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Population status and breeding ecology of White-rumped Vulture *Gyps bengalensis* in Rampur Valley, Nepal

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We conducted a survey of the Critically Endangered White-rumped Vulture *Gyps bengalensis* in lowland Nepal from October 2002 to May 2003. Direct observations were made at roosting and nesting sites to assess the population size, breeding success and nest-tree availability. A questionnaire survey was conducted to assess carcass disposal methods, threats from persecution and conservation attitudes. Six vulture colonies were found, which supported 72–102 birds during the breeding season, and 123 birds following the breeding season. Breeding success at 70 occupied nests was 0.5 young per nest. Most nests were in kapok *Bombax ceiba* trees, and nesting habitat may be a limiting factor because these trees are logged for commercial purposes. A total of 33 dead vultures was found, of which 30 were adults. The carcasses of domestic livestock appear to be the main source of food for vultures because there are few alternative wildlife prey species in the surrounding habitats. The abundance of carcasses observed suggests there is no shortage of food. Local people have favourable conservation attitudes, and their carcass disposal method is beneficial to vultures. A local model of 'debt-for-nature swap' is proposed to protect the nesting habitat of vultures in the area. Integrated vulture conservation and development programs may provide incentives to local people to initiate conservation actions.

INTRODUCTION

White-rumped Vulture *Gyps bengalensis* was once abundant in South-East Asia, and the Indian subcontinent. Vultures have declined from many parts of their former ranges owing to food shortages and loss of habitat (Pain *et al.* 2003). However, since the early 1990s there has been a catastrophic decline in three *Gyps* species in the Indian subcontinent: White-rumped, Indian *G. indicus* and Slender-billed Vultures *G. tenuirostris* (Prakash 1999, Virani *et al.* 2001, Prakash *et al.* 2003). In response to these population crashes, all three were reclassified as 'Critically Endangered', placing them among the species most threatened with global extinction (BirdLife International 2001).

Recent work in Pakistan has showed that diclofenac, a widely used painkiller and anti-inflammatory drug administered to livestock and humans, can cause mortality in vultures (Oaks *et al.* 2004). A postmortem examination of dead or dying birds from India and Nepal also showed the high incidence of

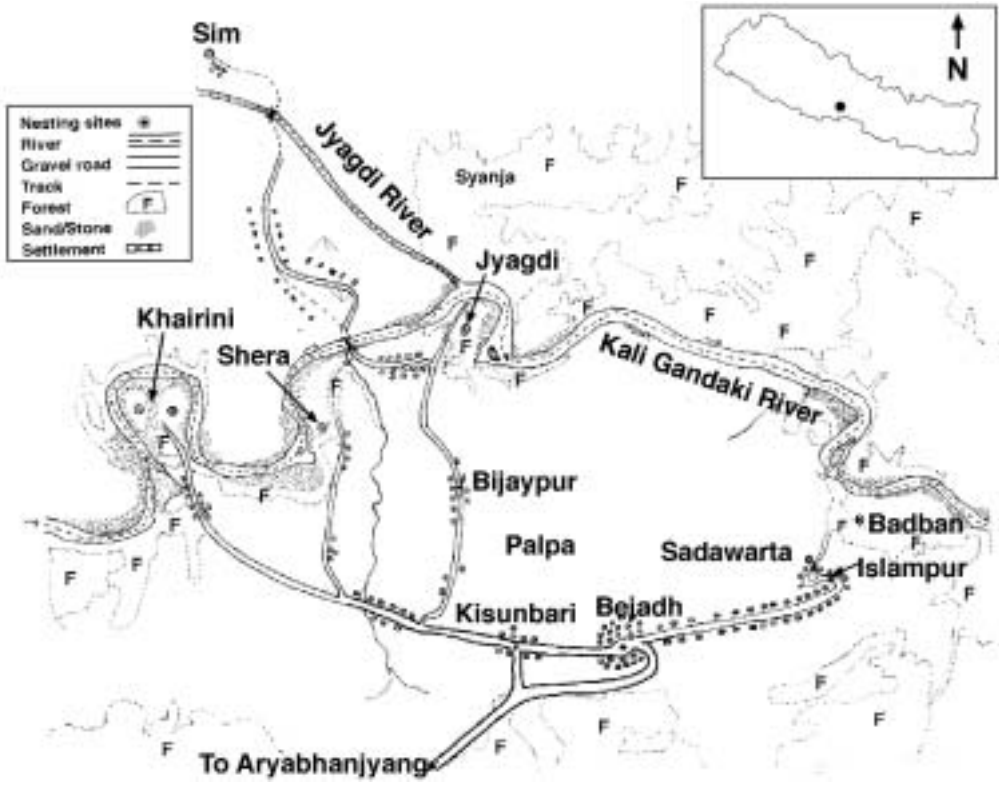

Figure 1. Map showing the study area and its location in Nepal (not to scale).

diclofenac residues and visceral gout (Shultz *et al.* 2004). The results of these studies suggest that diclofenac contamination is the major cause of the recent vulture population crashes. The result of a mathematical modelling is consistent with the observed rate of population decline. Models indicate that only a small proportion (one in 130) of carcasses contaminated with lethal levels of diclofenac can cause the observed vulture mortality rate (Green *et al.* 2004). We suspect the widespread use of diclofenac in Nepal, but so far there has been no attempt to quantify the extent of its use or the levels to which vultures are exposed.

Eight species of vultures have been recorded from Nepal, of which six are resident and two are migratory (Grimmett *et al.* 2000). White-rumped Vulture is reported up to 3,100 m, although it is most common up to about 1,000 m (Inskipp and Inskipp 1985). Koshi Tappu Wildlife Reserve (KTWR), Royal Suklaphanta Wildlife Reserve (RSWR) and the unprotected Rampur Valley are still strongholds for the species (Inskipp and Inskipp 2001, Virani *et al.* 2001, Baral and Gautam 2002). Vulture population declines may have gone unnoticed for many years simply because they were so abundant. Although data are scant, the monitoring of colonies indicates that *Gyps* vulture populations have been declining throughout their range in Nepal (Virani *et al.* 2001, Giri and GC 2002). Once distributed throughout the lowlands of Nepal, White-rumped Vulture is now patchily distributed, being rarer in the east (Inskipp and Inskipp 2001, Virani *et al.* 2001, Baral and Gautam 2002, Giri and GC 2002). During 2001–2002, 45 White-rumped Vultures were found dead in eastern Nepal, compared to only five in western Nepal (Virani *et al.* 2001, Giri and GC 2002). This suggests that mortality factors were less prevalent in the west or it may reflect lower survey effort in the east. Continued population declines may lead to extirpation unless remedial actions are taken.

In Nepal, only nine bird species—Black Stork *Ciconia nigra*, White Stork *C. ciconia*, Himalayan Monal *Lophophorus impejanus*, Satyr Tragopan *Tragopan satyra*, Cheer Pheasant *Catreus wallichii*, Bengal Florican *Houbaropsis bengalensis*, Lesser Florican *Sypheotides indica*, Sarus Crane *Grus antigone* and Great Hornbill *Buceros bicornis*—are protected by law (HMG 1977). No raptors are included. Accidental or deliberate persecution of vultures outside protected areas is not illegal.

In this paper, we estimate the population size, pattern of adult mortality and breeding success of White-rumped Vulture in the Rampur Valley, Nepal.

STUDY AREA

Rampur Valley (27°51′80″N 83°54′24″E, Fig 1.) lies in the eastern part of Palpa district, and is the second biggest business centre in the district. It has three Village Development Committees (the smallest political and administrative unit in rural Nepal). It is about 370 km south-west of Kathmandu, situated in the transition region between terai and hill ecological zones, at an elevation of 442 m. The Kali Gandaki River flows through the valley and marks its northern border. The climate of the area is subtropical monsoonal, with the rainy season extending from June to September, hot dry summer from February to May, and cool dry winter from October to January. The vegetation is in an early to middle successional stage. The dominant trees are kapok *Bombax ceiba*, khair *Acacia catechu*, karma *Adina cordifolia*, bel *Aegle marmelos*, mango *Mangifera indica*, kamuno *Cleistocalyx operculata*, kali katha *Aporusa octandra* and budhodhayar *Lagerstromia parviflora*. As well as White-rumped Vulture, the valley supports Slender-billed, Red-headed *Sarcogyps calvus* and Egyptian Vultures *Neophron percnopterus*. As part of community forestry programmes, there are 56 community forest user groups in Rampur, of which 44 groups already have their parcel of forests to manage. The valley is not contiguous with any protected area.

METHODS

As the study area in the Rampur Valley is small, it was practical to count regularly and accurately all nest and roost sites. We visited all six known colonies and counted all birds seen on nests or roosting early in the morning (06h30–09h30) and late in the evening (17h30–19h30) on five visits during 27 October to 2 November 2002, 12–16 December 2002, 23–27 February 2003, 10–14 April 2003 and 18–23 May

Table 1. Estimated population size of White-rumped Vulture at six colonies.

Colony	Breeding							Post-breeding
	Oct/Nov 2002		Dec 2002		Feb 2003		Apr 2003	May 2003
	AM	PM	AM	PM	AM	PM	AM	
Islampur	12	13	13	13	1	8	0	0
Sadawarta	12	18	9	9	5	5	8	10
Jyagdi	8	10	8	10	6	11	5	1
Shera	*	*	*	*	13	13	20	10
Khairini	33	39	42	47	37	48	48	87
Syanja	10	10	*	*	17	17	16	15
Total	75	90	72	79	79	102	97	123

*Sites not covered during surveys

Table 2. Number of White-rumped Vulture nests recorded in five tree species at six colonies.

Colony	*Bombax ceiba*	*Mangifera indica*	*Alstonia scholaris*	*Acacia catechu*	*Ficus lacor*	Total no. nesting trees	Total no. occupied nests
Islampur	0	2	0	0	0	2	3
Sadawarta	3	3	1	0	0	7	9
Jyagdi	7	0	0	0	0	7	7
Shera	6	0	0	0	0	6	8
Khairini	27	0	0	1	0	28	35
Syanja	5	0	0	0	1	6	8
Total	48	5	1	1	1	56	70
(%)	(86%)	(9%)	(2%)	(2%)	(2%)		

2003. We assumed fidelity to sites, fixed time of roosting, and geographic closure: no movement into (immigration) or out of (emigration) the site. We counted the number of animal carcasses encountered and the number of vultures at each one to assess the availability of food in the survey area. To study breeding ecology, nests were counted and nest occupancy, breeding status and general breeding behaviour were recorded. We followed Postupalsky's (1974) classification of nesting status, according to which 'occupied nests' are those in which substantial nest-building activities are observed, but egg-laying is not necessarily confirmed. Nesting trees were tagged for future reference. Birds were closely observed for 'head drooping' behaviour, regarded by some as an abnormal behaviour of sick birds (Prakash, 2001) but by others a response to high temperatures (Virani *et al.* 2001). Colonies were opportunistically searched for dead vultures, which were recorded and then buried. We conducted a questionnaire survey of 67 households in the vicinity of vulture colonies. Respondents were asked about their methods of carcass disposal, persecution of vultures, agricultural practices and conservation attitudes. Pearson's Chi-square test was used to test the null hypothesis of uniform distribution of nests among nesting trees. Means are presented ±1 standard deviation.

RESULTS

Population

We found six colonies of vultures in Rampur Valley. The average distance between colonies was 4.1±2.1 km (N=15, minimum=0.2 km between Islampur and Sadwarta, maximum=7.1 km between Islampur and Syanja). During the study period one colony (Islampur) was deserted because local people felled the nesting and roosting trees. The population of White-rumped Vultures in the Rampur Valley averaged 85±12 birds (range=72–102, N=7) during the breeding season, and 123 birds (N=1) after the breeding season (Table 1). The largest colony was at Khairini, supporting 33–48 individuals. Counts of vultures at carcasses are consistent with these numbers. Counts of vultures at carcasses averaged 63±20 birds (range=36–93 birds, N=9). Immatures and adults could not be clearly distinguished, so the age structure of the vulture population could not be assessed. A total of 33 dead vultures was recorded, of which 30 were adults and three were subadults and juveniles. This total included 16 found dead in December 2002 at Khairini and Sadawarta. We did not record any birds showing 'head drooping' behaviour.

Nesting and breeding

White-rumped Vultures bred from October to April. A total of 70 occupied nests were found in the six vulture colonies. Abandoned nests were frequently encountered, but the causes of nest abandonment could not be determined. The proportion of nests that was abandoned increased through the season, from 7% in October/November to 29% in April (Fig. 2). This may be because nests are abandoned once chicks die. Nesting success was 50% (and equates to 0.5 chicks per nest) based on the proportion of all occupied nests that still had chicks alive in April 2003, assuming that all these would successfully fledge (none was left in the nest in May 2003). Since we could not survey colonies subsequently, we were not able to determine the fledgling mortality rate. Nests were built in a total of 56 trees of five species at the six colonies (Table 2). Up to three nests were built in each tree, but most trees (77%) had just one nest (mean=1.2±0.45). Most nests (86%) were built in kapok trees (χ^2=152.2, df=4, P< 0.01).

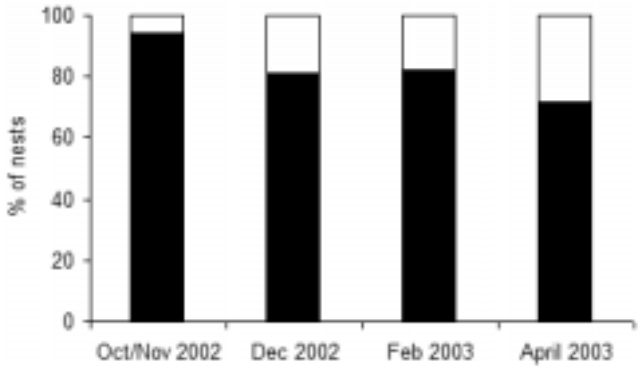

Figure 2. Percentage of nests that were occupied (solid bars) or abandoned (open bars).

Food availability
The biomass of potential food available from native wildlife is limited, so domestic livestock carcasses are likely to form the bulk of available food. We found 16 such carcasses during the study. Most (69%) were cattle, followed by water buffalo (25%). We could not determine the cause of livestock death. Not all carcasses had attendant vultures: only three carcasses were fully consumed, nine were partially consumed and four were unattended by vultures. On two occasions, four Egyptian Vultures *Neophron percnopterus* and two Red-headed Vultures *Sarcogyps calvus* were seen feeding with White-rumped Vultures. At six carcasses we found a few (3–10) stray dogs feeding.

Conservation attitudes
Local people apparently do not kill vultures in the Rampur Valley. A high proportion of respondents (99%, N=67) reported that they had never killed or seen anybody persecuting and poisoning vultures by any means. In one incident, children inadvertently killed one vulture while playing with catapults. The carcass disposal practice in the study area was beneficial to vultures. When asked what they do with dead livestock, 63% of respondents said they left carcasses in an open place, while 24% bury them. Local people had favourable attitudes towards vulture conservation. When asked whether we should conserve vultures, 85% said 'yes' while 15% said 'no' (N=67). The reasons given for vulture conservation were: sanitation (77% of respondents), aesthetics (7%), ecological role (9%) and medicinal purposes (7%). Although not quantified, the use of pesticides and chemical fertilisers was common practice among local farmers. Informal discussions indicated that local people were not aware of the potential adverse health effects of these chemicals on humans and wildlife. Diclofenac as a possible cause of vulture mortality was not known by us during the fieldwork, so we did not collect information on the extent of its use.

DISCUSSION

A population crash is taking place in three species of *Gyps* vultures in the Indian subcontinent, involving high mortality rates and breeding failure (Prakash 2001). It is likely to lead to their extinction if the causes are not addressed (BirdLife International 2001). In the Rampur Valley, we found 72–102 White-rumped Vultures at six colonies during the breeding season, with a 50% breeding success at 70 occupied nests. Of considerable concern, we found 33 dead vultures, including 30 adults. In Koshi Tappu Wildlife Reserve (eastern Nepal), Virani *et al.* (2001) reported a high fledgling mortality rate (50%), and only 28% of 67 nests successfully fledged young. In Rampur, we found that the proportion of abandoned nests increased from 7% to 29% towards the end of the breeding season, perhaps because of high nestling mortality. The breeding productivity of 0.5 chicks per occupied nest is higher than recorded for other parts of Nepal (Virani *et al.* 2001, Giri and GC 2002, Baral, 2002), but similar to the 0.48 fledglings/pair measured for other *Gyps* species in Africa (Martinez *et al.* 1997). However, our estimate may be inflated by the assumption that all chicks alive in April would survive to fledge successfully. If true, it implies that breeding failure is not causing population declines in the Rampur Valley.

In India, nesting and roosting habitats for the species are considered to be abundant (Prakash 2001). In Rampur, these could be limiting factors because the valley has sparse vegetation. Vultures mainly use kapok trees for nesting in the valley. These trees are commercially important to enable the Community Forest User Group (CFUG) to collect revenue, so logging of trees may limit the nest-site availability. At Khairini, local people informed us that they planned to log some mature kapok trees, including some that held vulture nests. We informed the district forest office and the logging was prevented, at least temporarily. We recommend piloting a local model of 'debt-for-nature swap' to protect critical habitats for vultures. A non-governmental organisation could buy mature kapok trees at a competitive market price and deposit the amount in the CFUG's bank account. In this way, local people would have the incentive to protect forests and to utilise the funds for integrated vulture conservation and development projects.

Nepal is a Hindu kingdom, so slaughtering of cattle is forbidden by law. Local people rarely eat beef. As livestock form the bulk of the species's diet, the food supply is unlikely to be limiting. At present, the population density of stray dogs is low. In India, vulture declines have led to increases in feral dog numbers, with associated human health risks (Cunningham *et al.* 2001, Pain *et al.* 2003). This problem may increase in Nepal if vultures continue to decline.

Land-use patterns influence raptor diversity and density (Herremans and Herremans-Tonnoeyr 2000). In Africa, Brandl *et al.* (1985) reported a negative correlation between human impact on the landscape and raptor diversity and density. However, vultures have the highest density at the interface between protected and unprotected areas (Herremans and Herremans-Tonnoeyr 2000). In the Rampur Valley, all six vulture colonies abut human settlements. Given this, protection of the sites could be a feasible and cost-effective conservation strategy. In addition, given their Critically Endangered status and pivotal ecological role, the three *Gyps* vultures should be added to the protected species list of the 1973 National Parks and Wildlife Conservation Act. Most importantly and urgently, now that the main cause of the vulture population decline has been discovered to be diclofenac (Oaks *et al.* 2004), the use of this drug needs to be banned, and stocks replaced with a safe alternative. An effective captive breeding population needs to be built up while this is being achieved.

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