xing 1995).

2. Human populations will further increase and continue to exert heavy pressure on wildlife. Currently, the average human increase is 14 million per year, and a population peak of 1.6 billion people is predicted in the 2030's or 2040's (Wang 1995). It has been documented that the habitats of moose are shrinking with increased human populations (Jia and Faber 1995).

3. Current popular awareness and education of conservation issues in China is weak. Although the Chinese government has made a determined effort to raise public understanding in wildlife conservation, there has been little response by the common people. Ideologically, Chinese people cannot extricate themselves from traditional Chinese medicine and there remains a conflict between animal utilization and conservation programs. Many people continue to poach in order to fulfill basic survival needs and traditional customs. Therefore, the destruction of nature, illegal trading, and consumption of wild animals (both I and II protected classes) are still commonplace. Although legislation concerning wildlife conservation and protection has been enacted, the law is not strictly obeyed. Rapid economic development has conflicted with resource conservation, especially with respect to the current agricultural exploitation that converted extensive areas of forestlands and wetlands into farmlands. Hence, in the future, human encroachment and intervention are the main threat to the Manchurian moose.

4. Wildlife conservation and research are seriously hampered by inadequate funding. Current nature reserves and parks cannot play their proper role due to a lack of funds, and it is difficult to develop moose conservation programs. China is now focused on economic development in order to increase living standards. Therefore, moose conservation gets relegated to a low priority and what efforts are expended get focused on endangered animals like the panda, golden monkey, tiger, and others. Nature reserves alone are not considered adequate for long-term moose conservation.

5. International involvement in moose research in China is minimal, even though some attention to Manchurian moose has recently begun. Studies on *A.a. cameloides* are extremely weak when compared to other subspecies (Jia *et al.* 1994), and the evolutionary position of *A. a. cameloides*, is still not clear, though preliminary data on mtDNA markers suggests that *A. a. cameloides* may be genetically similar to *A. a. alces* (Leif Andersson, *pers. comm.*). Panda research and protection have dem-

onstrated that international involvement can make a positive contribution to wildlife studies and conservation in China. However, it may be a more difficult venture to conserve moose because of its circumpolar distribution in the world.

From a more positive perspective, China and its people are making some efforts to improve the habitats and populations of wildlife including moose. These efforts include:

1. Increasing the area of forest cover. In Heilongjiang, it may be possible to increase forest cover from the current 35% to about 51%, considering the present rate of forestry development. It is even expected that in the Lesser Khingan the current forest cover rate of 56% could increase to about 75% (EBFH 1993).

2. Changing forest management policy from solely timber production to more sustainable ecological forestry. This includes recognizing the multi-values of forests, wise-use of resources, forest protection, intensive management, extensive reforestation, improvement of the environment, better living standards for local people, and increased use of fast growing stock (Yan and Chen 1995).

3. Increasing the number of nature reserves. The target area of nature reserves in China is 10% of the landmass by the year 2000, and 15% by the year 2050 (Xue and Jiang 1995).

4. Increasing public education and awareness of wildlife conservation, improving legislation concerning wildlife, and strengthening scientific research of wildlife.

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