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Authors: Virani, Munir Z., Giri, Jeet Bahadur, Watson, Richard T., and Baral, Hem Sagar

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SURVEYS OF HIMALAYAN VULTURES (*GYPS HIMALAYENSIS*) IN THE ANNAPURNA CONSERVATION AREA, MUSTANG, NEPAL

Munir Z. Virani[1]
The Peregrine Fund, 5668 West Flying Hawk Lane, Boise ID 83709 U.S.A.

Jeet Bahadur Giri
Institute of Forestry Hetauda Campus, Hetauda, Makawanpur, Narayani, Nepal

Richard T. Watson
The Peregrine Fund, 5668 West Flying Hawk Lane, Boise ID 83709 U.S.A.

Hem Sagar Baral
Bird Conservation Nepal, P.O. Box 12465, Kathmandu, Nepal

Abstract.—Populations of three species of lowland *Gyps* vultures (*G. bengalensis*, *G. tenuirostris* and *G. indicus*) in South Asia have declined precipitously over the last decade as a result of their feeding on diclofenac-contaminated livestock carcasses. Despite extensive studies on these three species, little is known about population trends in the highland species, Himalayan Vulture (*G. himalayensis*). We surveyed Himalayan Vultures in Nepal between 2001 and 2006. We found no evidence that their populations are facing the same magnitude of decline or threat as those of the three species of lowland *Gyps* vultures. We suggest that Himalayan Vultures may not be experiencing the same degree of diclofenac poisoning for a number of reasons, including possibly different foraging behaviors by Himalayan Vultures compared to the other *Gyps* vultures, and/or relatively lower use of diclofenac in the highland regions.

Key Words: *Himalayan Vulture*; Gyps himalayensis; *Annapurna Conservation Area*; *Nepal*; *population decline*; *vultures.*

CENSOS DE *GYPS HIMALAYENSIS* EN EL ÁREA DE CONSERVACIÓN DE ANNAPURNA, MUSTANG, NEPAL

Resumen.—Las poblaciones de tres especies de buitres del género *Gyps* de tierras bajas (*G. bengalensis*, *G. tenuirostris* y *G. indicus*) han declinado precipitadamente en el sur de Asia durante la última década, debido a que estas aves se alimentan de cadáveres de ganado contaminados con diclofenaco. Aunque se han realizado estudios intensivos acerca de esas tres especies, se conoce poco sobre las tendencias poblacionales de *G. himalayensis*, la especie de tierras altas. Realizamos censos de *G. himalayensis* en Nepal entre 2001 y 2006. No encontramos evidencia de que las poblaciones se estén enfrentando a disminuciones de la misma magnitud que las de las tres especies de *Gyps* de tierras bajas. Sugerimos que *G. himalayensis* podría no estar experimentando el mismo grado de envenenamiento por diclofenaco por varias razones, incluyendo posibles diferencias en el comportamiento de alimentación entre esta especie y las de tierras bajas, y/o un uso relativamente menor del diclofenaco en las regiones de tierras altas.

[Traducción del equipo editorial]

Since the mid-1990s, at least three species of *Gyps* vultures occurring in South Asia, Oriental White-backed (*G. bengalensis*), Long-billed (*G. indicus*), and Slender-billed (*G. tenuirostris*) have been listed by the IUCN as ''critically endangered'' following a catastrophic decrease in their populations throughout the region (IUCN 2004). These birds, once one of the most numerous groups of large raptors worldwide, are sustained mainly by feeding on livestock carcasses in the region (Newton 1979). The population declines were attributed to the use of a non-steroidal, anti-inflammatory drug, diclofenac sodi-

[1] Email address: tpf@africaonline.co.ke

um (diclofenac) that causes visceral gout subsequently leading to renal failure in vultures that consume carcasses contaminated with the drug (Green et al. 2004, Oaks et al. 2004, Shultz et al. 2004). Diclofenac has become widely administered to livestock since about 1993 when it was first registered for veterinary use in India and subsequently in Nepal and Pakistan (Oaks et al. 2004, Schultz et al. 2004). Experimental studies have shown that diclofenac is also lethal to African White-backed Vultures (*G. africanus*) and Eurasian Griffon Vultures (*G. fulvus*; Swan et al. 2006). This suggests that all species of *Gyps* vultures are vulnerable to the fatal effects of veterinary diclofenac.

In Nepal, declines in populations of Oriental White-backed and Slender-billed vultures have been well documented (Gautam et al. 2003, Baral et al. 2004, Baral and Inskipp 2005, Giri and Baral 2006, Giri and Som 2006). For example, at Koshi-Tappu National Park in lowland Nepal, Baral et al. (2004) recorded gout-related vulture mortalities and documented an 85.3% decline in numbers of active Oriental White-backed Vulture nests between 2000 and 2003. During that study, Baral et al. (2004) regularly observed wintering immature Himalayan vultures feeding alongside Oriental White-backed and Slender-billed vultures. They recorded a maximum of 66 immature Himalayan Vultures in one day (February 2003), although they found no dead individuals. Despite extensive ecological and diagnostic studies conducted on Oriental White-backed and Long-billed vultures on the Indian subcontinent (Green et al. 2004, Gilbert et al. 2006, M. Virani unpubl. data), information is lacking about the population status of Himalayan Vultures. The range of the Himalayan Vulture (HV) stretches along the Himalayan mountains (Ali and Ripley 1983) from Pakistan in the west to Assam in the east, as well as in parts of China and Russia in the north (del Hoyo et al. 1994). In Nepal, the species has been described as common to fairly common in the Kali Gandaki, Marsyangdi, and Langtang valleys where it breeds between January and May (Inskipp and Inskipp 1991, Baral et al. 2002). Himalayan Vultures occur in large numbers in the Annapurna Conservation Area of Nepal. Immature (subadult and juvenile) Himalayan Vultures are also recorded from several localities in Nepal's lowland areas, as well as in parts of India and Pakistan where they spend wintering months from November to March (Naoroji 2006). Diclofenac-caused mortalities in at least three species of *Gyps* vultures (*G. bengalensis*, *G. indicus* and *G. fulvus*) have been documented in the lowland wintering areas of Himalayan Vultures across the Indian subcontinent. Given the ubiquitous nature of diclofenac in livestock carcasses (Green et al. 2007), it seems highly probable that Himalayan Vultures may also be dying as a result of consuming diclofenac-contaminated livestock carcasses.

In May 2006, the government of India banned the manufacture of veterinary diclofenac (Kumar 2006, The Peregrine Fund 2007). The governments of Nepal and Pakistan followed suit (The Peregrine Fund 2007), and although the human form of the drug is still widely available, the institution of these government regulations should have significant conservation benefits for the *Gyps* vultures remaining in the wild.

We here present results of surveys of Himalayan Vultures conducted between 2002 and 2006 in the Annapurna Conservation Area of Nepal. This period coincided with observed accelerating population declines of Oriental White-backed and Long-billed vultures throughout the Indian subcontinent. It seemed prudent therefore to evaluate whether these declines were being mirrored in populations of Himalayan Vultures. Our specific objectives were (1) to establish whether there was a significant decline in the number of Himalayan Vultures observed during this period, and (2) to assess Himalayan Vulture population age structure as a potential means to evaluate their breeding performance.

STUDY AREA AND METHODS

Study Area. The study was conducted in The Annapurna Conservation Area (ACA) that encompasses the Annapurna range and its adjoining areas in western Nepal. ACA (28°36′N to 29°19′N and 83°28′E to 84°08′E) covers an area of nearly 7629 km^2, comprising the districts of Manang and Mustang and parts of Kaski, Lamjung, and Myangdi (Chaudhary 1998; Fig. 1). The vegetation is subtropical to alpine with subtropical forests in the lower elevations (500 m to 1600 m), conifer forests in the middle elevations (1600 m to 3000 m) and alpine vegetation including grasses, lichens, and shrubs, in the high mountain region (>3400 m). For all elevations, the maximum temperature ranges from 22°C to 26°C in June and July and the minimum temperature varies from −2.7°C to −10°C in December and January, respectively. ACA has three major seasons: wet season from July to September, dry season from March to June and October, and winter snowfall from November to February.

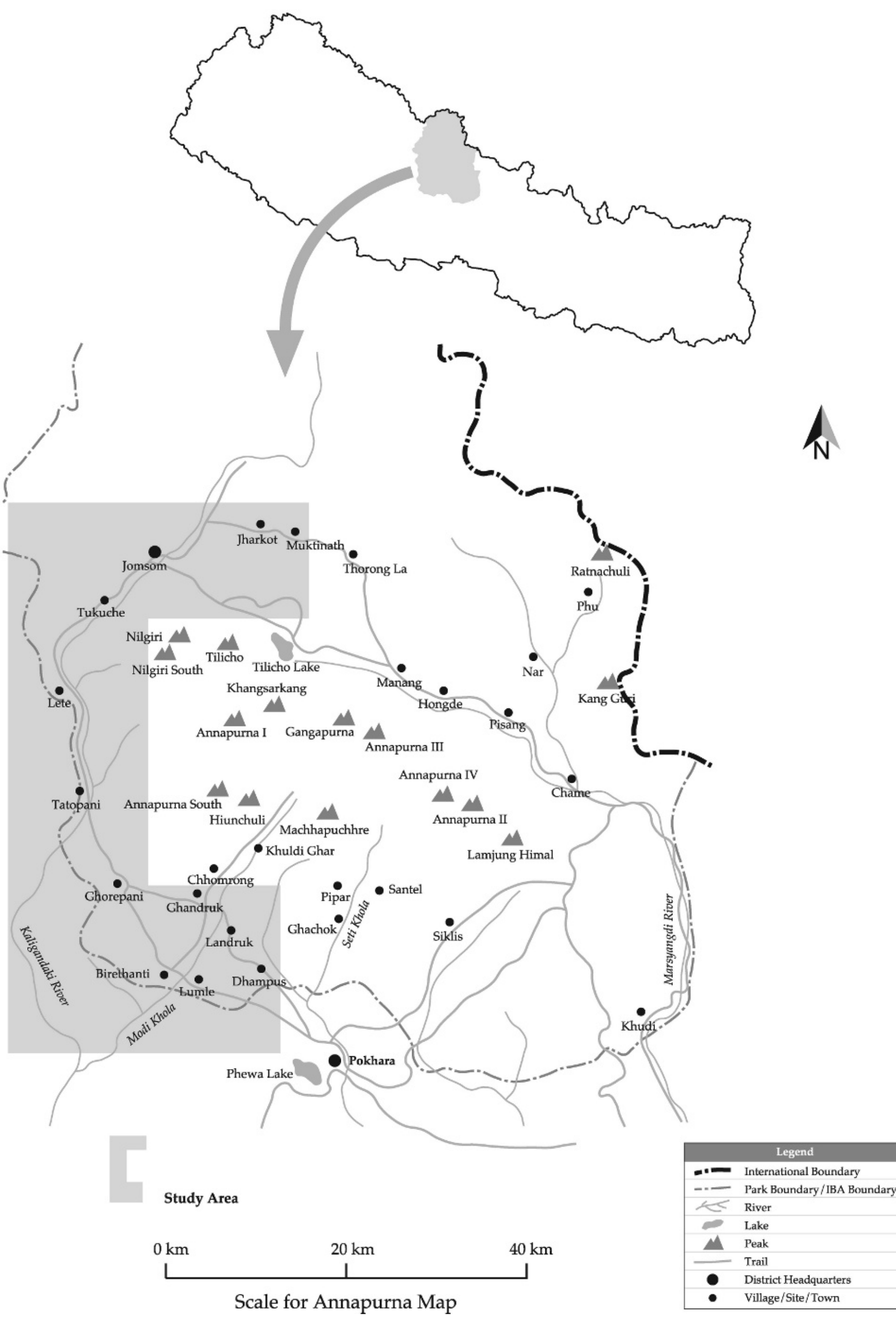

Figure 1. Map of the Annapurna Conservation Area in Nepal showing the study area.

Vulture Surveys. We spent 109 d between 2001 and 2006 conducting 11 walking surveys, each over multiple days (13 d in November 2001, 9 d in February 2002, 11 d in May 2002, 10 d in November 2002, 9 d in February 2003, 10 d in May 2003, 9 d in November 2003, 9 d in February 2004, 10 d in May 2004, 10 d in May 2005 and 9 d in May 2006). Thus we conducted five surveys in May, three

Table 1. Himalayan Vulture surveys conducted in the Annapurna Conservation Area of Nepal from 2001–06.

Period	Number of Days Surveyed	Adults		Immatures		Ratio of Immatures: Adults
		Total	Mean/d (SE)	Total	Mean/d (SE)	
Nov-01	13	53	4.08 (1.85)	10	0.77 (0.43)	0.19
Feb-02	9	15	1.70 (0.58)	6	0.70 (0.33)	0.41
May-02	11	89	8.10 (1.68)	49	4.50 (0.99)	0.56
Nov-02	10	118	11.80 (2.43)	27	2.70 (0.70)	0.23
Feb-03	9	59	6.60 (1.56)	21	2.30 (0.50)	0.35
May-03	10	116	11.60 (1.94)	24	2.40 (0.34)	0.21
Nov-03	9	189	21.00 (5.75)	98	10.90 (4.30)	0.52
Feb-04	9	61	6.80 (1.32)	31	3.40 (1.26)	0.50
May-04	10	56	5.60 (1.05)	39	3.90 (1.79)	0.70
May-05	10	101	10.10 (3.52)	41	4.10 (1.29)	0.41
May-06	9	77	8.60 (2.50)	27	3.00 (0.58)	0.35
TOTAL		934	8.56	373	3.42	0.29

in February and three in November for consistency among years. Our first survey in November 2001 was considered preliminary because we were establishing a fixed survey route and familiarity with the terrain. As a result, we excluded data from this survey in the final analysis although we present these results. From February 2002, all surveys began from Muktinath (Mustang) to Beni (Myagdi) along the Kali Gandaki valley, and continued through Ghandruk (elevation 2012 m), Chhomrong (2100 m), Annapurna Base Camp (8413 m), and Ghorepani (2819 m). We also included part of the upper Mustang area (Tetang and Chhuksang). Most survey days were clear and sunny with good visibility. Our survey included the following villages and towns: Jomsom (2715 m), Marpha (2670 m), Tatopani (1190 m), Thini (2995 m), Tukuche (2590 m), Pokharebagar (1110 m), Eklebhatti (2750 m), Kobang (2640 m), Ratopani (1085 m), Kagbeni (2805 m), Lete (2480 m), Tiplyang (1040 m), Jharkot (3550 m), Chhayu (2360 m), Ghaleshwor (1170 m), Muktinath (3802 m), Ghasa (2010 m), Beni (500 m), Chhuksang (3882 m), Talbagar (1950 m), Nayapul (2450 m), Syang (2705 m), Pairothapla (1100 m), and Pokhara (915 m).

All surveys were conducted by JBG and two field assistants. Binoculars were used for observing vultures; identification and age class were confirmed using Grimmett et al. (2000). On average, we walked 15 km/d. We recorded two age classes, adults and immatures (subadults and juveniles). We minimized double-counting by recording Himalayan Vultures flock size, age class, flight direction, time interval between successive sightings, and height and speed of flight. Recording numbers of raptors observed over distance traveled is usually the primary method of estimating a relative population index (Fuller and Mosher 1981, Bibby et al. 2000). However, because our study involved walking from elevations as low as 500 m (Beni) to an altitude of 3800 m (Muktinath) under strenuous conditions, and was more time-dependent rather than distance-dependent (observers needed to acclimatize), we calculated the relative abundance of Himalayan Vultures for each survey as a rate (HV/d) for survey comparisons. Rates were then log-transformed ($\log_e + 1$) for statistical analysis. We used general linear models (GLM) to determine whether there were any significant differences in mean HV/d among surveys. Because May had the largest and most consistent sample size, and it coincided with the breeding season (when adults were focused on their nests and the migratory Griffon Vultures [*G. fulvus*], which are similar in appearance, were not present), we used this data set to test for annual differences in mean HV/d for adult and immature vultures. Results are reported as mean ± SE, and values of $P < 0.05$ were considered significant.

RESULTS

We observed 1307 Himalayan Vultures over 109 d from November 2001 to May 2006 (11.99 HV/d). Of these, 934 (71.5%) were adults and 373 (28.5%) were immatures (Table 1). Observations ranged from 189 adults (21 HV/d) and 98 immatures (10.9 HV/d) during November 2003, to 15 (1.7 HV/d) adults and 6 immatures (0.7 HV/d) in February 2002 (Table 1).

We found no significant difference ($P = 0.40$) in the mean number of adults (9.0 ± 2.1 HV/d) and immatures (3.7 ± 1.00 HV/d) observed among the five surveys conducted in May. The mean ratio of immature to adult Himalayan Vultures was 0.42 ± 0.04 in February, 0.44 ± 0.08 in May, and 0.31 ± 0.10 in November. Ratios did not differ among months (Kruskal-Wallis, $H = 1.09$, df = 2, $P = 0.580$). The ratio of immature to adult Himalayan Vultures throughout the study ranged from 0.19 (November 2001) to 0.70 (May 2004; Table 1). There was no correlation between the total number of Himalayan Vultures and the ratio of immature to adult birds observed during the study period (Pearson correlation = 0.172, $P = 0.613$).

DISCUSSION

We found no evidence of a recent decline in the population of adult and immature Himalayan Vultures in the Annapurna Conservation Area based on a lack of temporal trend in mean counts over five years. However, the large standard errors of mean counts indicated that the statistical test was not overly sensitive. The lack of a significant correlation between the total number of Himalayan Vultures observed and the ratio of immature to adults is consistent with results from other studies of cliff-nesting vultures in Spain and South Africa where numbers of breeding pairs were found to have no relationship with age class ratios (Vernon and Robertson 1982, A. Camina pers. comm.). The lack of knowledge of Himalayan Vultures reproductive ecology further complicates the investigation of whether age ratios can provide an index to assess the breeding performance of Himalayan Vulture populations.

The high frequency of observations of Himalayan Vultures in November 2002 and 2003 may be explained by the fact that this period coincided with the time between breeding seasons (December to July; Naoroji 2006). Although unlikely, there was a slight possibility that migrating Eurasian Griffon Vultures may have been recorded as immature Himalayan Vultures during this time, thereby increasing the apparent frequency of observation during this period. Our counts in November 2003 were consistent with those of Gurung et al. (2004) who recorded 233 Himalayan Vultures over 44 d (6.0 HV/d) between 23 October and 5 December, 2003 at Dhikur Pokhari, ca.10 km south of the Annapurna Range (28°40′N, 83°40′E). Den Besten (2004) observed more than twice as many Himalayan Vultures during October–November 2001 compared to February–March 2002 (88 vs. 40, respectively) during his study in the Mcleod Ganj of the Daraudhar Range in Himachal Pradesh, India, although Den Besten attributed low frequency of observations in February 2002 to bad weather and poor visibility.

Himalayan Vultures may not be subject to the same degree of diclofenac poisoning as *Gyps* vultures in South Asia because there is less use of veterinary diclofenac in the remote Himalayas for social, cultural, and economic reasons. Genetically, Himalayan Vultures are closely related to other *Gyps* species (Johnson et al. 2006), so it is unlikely that a difference in sensitivity to diclofenac is the reason for the dissimilar population trend of this species compared with *Gyps bengalensis*, *G. indicus*, and *G. tenuirostris*.

Behavioral differences among *Gyps* species may also contribute to a lower frequency of poisoning events for Himalayan Vultures compared to the other species. Adult Himalayan Vultures are less gregarious than all the other *Gyps* vultures occurring in the Indian subcontinent, preferring to nest singly or in small colonies of four to six pairs on cliff faces (Naoroji 2006). Little is known about Himalayan Vulture foraging strategy and more studies are needed to investigate little-known aspects of its reproductive ecology (Naoroji 2006). During the breeding season from December to July (Naoroji 2006), adult Himalayan Vultures apparently remain close to their nests in the Himalayan mountains. Diclofenac poisoning has mainly been documented in *Gyps* vultures resident in the lowland regions of the Indian subcontinent; among Himalayan Vultures, only the first-year immatures winter there. The lower immature-to-adult ratio we documented for the November period compared to those of February and May (although not significantly different) suggests that immatures may move out of the ACA region, perhaps to their wintering grounds.

Although we did not find any evidence in declines of populations of Himalayan Vultures in the Annapurnas, we could not show that juvenile Himalayan Vultures wintering in lowland Nepal, India, and Pakistan are not succumbing to the lethal effects of veterinary diclofenac. As an additional caveat, we also note that, because of the short duration of our study (5 yr) and the large variance in HV/d, it is possible that a slow decrease in the ACA population occurred and we were unable to detect it. We acknowledge that this study represents a crude but cost-efficient method to evaluate the species' population status in the ACA. It is not comprehensive and does not reflect range-wide status or stability of breeding populations. We recommend that future studies focus on Himalayan Vulture reproductive success and foraging strategies. Surveys of Himalayan Vulture populations should continue in the ACA to build on existing data and establish population trends. Similar cost-effective surveys of Himalayan Vultures should be conducted in other parts of the species' range so that its conservation status can be further reviewed.

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