

## Cinereous Vulture Nesting Ecology in Ikh Nartyn Chuluu Nature Reserve, Mongolia

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### Abstract

Cinereous vultures (*Aegypius monachus*) are the largest raptors in Eurasia. Little is known about the species, especially in Mongolia. We studied the nesting ecology of cinereous vultures in Ikh Nartyn Chuluu Nature Reserve, Dornogobi Aimag. To assess reproductive success, we located active nests and periodically checked to determine if they remained active. We measured nest sizes and, periodically, nestling sizes and weights. We located 42 active cinereous vulture nests (27 on rocks and 15 on trees) in 2003 and 19 nests (14 on rocks and 5 on trees) in 2004. Mean volume of active nests was  $3.92 \pm 0.39 \text{ m}^3$  ( $n = 36$ ). Most nests failed prior to egg hatching, but after hatching nesting success rates increased dramatically. Following hatching, cinereous vulture chicks grew linearly until leveling off just prior to fledging. We generated growth curves for chicks that allowed us to determine the average size of chicks on specific dates. Improving the prospects for successful cinereous vulture conservation likely requires a better understanding of nesting ecology. As such, we plan to improve the quality of our data by monitoring nests more intensively to determine incubation and fledging lengths, as well as causes of nest failures.

**Key words:** *Aegypius monachus*, Cinereous vulture, Gobi, Mongolia, nesting ecology

### Introduction

Cinereous vultures (*Aegypius monachus*) are the largest raptors in Eurasia, sporting impressive 2.5 – 3 m wingspans and weighing 7 – 13 kg (Del Hoyo *et al.*, 1992; Álvarez & Garcés, 1997). The species appears to be faring well in Mongolia, although internationally conservationists have expressed concern over the status of the species. Listed as Vulnerable in 1994 by the IUCN, the species was upgraded to Near Threatened in 2000, where it remains today despite continued population declines (IUCN, 2004). Little is known about the species in Mongolia, although a few research projects were recently initiated. For example, Korean researchers have studied the species in Ikh Gazariin Chuluu in Dundgobi Aimag, and researchers from Mongolia and USA have been studying the ecology of cinereous vultures in Hustai National Park and Erdenesant soum of Tov aimag since 2002 (Batbayar, 2004).

Ikh Nartyn Chuluu Nature Reserve (Ikh Nart) in Dornogobi Aimag supports a large, dense

(measured by total nests per unit area) breeding colony of cinereous vultures that usually includes >40 active nests/year in the northern 23,000 ha of the reserve. Vultures in Ikh Nart nest primarily on rocky outcrops and the scattered elm trees (*Ulmus pumila*) in the reserve. As with other vulture species in other areas of the world, nest site availability appears to constrain breeding cinereous vultures to areas with suitable nesting habitat; in this case, the more rugged areas like Ikh Nart (Sarà & Di Vittorio, 2003; Batbayar, 2004; Parra & Tellería, 2004). Nests on outcrops appear to be readily approachable by people and ground predators. In 2003 we initiated a research project to explore the nesting ecology of these large vultures in Ikh Nart. Our objectives were to compare nesting success rates of pairs using rocky outcrops with those using trees and to document growth rates of cinereous vulture nestlings.

### Study Area

We conducted our research in the northern 23,000 ha of Ikh Nartyn Chuluu Nature Reserve. The reserve, located in northwestern Dornogobi

Aimag was established in 1996 to protect 43,740 ha of rocky outcrops and associated wildlife in northwestern Dornogobi Aimag (Myagmarsuren, 2000). No permanent human settlements exist in or near the protected area (i.e. all towns > 30 km away), although nomadic pastoralists use the area seasonally for livestock grazing and maintain some permanent wintering structures (mostly stone corrals) in the reserve. 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 30 mps), and relatively wet (compared with the surrounding area) and hot summers (to 35 °C). Precipitation is low and seasonal, with most precipitation falling in the summer (late June – August). Flora and fauna are representative of the semi-arid regions of Central Asia, with a mix of desert and steppe species. Vegetation is sparse. Potential nesting trees for cinereous vultures and other birds are sparsely distributed along some of the drainages in the reserve. These trees are invariably elm trees. Xerophytic and hyperxerophytic semi-shrubs, shrubs, scrub vegetation, and turfy grasses dominate the reserve, although different plant communities can be found around oases and streams, on rocky outcrops, and other localized areas. Other globally significant wildlife species occurring in Ikh Nart include argalis (*Ovis ammon*), ibex (*Capra sibirica*), goitered gazelles (*Gazella subgutturosa*), Mongolian gazelles (*Procapra gutturosa*), lesser kestrels (*Falco naumanni*) and saker falcons (*F. cherrug*).

## Methods

To assess reproductive success, we located as many active nests as possible in the region, traversing the northern part of Ikh Nart on foot and in vehicles. Active nests were defined as nests with an egg or a chick (but see Steenhof, 1987). Where necessary we used binoculars, spotting scopes, or climbed into nests or onto adjacent rocks or tree limbs to confirm the presence of an active nest with an egg or chick. We collected location coordinates for all active nests using a global positioning system and noted the nesting substrate (i.e. tree or rock). Throughout the summer we periodically determined if nests remained active or not and

collected data on nests and nestlings. We spent as little time as possible in the vicinity of nests to minimize disturbance (Steenhof, 1987).

We measured nest sizes, including nest height, external diameter and internal diameter (diameter of the nest bowl), early in the nesting season. We used the nest height and external diameter to roughly determine nest volume ( $V = H * 2\check{r}^2$ , where  $V$  = volume,  $H$  = nest height, and  $r$  = external nest radius). We also periodically measured nestling size, including total body length (with and without feathers), wing lengths (with and without feathers), leg length (from the top of the femur to the tip of the middle toe), middle toe length, talon length, beak length, and weight. In late August and September 2004, we banded 5 nestlings with leg bands obtained from the Ornithology Laboratory of the Mongolian Academy of Sciences.

We examined all variables for normality and homogeneity of group variance using Bartlett's test. We used natural log, sine, and square root transformations or excluded outliers ( $n = 1-3$ ) to normalize data where appropriate. We compared paired means using simple t-tests, with corrections for separate variances where appropriate. We used linear and log-linear regressions of body measurements against the number of days since June 1 to evaluate growth patterns of various vulture chick morphological measurements. Unless otherwise indicated, we present all means  $\pm$  1 S.E. We set significance at  $P < 0.05$ .

## Results

We located a total of 42 active cinereous vulture nests (27 on rocks and 15 on trees) in 2003 and 19 active nests (14 on rocks and 5 on trees) in 2004. Cinereous vultures construct very large nests. In Ikh Nart, mean volume of active nests was  $3.92 \pm 0.39$  m<sup>3</sup> ( $n = 36$ ). Mean dimensions were: height =  $75.47 \pm 4.49$  cm and external diameter =  $174.22 \pm 4.63$  cm. Nests in trees ( $4.30 \pm 1.00$  m<sup>3</sup>,  $n = 11$ ) had larger volumes than nests on rocks ( $3.75 \pm 0.36$  m<sup>3</sup>,  $n = 25$ ), but this difference was not significant ( $t_{12,7} = 0.52$ ,  $P = 0.62$ ). Nests on trees were slightly wider ( $174.73 \pm 11.59$  cm), but a little shorter ( $75.18 \pm 9.28$  cm) than nests on rocks ( $174.00 \pm 4.60$  cm and  $75.60 \pm 5.15$  cm, respectively). These differences were not significant ( $t_{13,3} = 0.06$ ,  $P = 0.70$  and  $t_{16,5} = 0.04$ ,  $P = 0.97$ , respectively).

Most nests failed prior to egg hatching (Fig. 1). In 2003, only 12 of 42 nests (28.6 %) retained

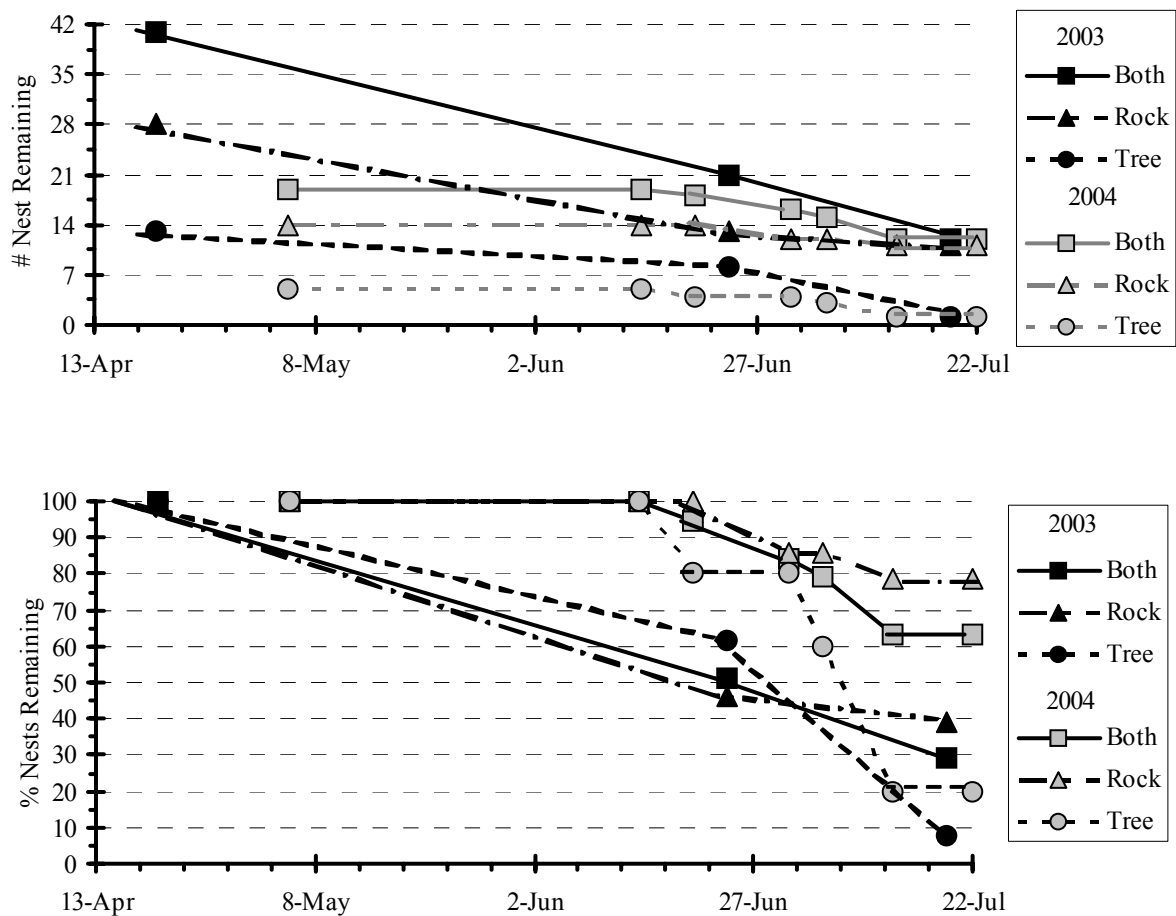


Figure 1. Cinereous vulture (*Aegypius monachus*) nesting success in Ikh Nartiin Chuluu Nature Reserve, Dornogobi Aimag, 2003-2004. Decrease in number (top) and % (bottom) of active nests over time.

fledglings by late July. After hatching (throughout May for most nests in Ikh Nart) nesting success rates increased dramatically. In 2004 we began monitoring nests in May, after the nesting began and eggs were laid. We found in total 19 nests, of which 12 (63.2%) retained fledglings by late July. Most nests on rocky out-crops (78.6%) lasted until late July in 2004, but tree nests still failed at a high rate (20.0%). Similarly, in 2003 84.6% of rock nests that survived until June retained fledglings by late July, but only 12.5% of tree nests survived that long (Fig. 1).

Following hatching, cinereous vulture chicks grew at a steady rate (i.e. linearly) that tended to level off just prior to fledging (Fig. 2). Combining data from 2003 and 2004 we were able to generate growth curves for chicks. These curves were highly significant for each of the morphological traits we measured (Table 1). Log-linear regressions did not improve curve fit (adjusted  $R^2$  values were all lower for log-linear regressions), and thus we only report

the linear regressions here. Alternatively, using data only through September 1 did increase the  $R^2$  values substantially (Table 1). Using a September 1 cut-off date for our growth curves eliminates only 5-6 data points ( $n = 2$  chicks) for each variable (Fig. 2). In addition, these 2 nests were located late in the year, so we cannot be sure they were not re-nesting attempts.

Using the growth curves from our linear regressions on data through September 1 (Table 1, Fig. 2), we can determine the average size of cinereous vulture chicks on specific dates. For example, on average a vulture chick will weigh 7.6 kg on July 1, 9.2 kg on August 1, and 10.7 kg on September 1. He or she will also reach a total body length (with feathers) of 77.3 cm with a wing length (with feathers) of 82.3 cm and a girth of 50.9 cm by July 1. By September 1, right around fledging, the average chick will grow to 126.9 cm in length and 68.9 cm in girth, with a total wingspan (both wings) of 314.7 cm.

Table 1. Cinereous vulture (*Aegypius monachus*) nestlings in Ikh Nartiin Chuluu Nature Reserve, Dornogobi Aimag, 2003-2004. All linear measurements are in cm or weight in kg against number of days since June 1. TBL = total body length; constant = intercept; and coefficient = slope.

Variable	N	Constant $\pm$ S.E.	Coefficient $\pm$ S.E.	Adj. R <sup>2</sup>	F-Value	P
<b>All data</b>						
TBL (feathers)	116	61.74 $\pm$ 2.13	0.56 $\pm$ 0.04	0.59	165.69	<0.001
TBL (no feathers)	85	62.49 $\pm$ 1.57	0.19 $\pm$ 0.03	0.30	36.59	<0.001
Wing (feathers)	120	57.85 $\pm$ 2.74	0.86 $\pm$ 0.06	0.66	228.75	<0.001
Wing (no feathers)	82	54.36 $\pm$ 1.93	0.27 $\pm$ 0.04	0.40	54.302	<0.001
Girth	86	46.54 $\pm$ 1.19	0.17 $\pm$ 0.02	0.38	52.23	<0.001
Leg	115	42.79 $\pm$ 1.20	0.18 $\pm$ 0.03	0.29	46.46	<0.001
Toe & Talon	113	12.81 $\pm$ 0.18	0.02 $\pm$ 0.003	0.13	17.34	<0.001
Talon	86	2.87 $\pm$ 0.09	0.01 $\pm$ 0.002	0.34	43.90	<0.001
Beak	85	5.50 $\pm$ 0.14	0.03 $\pm$ 0.003	0.51	87.63	<0.001
Weight	113	6.82 $\pm$ 0.23	0.03 $\pm$ 0.01	0.25	39.00	<0.001
<b>Through September 1 only</b>						
TBL (feathers)	110	53.31 $\pm$ 2.21	0.80 $\pm$ 0.83	0.69	242.07	<0.001
Wings (feathers)	114	46.05 $\pm$ 2.70	1.21 $\pm$ 0.06	0.76	356.99	<0.001
Girth	80	42.22 $\pm$ 1.25	0.29 $\pm$ 0.03	0.57	104.58	<0.001
Toe & Talon	107	12.05 $\pm$ 0.20	0.03 $\pm$ 0.004	0.36	61.14	<0.001
Talon	79	2.55 $\pm$ 0.08	0.02 $\pm$ 0.002	0.64	139.38	<0.001
Beak	79	4.98 $\pm$ 0.14	0.04 $\pm$ 0.003	0.67	156.81	<0.001
Weight	107	6.14 $\pm$ 0.28	0.05 $\pm$ 0.01	0.37	54.87	<0.001

We located several nests only after eggs were laid and chicks hatched and due to personnel and time constraints, we did not monitor nests continuously from egg laying to hatching and to fledging. As a result, we could not determine the exact incubation and fledging periods for vultures.

## Discussion

Improving the prospects for successful cinereous vulture conservation will likely require a better understanding of the nesting ecology of the species. Research in Spain and Greece found that human disturbance (measured by distance to human habitation or density of roads) negatively impacted nesting success of cinereous vultures (Fargallo *et al.*, 1998; Donázar *et al.*, 1993; Poirazidis *et al.*, 2004). Batbayar (2004) found cinereous vulture nests on relatively steep slopes in central Mongolia, but did not directly compare nest sites with the surrounding terrain. In Spain vultures preferred to nest in rugged habitat (Donázar *et al.*, 2002). Similarly, vultures in Greece preferred old, isolated trees on steeper slopes (Poirazidis *et al.*, 2004). Egyptian vultures (*Neophron percnopterus*) and griffon vultures (*Gyps fulvus*) also appear to prefer nest sites far from humans and on rugged terrain (Sarà & Di Vittorio, 2003; Parra & Tellería, 2004). Competition for preferred nest sites can be intense, occasionally leading to

aggressive encounters (Blanco *et al.*, 1997). The densities of nesting pairs we found in Ikh Nart (~1.8 pairs/1,000 ha) is similar to the 1.3-2.9 pairs/1,000 ha reported for central Mongolia by Batbayar (2004) and the 1.7-2.0 pairs/1,000 ha reported for Uzbekistan (Del Hoyo *et al.*, 1992), but far more than the 0.5 pair/1,000 ha reported for the Khentii Mountains of Mongolia (Del Hoyo *et al.*, 1992).

Del Hoyo *et al.* (1992) reports typical nest dimensions for cinereous vultures of 145 – 190 cm wide by 95 – 300 cm high. Batbayar (2004) reported mean nest surface dimensions of 168  $\pm$  4.24 cm by 185  $\pm$  4.90 cm and a mean nest height of 74  $\pm$  3.62 cm. We found similar widths (mean = 174.22  $\pm$  4.63 cm) and heights (mean = 75.47  $\pm$  4.49 cm) to that found by Batbayar (2004), but smaller heights than those reported by Del Hoyo *et al.* (1992).

We plan to continue our work to improve the quality of our data by monitoring vulture nests more intensively, but primarily from remote locations in the future. Gaps in our data necessitated that we assumed that all nests with nestlings hatched on the same day. This assumption is obviously incorrect and likely accounts for much of the variation in nestling sizes we observed. In addition, some nests that contained chicks in late August and September likely represent re-nesting attempts of pairs that lost eggs (or perhaps even chicks) early in the breeding season, although they could simply result from late nesting pairs. However, Del Hoyo

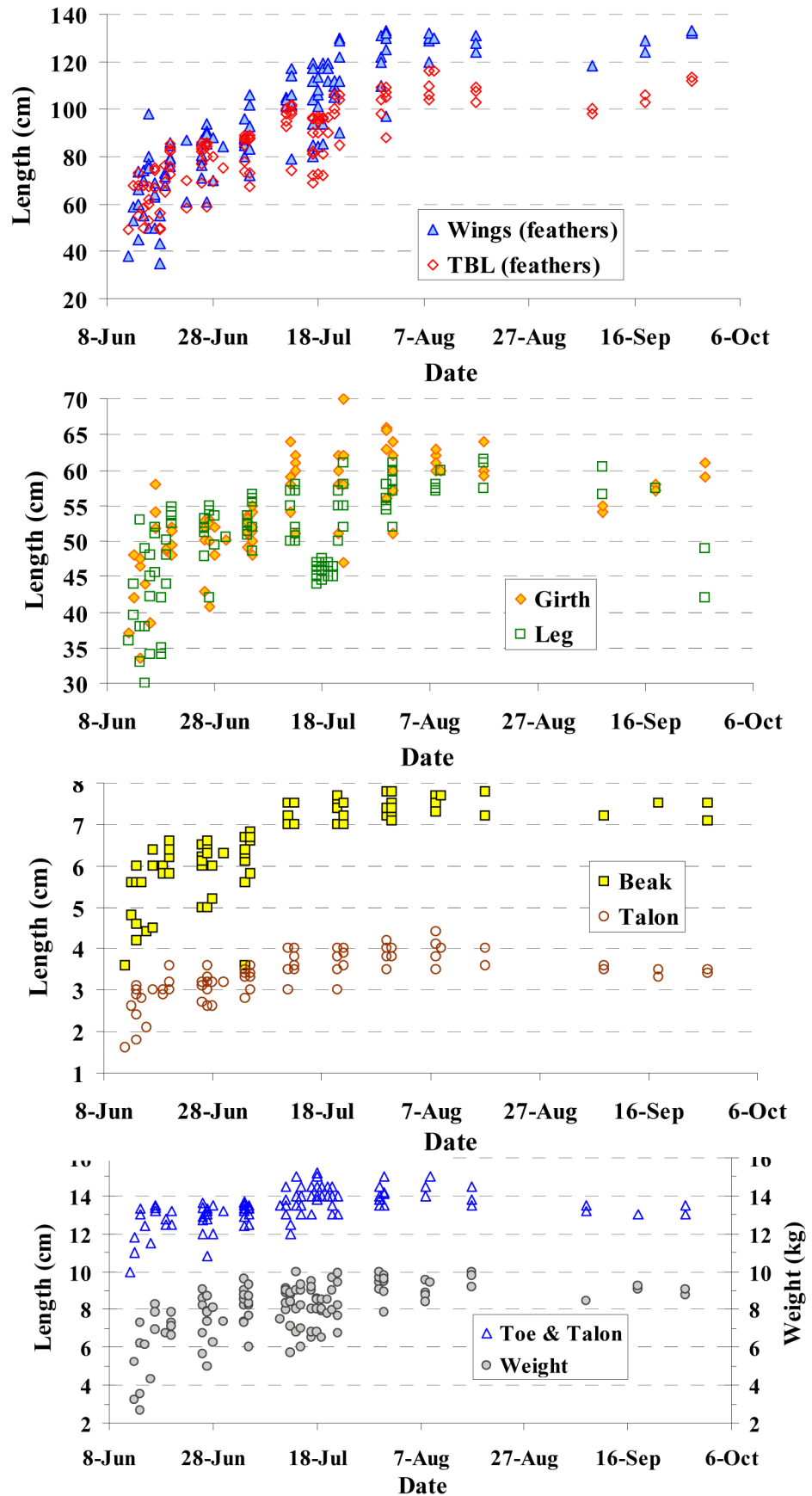


Figure 2. Growth patterns of cinereous vulture (*Aegypius monachus*) nestlings over time in Ikh Nartiin Chuluu Nature Reserve, Dornogobi Aimag, 2003-2004.



et al. (1992) report that cinereous vultures have incubation periods of 54 - 56 days and fledging periods of 104 - 120 days in Central Asia. Thus, eggs laid in late March could very well result in nestlings that fledge as late as late September. Nevertheless, we believe that the growth curves that exclude data past September 1 are more accurate (Table 1).

Batbayar (2004) found higher rates of nesting success (43 - 73%) at 2 sites in Central Mongolia from 2002 - 2003 (59 % overall) than we found in our study (Fig. 1). Similar to our study (Fig 1), he found that most nest failures (70 %) occurred during incubation, as opposed to the nestling period (30 %) (Batbayar, 2004).

Future research will also strive to determine the causes of nest failures. We are particularly interested in why tree nests appear to fail at higher rates than nests on rocky outcrops, especially since ground predators (e.g. wolves (*Canis lupus*); foxes (*Vulpes* spp.); Pallas' cats (*Otocolobus manul*) should be able to access nests on rocks more easily. Trees may attract nomadic pastoralists with their herds in search of shade, increasing disturbance (D. Houston, pers. comm.). Aerial predators, especially northern ravens (*Corvus corax*) are common in Ikh Nart and likely contribute to nest failures, especially egg predation. We believe that heavy winds may be responsible for the loss of chicks in some tree nests as well. We also plan to band more fledglings to understand survivorship of fledglings, especially comparing the survivorship of cinereous vulture young.

As we continue to obtain more detailed data on cinereous vulture nesting ecology, we hope to better understand the factors that influence nesting success. In turn, we hope these results will help us develop a better conservation management plan for the species in Mongolia.

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### Хураангуй

Хар буюу нохой тас (*Aegypius monachus*) нь Евроазийн томоохон махчин шувуудын нэг бөгөөд энэ зүйл Монгол болон бусад улсад харьцангуй бага судлагдсан юм. Бид хар тасны үүрлэлтийн экологийн судалгааг Дорноговь аймгийн нутагт байрлах Их Нартын Чулуу хэмээх байгалийн нөөц газарт хийж гүйцэтгэв. Тасын нөхөн төлжилтийг тогтоохын тулд судалгаанд хамрагдсан нутагт орших эзэнтэй үүрнүүдийг тогтоож, тэдгээрийг тодорхой хугацааны давтамжтайгаар хянаж тухайн үүр байнга

ашиглагдаж байгаа эсэхийг тогтоов. Түүнчлэн үүрнүүдийг хэмжиж, мөн тасын ангайхайн биеийн хэмжээ ба жинг тодорхой хугацааны давтамжтайгаар хэмжиж тодорхойлж байв. 2003 онд нийт 42 амьдралтай үүрийг (27 үүр нь хад чулуун дээр, 15 үүр нь модон дээр байрлалтай), 2004 онд 19 үүрийг (14 үүр нь хад чулуун дээр, 5 үүр нь модон дээр байрлалтай) илрүүлсэн юм. Ашиглагдаж буй үүрний дундаж эзэлхүүн  $3.92 \pm 0.39 \text{ m}^3$  ( $n=36$ ) байв. Ихэнх тохиолдолд үүрнүүд дэх өндөг бойжиж амжилгүй хорогдсонтой холбогдож үүрнүүд эзэнгүй болж байсан бөгөөд харин ангаахай бойжиж гарснаас үүрний ашиглалт эрс нэмэгдэж байв. Өндөгнөөс бойжиж гарснаас хойш өдлөх хүртэл тасын ангаахай шугаман байдлаар буюу жигд өсөлттэй байв. Бид тасын ангаахайны өсөлтийн муруйг гаргасан бөгөөд энэ нь бойжилтын аль нэгэн үе дэх ангаахайн биеийн дундаж хэмжээг тодорхойлох боломжийг олгож байгаа юм. Тасыг хамгаалах үйл ажиллагааг үр дүнтэй болгоход түүний үүрлэлтийн экологийн судалгаа шаардагдах бөгөөд бид цаашид мониторингийн судалгаагаа үргэлжлүүлэн нэмэлт мэдээлэл цуглуулж, тасын өндөгөө дарах болон ангаахайны өдлөх хугацаа, үүрний эзэнгүй болдгийн шалтгаан зэргийг тодорхойлохоор төлөвлөж байна.

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