

Distribution and conservation of the Sino-Mongolian beaver *Castor fiber birulai* in China

HONGJUN CHU and ZHIGANG JIANG

Abstract The Sino-Mongolian beaver *Castor fiber birulai* lives in the Ulungur watershed in China and Mongolia, an area little known to the people outside this region. We recorded the number of families, adults, subadults and juveniles at each of three beaver lodges in the Bulgan Beaver Nature Reserve in 2003, 2006 and 2007. Along the whole Ulungur watershed in China in each of the 3 years we conducted surveys for the beaver and estimated the total population based on the area of food caches. We recorded 135, 167 and 145 Sino-Mongolian beaver colonies and estimated a population 472–599, 543–700 and 508–645 beavers in 2003, 2006 and 2007, respectively. From 1989 to 2007 the number of human households in the Bulgan Nature Reserve increased by 112% and the population by 71%. Consequently human activities in the river valley, including collection of wood for fuel, increased. We also surveyed the site of a relocation of *C. f. birulai* from the Bulgan River to the Ertix River in 1992 but found no sign of living beavers. The population of the Sino-Mongolian beaver in China is small and restricted geographically. Threats, such as habitat modification and deterioration and competition with people for wood, continue. We recommend that the Bulgan Beaver Nature Reserve be expanded by a transfrontier agreement with the appropriate authorities in Mongolia, and that a plan for sustainable wetland management and restoration is required.

Keywords Beaver, *Castor fiber birulai*, Mongolia, Ulungur watershed, China.

Introduction

There are two beaver species: the American beaver *Castor canadensis* and the Eurasian beaver *Castor fiber* (Müller-Schwarze & Sun, 2003). *C. fiber* has recovered across much of its range as a result of conservation programmes and has been assessed for the IUCN Red List as of Least Concern (IUCN, 2008). The Asian populations, however, are small and threatened and conservation measures are urgently required (IUCN, 2008). The Sino-Mongolian beaver

C. f. birulai is a threatened subspecies that lives only in the Ulungur watershed between Mongolia and China, comprising the Bulgan River, which flows from Mongolia, and the Major and Minor Qinghe and Chargan Rivers, which flow into the Ulungur River and into Ulungur Lake in Altay Prefecture, Xinjiang Uygur Autonomous Region (Fig. 1). Russian authorities introduced both *C. fiber* and *C. canadensis* to the Amur river (Halley & Rosell, 2002) but there is no evidence that populations established on the bank of the Amur river in Chinese territory.

C. f. birulai is one of the rarest and least known aquatic mammals in China, with only one substantial population known (in the Bulgan River Beaver Reserve along the Xinjiang-Mongolian border, with an estimated 500 individuals; IUCN, 2008). *C. f. birulai* was listed as endangered by the US Fish and Wildlife Service in 1980 (USFWS, 1999) and is listed as a First Class National Key Protected Wild Animal Species in both China and Mongolia.

C. f. birulai lives in rivers that pass through desert and thus the biology of this subspecies is typical of a beaver living in an environment that has limited productivity. Reproductive rate is low and it is difficult to breed the subspecies in captivity (Lu, 1981). The forested river valleys that are the typical habitat of *C. f. birulai* have many human settlements and intensively farmed or grazed areas; these activities are threatening the survival of *C. f. birulai* (Lu, 1981; Liang, 1985). To protect the subspecies' population and habitats two reserves were established, in the Bulgan River valleys in Mongolia and China, in 1965 and 1980, respectively.

The first survey of *C. f. birulai* was carried out on the Major and Minor Qinghe, Chargan and Bulgan Rivers in the 1950s (Lu, 1981), and a further survey was conducted at the time of the establishment of the Bulgan Beaver Nature Reserve in 1980 (Liang, 1985). In 1989, 860 km of surveys were conducted along the Major and Minor Qinghe, Chargan and Bulgan Rivers of the Ulungur watershed in China; the number of beaver families was recorded, the total number of beavers estimated, and conservation recommendations made (Shao, 1990). However, because of a shortage of funds no surveys of *C. f. birulai* in the Ulungur River valley were conducted in the 1990s apart from occasional patrols by wildlife managers along the Ulungur watershed in China and the 250 km Bulgan River in Mongolia. The lack of surveys and monitoring has hindered the implementation of effective conservation measures for the species. We therefore conducted surveys for *C. f. birulai* along the Major and Minor Qinghe, Chargan, Bulgan Rivers and other sections of the whole Ulungur watershed in China in 2003, 2006 and 2007. Based

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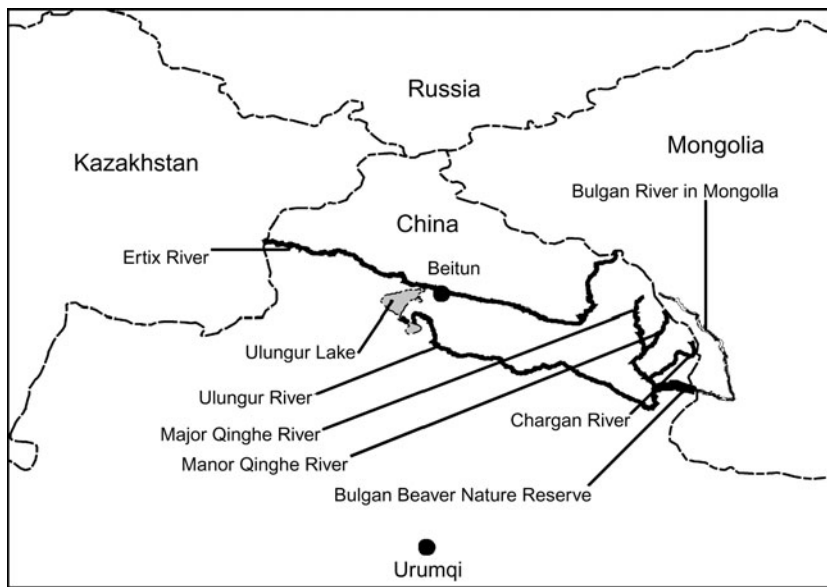


FIG. 1 The Ulungur watershed in Altay Prefecture, Xinjiang Uygur Autonomous Region, China, showing the rivers surveyed, including that of the Bulgan Beaver Nature Reserve.

on our results and other available data, we make conservation recommendations for this threatened subspecies.

Study area

The rivers of the Ulungur watershed flow through 16 *Xiang* (townships, an administrative level under the county government in China) in Qinghe, Fuyun and Fuhai Counties in Xinjiang (Fig. 1). The oases along the rivers are surrounded by the moraine of Mount Altay and Gurbantunggut Gobi. The altitude of the watershed is 460–4,000 m, and the climate is continental cold temperate, with a 6-month winter, a frost free period of c. 67–115 days, and maximum and minimum temperatures of 34.3 and -49.7°C , respectively. The area is dry, annual precipitation is only one tenth of the evaporation, and c. 33% of the annual precipitation falls as snow. Depth of snow cover is usually c. 80 cm and the frozen soil layer is c. 70 cm deep in winter.

Methods

Along the 50 km river valley of the Bulgan Beaver Nature Reserve (Fig. 1) we interviewed the head of every household in 2003, 2006 and 2007 to record the number of people and the number of livestock held (there are Kazak, Han, Uygur and Mongol ethnic groups in the region but Kazaks comprise the majority of the population).

A beaver colony is defined as a group of beavers occupying a pond or a stretch of stream, using a common food supply, and maintaining a common dam or dams (Bradt, 1938). A colony may use several lodges or bank dens in summer but only a single food cache in the autumn and one lodge in winter (Hay, 1958). A colony site, as defined in this study, was a pond or series of ponds used by a colony of beavers throughout the year. Individual sites were usually

separated by a section of stream unaltered by beavers. If there was no unaltered section of stream the use of separate food caches in the autumn was presumed to distinguish colonies (Hay, 1958).

We made dawn and dusk observations, following Easter-Pilcher (1990), Osmundson & Buskirk (1993) and Rosell et al. (2006), of three *C. f. birulai* families in the Bulgan Beaver Nature Reserve in September and October of 2003, 2006 and 2007. One person conducted observations upstream of a beaver lodge whilst a second observed downstream, over 3 consecutive days.

In October of 2003, 2006 and 2007 we searched the whole Ulungur watershed for beaver food caches, lodges and foraging sites. In November of all 3 years we then used standard beaver survey methods (Hay, 1958; Novak, 1977; Svendsen, 1980; Shao, 1990) in all locations where we found evidence of beavers, recording vegetation composition and coverage, food caches, incisor cutting width by beavers on tree trunks, size of hind footprints, positions and sizes of overwinter lodges, any dams, and presence of a breathing hole on beaver lodges after snow covered the ground. We also took photos of each beaver family.

Following Easter-Pilcher (1990) we estimated the number of beavers in the whole Ulungur River watershed in China based on the food cache sizes recorded and the relationship between number of beavers and food cache size.

TABLE 1 Number of human residents and livestock in the Bulgan Beaver Nature Reserve (Fig. 1). Data for 1989 are from Shao (1990).

Year	Households	Number of				
		residents	Sheep	Horses	Cattle	Camels
1989	329	2,159	50,969	2,184	4,677	1,390
2003	601	3,325	44,226	1,559	3,635	885
2006	703	3,749	22,351	1,709	3,534	736
2007	698	3,689	36,698	1,938	3,534	684

TABLE 2 Numbers of adults, subadults and juveniles, family size, and food cache area of *Castor fiber birulai* at three beaver lodges observed in October–November 2003, 2006 and 2007. The ranges of the data are the results of two observers, each searching for beavers either up or downstream (Easter-Pilcher, 1990).

Lodge	No. of adults	No. of subadults	Juveniles	Family size	Food cache area (m ²)
2003					
Grassland station	1	0	0–1	1–2	12
Delehan's	2	0	0–2	2–4	20.8
Poplar dam	2	2–3	2–3	6–8	42
2006					
Grassland station	1	0–1	0	1–2	29.5
Delehan's	2	0–1	1–2	3–5	50
Poplar dam	2	1–2	2–3	5–7	75
2007					
Grassland station	2	0–2	1–2	5–6	70
Delehan's	2	1	0–1	2–4	44
Poplar dam	2	1	1–2	4–6	60

C. f. birulai used to inhabit in the Ertix River but was extirpated there in the 1980s (Lu, 1981; Liang, 1985). In a restoration attempt two *C. f. birulai* families, including a subadult, were translocated from the Bulgan Beaver Nature Reserve to the Ertix River, near Beitun (Fig. 1), on 12 October 1992. On 18 October 2003 we surveyed the translocation site to verify the fate of the released beavers.

We used the Kolmogorov-Smirnov Test to check normality of the data collected, and then a 1-way ANOVA to examine differences in habitat variables at colony sites between years. SPSS v. 13.0 was used for all statistical analyses (SPSS, Chicago, USA).

Results

Human activities generally increased in the region. From 1989 to 2007 the number of households in the Bulgan Beaver Nature Reserve increased by 112% and the human population by 71% (Table 1).

Areas of the food caches of poplar *Populus canescens* and *Populus laurifolia* twigs, and numbers of beaver families, adult, subadult and juvenile beavers at the three

beaver lodges in 2003, 2006 and 2007 in Bulgan Beaver Nature Reserve are given in Table 2.

Beaver families were found on all of the rivers surveyed (Fig. 1) and there was little variation in locations of lodges between years. We recorded 135, 167 and 145 beaver colonies in 2003, 2006 and 2007, respectively. Based on the relationship between food cache area and beaver family size (Table 2), we estimated there were 472–599, 543–700, 508–645 beavers in 2003, 2006 and 2007 respectively (Table 3). Numbers of *C. f. birulai* families in the Ulungur watershed remained relatively stable during the study period, except that the number of beaver colonies in the Ulungur River decreased slightly (Fig. 2).

Characteristics of the habitat of *C. f. birulai* in the Ulungur watershed are summarized in Table 4. One-way ANOVA indicated that the altitudes of locations where *C. f. birulai* were found did not differ among years but that all other characteristics were significantly different between years.

The number and characteristics of located beaver dams, built to elevate the water table, are given in Table 5. Beavers debarked trees and cut tree branches and twigs to build dams where the water flow was slow, and filled dams with leaves, grasses and mud.

TABLE 3 Food cache area, number of colonies, number of beavers per colony and estimated total number of *Castor fiber birulai* in the Ulungur watershed (Fig. 1) in 2003, 2006 and 2007.

Area of food cache (m ²)			No. of colonies			No. of beavers per colony			Total no. of beavers		
2003	2006	2007	2003	2006	2007	2003	2006	2007	2003	2006	2007
≤10	≤20	≤18	10	10	9	1	1	1	10	10	9
10.1–15	20.1–30	18.1–30	18	23	17	1–2	1–2	1–2	18–36	23–46	17–34
15.1–20	30.1–40	30.1–38	20	37	19	2–3	2–3	2–3	40–60	74–111	38–57
20.1–25	40.1–50	38.1–45	27	31	33	3–4	3–4	3–4	81–108	93–124	99–132
25.1–30	50.1–70	45.1–60	22	25	26	4–5	4–5	4–5	88–110	100–125	104–130
30.1–35	70.1–85	60.1–80	16	16	21	5–6	5–6	5–6	80–96	80–96	105–126
35.1–40	85.1–100	80.1–100	13	12	11	6–7	6–7	6–7	78–91	72–84	66–77
>40	>100	>100	11	13	10	7–8	7–8	7–8	77–88	91–104	70–80
<i>Total</i>			137	167	145				472–599	543–700	508–645

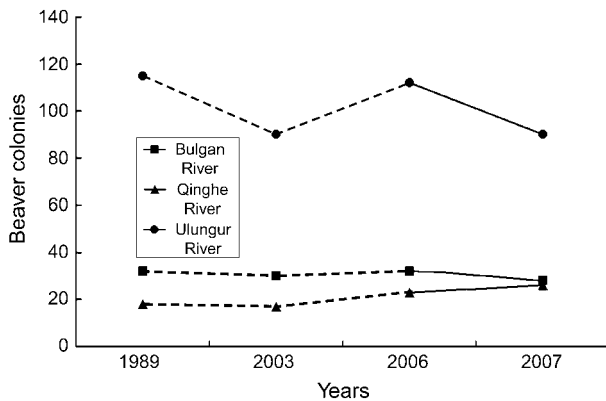


FIG. 2 Number of Sino-Mongolian beaver families in the Bulgan, Qinghe and Ulungur Rivers (Fig. 1). Data for 1989 are from Shao (1990).

We did not discover any trace of *C. f. birulai* in the Ertix River where they were released in 1992, despite a thorough search up and downstream of the release site.

Discussion

There are many reports of the dam-building behaviour of beavers, especially of the American beaver. Berry (1923) reported American beavers building dams up to 65.5 m long but *C. f. birulai* do not usually build dams because they live in deep water rivers. However, a severe drought in the Bulgan River in August 1982 caused the flow to reduce to 0.31–0.41 m³ sec⁻¹, only 1.0–1.3% of the average flow volume. There was almost no water in the upper river, and *C. f. birulai* built dams to increase the water level (Liang, 1985). We found that *C. f. birulai* built dams in areas of shallow water, presumably to elevate the water table to cover up the entrance of the lodge to protect cubs. The current dam-building behaviour of *C. f. birulai* in China may reflect the deterioration of their habitat.

From mid October to mid November is the best season for surveying the Sino-Mongolian beaver, as for the America beaver (Swank & Glover, 1948; Payne, 1981, 1982; Swenson

et al., 1983; Robel & Fox, 1993; McTaggart & Nelson, 2003) and other subspecies of *C. fiber* (Hartman, 1994; Halley & Rosell, 2002; Rosell et al., 2006). If we had started the surveys earlier the beavers would have not yet have started building their lodges, observation of which is the main method of counting beavers. If the survey was conducted after late November, the beaver lodges would already have been covered by snow and therefore difficult to locate.

The size of *C. f. birulai* food caches that we recorded was smaller than reported by Lu (1993), possibly because our surveys were 1 month earlier than his. A food cache is the sign of overwinter activity. Osmundson & Buskirk (1993) argued that American beavers stop caching foods when the water freezes and that thus the area of food cache is not correlated with family size. However, Lu (1993) and Easter-Pilcher (1990) affirmed a correlation between food cache and family size, and we also found the family size of *C. f. birulai* is related to the area of the food cache.

Although the Bulgan River is only c. 10% of the total length of the Ulungur watershed in China, c. 23% of the *C. f. birulai* population in China live along this river. The Bulgan Beaver Nature Reserve thus plays a key role in the conservation of the species in China. However, the beaver population in the 50 km² reserve may be at carrying capacity and therefore consideration should be given to enlargement of the Reserve. One possibility would be the establishment of a transfrontier Nature Reserve. This would require negotiations between the Wildlife Management Authority in Altay Prefecture and its Mongolian counterpart.

We estimated there were 472–599 Sino-Mongolian beavers in 2003, 543–700 in 2006 and 508–645 in 2007 in the Ulungur River watershed of China. Surveys in 1991 estimated there were c. 300 *C. f. birulai* along the Bulgan and Chovd Rivers in Mongolia (Stubbe et al., 1991), and this number remained stable up to 2005 (Ducroz et al., 2005). In 1983 the total population of *C. f. birulai* was estimated to be 800 (Lavrov, 1983) and was presumed stable up to 2002 (Halley & Rosell, 2002). Compared with the census in 1989

TABLE 4 Characteristics of the habitat of *C. f. birulai* in Ulungur watershed (Fig. 1) in 2003, 2006 and 2007 (all values are mean ± SD), and results of ANOVA (*F*) comparisons between years.

Habitat characteristic	2003 (n = 137)	2006 (n = 167)	2007 (n = 145)	<i>F</i> (<i>P</i>)
Altitude (m)	876.45 ± 201.60	880.49 ± 215.72	889.59 ± 215.11	0.236 (0.790)
River bank height above river water level (m)	1.42 ± 0.33	1.14 ± 0.49	1.55 ± 0.45	34.405 (<0.001)
River bank water depth (m)	1.39 ± 0.42	1.83 ± 0.49	1.61 ± 0.47	32.363 (<0.001)
Maximum tree trunk diameter 10 cm above ground of trees cut by beaver (m)	0.24 ± 0.17	0.32 ± 0.19	0.19 ± 0.20	26.597 (<0.001)
Tree branch diameter 10 cm above ground of trees cut by beaver (m)	0.02 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	27.666 (<0.001)
Longest harvesting distance to river bank (m)	19.50 ± 4.06	54.64 ± 52.99	50.92 ± 46.72	41.657 (<0.001)
Shortest harvesting distance to river bank (m)	2.37 ± 1.16	2.51 ± 1.97	0.04 ± 0.09	7.013 (<0.001)
Arboreal cover at colony (%)	0.16 ± 0.13	0.29 ± 0.17	0.44 ± 0.19	97.998 (<0.001)
Furthest cutting signs found upstream (m)	82.19 ± 40.37	163.89 ± 104.09	188.82 ± 128.21	26.325 (<0.001)
Furthest cutting signs found downstream (m)	23.70 ± 35.70	127.04 ± 86.45	132.16 ± 108.24	23.677 (<0.001)

TABLE 5 Characteristics of *C. f. birulai* dams located in the Ulungur watershed (Fig. 1) in 2003, 2006 and 2007. All values are mean \pm SD.

Years	n	Length of dam (m)	Width at bottom of dam (m)	Width at top of dam (m)	Height of bottom of dam (m)	Water table level elevated (m)
2003	6	15.71 \pm 6.41	1.08 \pm 0.28	0.42 \pm 0.14	0.76 \pm 0.26	0.58 \pm 0.29
2006	16	18.31 \pm 29.74	0.84 \pm 0.68	0.52 \pm 0.25	0.92 \pm 0.22	0.55 \pm 0.20
2007	12	22.86 \pm 33.98	0.45 \pm 0.17	0.74 \pm 0.36	1.01 \pm 0.4	0.60 \pm 0.19

(Shao, 1990) our surveys indicate a potential decline in the number of beaver colonies in the Ulungur River (Fig. 2). Causes for this decline could be the logging and land reclamation that has occurred in the river valley and construction of a dam in the upper Bulgan River, which lowered the water table in the river. The increasing human population, and a concomitant increase in wood-burning stoves, means that the human population is competing with beavers for the wood of poplars.

The Mongolian Wildlife Management Authority has successfully relocated *C. f. birulai* from the Bulgan River to the Chovd River, where the beaver had been earlier extirpated (Halley & Rosell, 2002). The most recent population assessment, in 2004, recorded 40 beaver lodges along the Chovd River and a population of c. 130–150 beavers (Shar, 2005). The attempted relocation of *C. f. birulai* to the Ertix River in China appears to have been unsuccessful, although field surveys found traces of beavers during the year immediately after the relocation (Huang, 1993). The number of beavers relocated, only five, was probably insufficient. In contrast, four *C. f. birulai* were translocated to the Chovd River in 1959–1960, and 35 in 1974–1985 (Stubbe & Dawaa, 1986).

There is a cluster of populated oases in the Ulungur River watershed in northern Xinjiang (Shen et al., 2001), and *C. f. birulai* is a potential flagship species for conservation in these areas because the status of the beaver reflects the condition of the river and wetlands of the watershed (Chu, 1993). For the protection of the biodiversity of the Ulungur River watershed and its oases, and of the only Sino-Mongolian beaver population in China, a plan for sustainable wetland management and restoration is required. An alternative energy source for the human population is also required, to reduce their dependence on fuelwood collected in the river valleys. Any such plan will need to include reforestation of the river valleys.

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Biographical sketches

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