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BREEDING ECOLOGY AND DISTRIBUTION OF WHITE-RUMPED VULTURES (*GYPS BENGALENSIS*) IN HIMACHAL PRADESH, INDIA

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ABSTRACT.—I studied breeding ecology of White-rumped Vultures (*Gyps bengalensis*) in Himachal Pradesh, northern India, 2009–2012. Twenty-four breeding colonies of White-rumped Vultures were found, mainly in the Shahpur, Nurpur, and Kangra regions of Kangra District. In 2011–2012, the colonies contained a total of 102 nests, at which 81 pairs bred successfully. Nest success increased slightly from 56.1% in 2009–2010 to 79.4% in 2011–2012. All the nests of White-rumped Vultures were built in pine trees (*Pinus roxburghii*), at an average height of 15.4 m. In 2011–2012, approximately 65% of the nests were newly built, possibly indicating a high percentage of intra-colony movements. The number of adult and immature birds counted at the nesting colonies during the breeding season ranged from 13.3–27.3 individuals/colony; the ratio of immatures/adults varied from 0.44–0.97. Disturbance due to human activity and roads is a cause of concern for most of the breeding sites of White-rumped Vultures in Himachal Pradesh.

KEY WORDS: *White-rumped Vulture*; Gyps bengalensis; *breeding*; *ecology*; *Himachal Pradesh*; *India*; *nesting*; *reproduction*.

ECOLOGÍA REPRODUCTIVA Y DISTRIBUCIÓN DE *GYPS BENGALENSIS* EN HIMACHAL PRADESH, INDIA

RESUMEN.—Estudié la ecología reproductiva de *Gyps bengalensis* en Himachal Pradesh, al norte de India, durante el periodo 2009–2012. Se encontraron 24 colonias reproductoras de *G. bengalensis*, principalmente en las regiones Shahpur, Nurpur y Kangra del Distrito de Kangra. En el periodo 2011–2012 las colonias albergaron un total de 102 nidos, de los cuales 81 parejas lograron reproducirse con éxito. El éxito del nido aumentó levemente de un 56.1% en el periodo 2009–2010 a un 79.4% durante el periodo 2011–2012. Todos los nidos de *G. bengalensis* fueron construidos en *Pinus roxburghii*, a una altura promedio de 15.4 m. En el periodo 2011–2012, aproximadamente el 65% de los nidos encontrados fueron nuevos, lo que posiblemente evidencia un alto porcentaje de movimientos intra-coloniales. El número de aves adultas e inmaduras contadas en las colonias durante la época de cría osciló entre 13.3–27.3 individuos/colonia. El cociente de individuos inmaduros/adultos varió entre 0.44–0.97. Las molestias ocasionadas por la actividad humana y las carreteras son una causa de preocupación para la mayoría de los lugares de cría de *G. bengalensis* en Himachal Pradesh.
[Traducción del equipo editorial]

Catastrophic decline of vulture populations in the Indian subcontinent was first documented in Keoladeo National Park, Bharatpur, in Rajasthan in the 1990s (Prakash 1999, Prakash et al. 2003). Subsequently, this population crash was documented throughout the Indian subcontinent (Prakash et al. 2003, 2005a, 2005b, 2007, Gilbert et al. 2004, 2006, Green et al. 2004, Pain et al. 2008). Currently, six of the nine species of vultures found in India have been classified as threatened or endangered due to population declines. Of these, three species endemic to South Asia, the White-rumped Vulture, Long-billed Vulture (*Gyps indicus*), and Slender-billed Vulture (*Gyps tenuirostris*), are at high risk of global extinction and are listed as critically endangered because of rapid population declines within the last decade on the Indian subcontinent. Further, the Red-headed Vulture (*Sarcogyps calvus*) has been recently upgraded to the critical category. Moreover, the Egyptian Vulture (*Neophron percnopterus*) has been categorized as endangered and the Cinereous Vulture (*Aegypius monachus*) has been classified as near-threatened (IUCN 2007).

The breeding ecology and population dynamics of the White-rumped Vulture are poorly studied, with the exception of a doctoral thesis (Grubh

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1974) and a few related reports from the Gir forest, Gujarat (Grubh 1978a, 1978b, 1986). Several short publications report various ecological and behavioral aspects of multiple species of vultures, including feeding (Fox 1913, Smith 1915, Ezra 1918, Gough 1936, Livesey 1937, Grubh 1973), breeding (Jones 1916, Gill 1921, Sharma 1970, Bhat 1992, Kanoje 1996) and interspecific interactions (Grubh 1978a, 1978b, Arun and Azeez 2004). No comprehensive studies on the breeding ecology and colony status of vultures have been conducted to date in Himachal Pradesh, despite the crucial importance of vultures as scavengers in the ecosystem, and the value of baseline data for management and conservation. I here report my investigation of the breeding ecology and distribution of this species in the state of Himachal Pradesh.

METHODS

I studied distribution of White-rumped Vultures in Himachal Pradesh using a stratified random sampling technique (Snedecore and Cochran 1993), modified by sampling primarily areas connected by roads and apparently suitable habitats. Initially, because there was no information available on nesting sites of this species in Himachal Pradesh, I followed vultures that were flying and/or leaving feeding groups at carcasses, especially during breeding season, to find nesting sites. I travelled approximately 15 000 km of roads in Himachal Pradesh, up to 2500 masl (the typical breeding range of White-rumped Vulture) in Bilaspur, Chamba, Hamirpur, Kangra, Kullu, Mandi, Shimla, Sirmour, Solan, and Una districts. The goal of this investigation was not to census the overall population of this species in Himachal Pradesh, but to study the breeding ecology at the nesting colonies.

Nesting colony surveys were first conducted during October 2009, and surveys were continued approximately every two months during the three breeding seasons from 2009–2010 until 2011–2012. Vultures were counted during early morning or late evening hours so as to get the exact number of vultures at each nesting site. Observations were made using 10 × 40 Nikon field binoculars and a Fujinon 60 S super field scope. Identifications were confirmed using Grimmett et al. (2001). I counted the number of hatch-year juveniles, subadults, and adults, as well as the number of occupied nests and successful nests (defined following Postupalsky [1974]). I calculated nest success as thenumber of nests producing at least one fledgling/the number of occupied nests. For elucidating the monthly fluctuations in vulture population, I defined ''immatures'' as including both hatch-year juveniles and subadults (which normally reside in the parent colony but not in the nest in the next breeding season). These age-classes can be easily identified in the field using plumage characteristics (Gilbert et al. 2002). Descriptive statistics and the ratios of hatch-year juveniles, subadults, and immatures to adults were calculated and compared.

In addition to the population estimates, I identified nest-tree species and estimated the heights of nests. In 2011–2012, I recorded whether nests were rebuilt or refurbished old nests. I also made observations on some ecological and sociocultural parameters including habitat type, terrain type, nearby human settlements, source of water and food (carcasses), sociocultural practices of disposal of carcasses, and human/animal disturbances to the vultures. Some opportunistic observations were also made around cattle sheds at Khajjian (near Nurpur; run by Department of Animal Husbandry, Himachal Pradesh) and Baroh (run by Radha Krishna Welfare Trust) in the Kangra valley of Himachal Pradesh.

RESULTS

Twenty-four breeding colonies of White-rumped Vultures were found, mainly in the Shahpur, Nurpur, and Kangra regions of Kangra District. In 2011–2012, the colonies contained a total of 102 nests, at which 81 pairs bred successfully. The number of nests increased from 41 in 2009–2010 to 102 in 2011–2012, mainly due to an increase in investigator effort of the course of the study. Nest success increased slightly from 56.1% in 2009–2010 to 72.7% in 2010–2011 to 79.4% in 2011–2012. Most of the nesting areas were found in the Shahpur, Nurpur, and Kangra regions of Kangra District (Table 1; Fig. 1).

All the nests of White-rumped Vultures were built in pine trees (*Pinus roxburghii*), at an average height of 15.4 m. All the nest sites were in pine forests on slopes along streams or lakes. Nests were typically placed in a prominent fork within the tree, though a few were found on tree tops and on top of large branches. In 2011–2012, approximately 65% of the nests were newly built, possibly suggesting a high percentage of intra-colony movements or high adult turnover rates (Table 1). In addition, all the nesting sites of White-rumped Vultures were near human settlements, and dead cattle carcasses from the villages were the major source of food for this vulture species.

Table 1. Nesting of White-rumped Vultures in Himachal Pradesh.

SITE NO.	LOCALITY (NEAREST VILLAGE/TOWN), DISTRICT	TOTAL NUMBER OF NESTS/SUCCESSFUL NESTS			NUMBER OF NEW/OLD NESTS IN 2011–2012
		2009–2010	2010–2011	2011–2012	
1	Pehad (near Shahpur), Kangra	9/6	4/1	4/2	2/2
2	Tunnuhatti, Chamba	2/0	–	–	–
3	Baghola, (near Nurpur), Kangra	1/1	3/3 (2 nests on a single tree)	4/4 (2 nests on a single tree)	3/1
4	Dhameta, (near Pong Wetland), Kangra	1/0	–	–	–
5	Katrah (near Pong Wetland), Kangra	4/1	–	–	–
6	Salol (near Lunj), Kangra	7/4	9/8	8/7 (2 nests on a single tree)	3/5
7	Dolla (near 32 Miles), Kangra	4/2	5/4	8/6 (5 on top)[a]	5/3
8	Tarkhankad (near Daulatpur), Kangra	4/3	–	–	–
9	Nihari (Ghumarwin), Bilaspur	2/2	3/2	2/1	1/1
10	Thurahan (Gumarwin), Bilaspur	3/2	3/1	2/1	1/1
11	Badgaon (Lathiani), Hamirpur	4/2	3/2	1/1	1/0
12	Karnola (near Manei), Kangra	–	1/1	4/3	3/1
13	Harnera (near Manei), Kangra	–	1/1	2/2 (both nests on a single tree)	1/1
14	Padhu (near Manei), Kangra	–	5/5	9/8 (2 nests on a single tree)	6/3
15	Chhalahan (near Mhhad), Kangra	–	13/10	9/7 (3 nests on a single tree)	5/4
16	Mastgarh (near Jaunta), Kangra	–	6/3	4/4	3/1
17	Baroh, Kangra	–	3/1	4/3	4/0
18	Palra (near Kandhi), Kangra	–	6/6	8/7	6/2
19	Khabbal Kholi (near Badoh), Kangra	–	1/1	–	–
20	Badd Dramman (near Thulel), Chamba	–	2/1	2/2	1/1
21	Chattri (near Shahpur), Kangra	–	6/3	4/2	2/2
22	Palothar (near Lunj), Kangra	–	3/3	4/3	1/3
23	Mhhad (near Shahpur), Kangra	–	–	10/8 (6 on top)[a]	–
24	Barnera (near Shahpur), Kangra	–	–	13/10 (3 on top)[a]	–
	Total	**41/23**	**77/56**	**102/81**	**48/31**

[a] Most nests were placed within the canopy of the trees; however, a few were built on the top of a tree (i.e., outside the protection of the canopy); the number of these is indicated in parentheses.

During the study period, the ratio of hatch-year juveniles to adults in all the study sites ranged from 0.04 to 0.50; however, the ratio of subadult to adults ranged from 0.02 to 2.03 (Table 2). Nesting colonies of White-rumped Vultures may be divided into two groups on the basis of the ratio of subadults to adults. This ratio in most nesting sites was <1; however, there were three sites where this ratio was >1: Dolla (subadult/adult ratio 2.03), Karnola (1.50), and Baroh (1.51). In addition, two other nesting sites, Mhhad (0.88) and Barnera (0.83), also showed high subadult/adult ratios (Table 2).

A slight decreasing trend in the ratio of immatures (including juveniles and subadults)/adults was observed at 13 nesting sites, whereas a slight increase in this ratio was observed at seven nesting sites (Fig. 2). The ratio of immatures/adults did not fluctuate in a regular way during the different months of the breeding season, but the overall data of three years' study pointed toward a small increase in the ratio, from 0.44 to 0.98. Similarly, the mean number of birds seen per survey increased slightly for adults (9.27 to 13.89 birds/site) and immatures (4.02 to 13.42 birds/site; Table 3).

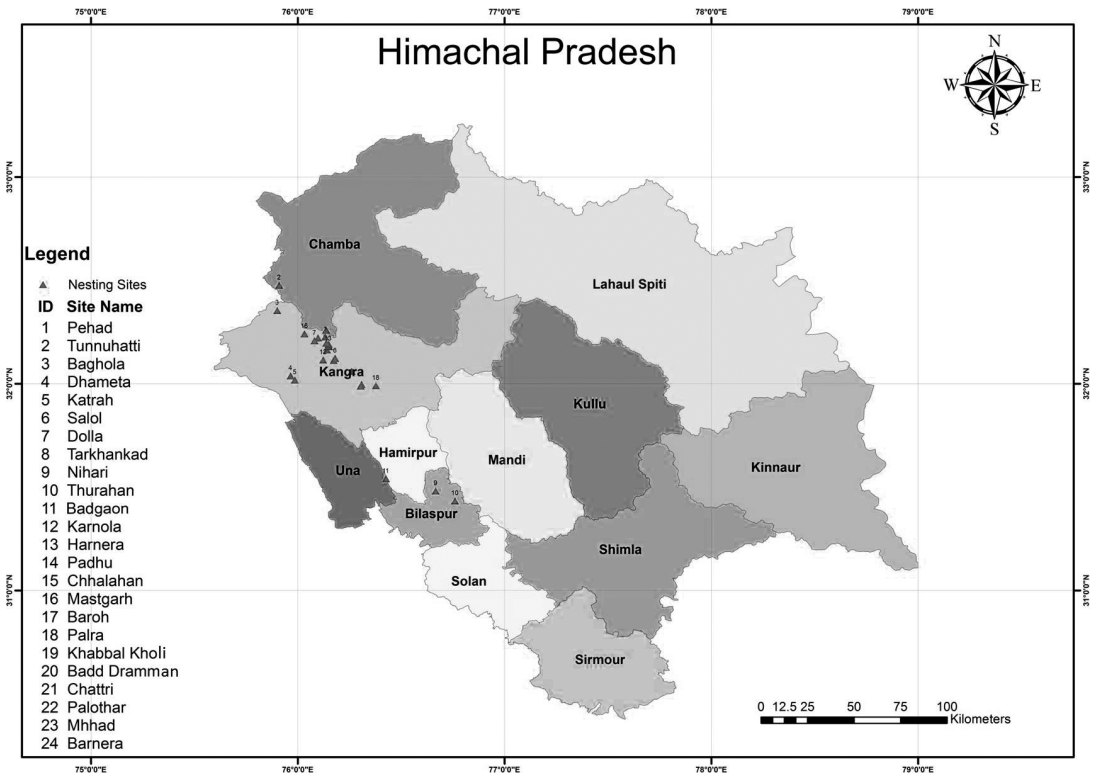

Figure 1. Map of Himachal Pradesh showing nesting sites of White-rumped Vulture.

Carcasses were frequently observed in the Kangra valley, which supports most of the population of White-rumped Vultures in this area; nearly one carcass was recorded on every second day in different areas separated by about 40–50 km. In addition, opportunistic counts of vultures (conducted almost on a monthly basis) around cattle sheds at Khajjian and Baroh highlighted the attraction of vultures to easily available sources of food, as I recorded approximately 60 (±10) individuals of different species of vultures around these cattle sheds on all fieldwork days.

DISCUSSION

The White-rumped Vulture, which was once the most numerous vulture species in India, began disappearing in the 1990s due to the effect of diclofenac and presently it is believed that only one-thousandth of the 1992 population remains in the wild. The decline of the White-rumped Vulture population was estimated to be approximately 96% between 1991 and 2000 (Prakash et al. 2003, 2005a, 2005b, Pain et al. 2008). However, there has been some deceleration of the rate of decline between 2000 and 2007, with average decrease of approximately 44% during this period (Prakash et al. 2007). Therefore, the presence of small self-sustaining nesting colonies in Himachal Pradesh might be very important from a conservation point of view. Most of the White-rumped Vulture population recorded in this study in Himachal Pradesh were in the Kangra valley. Similarly, Chaudhary et al. (2011) reported that most of the White-rumped Vultures in the lowlands of Nepal are now found in the western regions of that country. Therefore, the nesting sites documented herein in Himachal Pradesh may be partially protected or may benefit from the concept of ''Vulture Safe Zones'' in Nepal, where breeding numbers of White-rumped Vultures have increased many times over a period of 3 yr (Chaudhary et al. 2010).

Although the data in this report seem to indicate a three-fold increase in the number of successful nests in Himachal Pradesh in a span of 3 yr from 2009–2010 to 2011–2012, the number of nests and individual birds in each of the 3 yr cannot be compared due to my increased sampling effort during

Table 2. Ratio of young birds to adult White-rumped Vultures in Himachal Pradesh, India. Dashes (–) indicate that no active nests were found in that breeding season.

	Breeding Season 2009–2010		Breeding Season 2010–2011		Breeding Season 2011–2012			
Nesting Locality	Ratio of Subadult/ Adults	Ratio of Hatch-year Juveniles/ Adults	Ratio of Subadult/ Adults	Ratio of Hatch-year Juveniles/ Adults	Ratio of Subadult/ Adults	Ratio of Hatch-year Juveniles/ Adults	Overall Ratio of Subadult/ Adults	Overall Ratio of Hatch-year Juveniles/ Adults
Pehad	0.06	0.36	0.18	0.11	0.18	0.20	0.14	0.22
Tunnuhatti	–	–	–	–	–	–	–	–
Baghola	0.30	0.40	0.15	0.46	0.18	0.36	0.21	0.41
Dhameta	–	–	–	–	–	–	–	–
Katrah	0.21	0.14	–	–	–	–	0.07	0.05
Salol	0.19	0.20	0.11	0.34	0.14	0.30	0.15	0.28
Dolla	2.27	0.16	1.99	0.24	1.84	0.26	2.03	0.22
Tarkhankad	0.05	0.32	–	–	–	–	0.02	0.11
Nihari	0.09	0.35	0.20	0.27	0.24	0.19	0.18	0.27
Thurahan	0.17	0.28	0.21	0.14	0.15	0.15	0.18	0.19
Badgaon	0.05	0.22	0.17	0.28	0.15	0.31	0.12	0.27
Karnola[a]			1.58	0.12	1.43	0.24	1.50	0.18
Harnera[a]			0.27	0.36	0.05	0.40	0.16	0.38
Padhu[a]			0.48	0.33	0.17	0.39	0.33	0.36
Chhalahan[a]			0.07	0.37	0.28	0.35	0.18	0.36
Mastgarh[a]			0.17	0.23	0.36	0.44	0.27	0.34
Baroh[a]			1.55	0.04	1.46	0.11	1.51	0.08
Palra[a]			0.29	0.33	0.47	0.32	0.38	0.33
Khabbal Kholi[a]			0.53	0.07	–	–	0.27	0.04
Badd Dramman[a]			0.56	0.16	0.33	0.44	0.45	0.30
Chattri[a]			0.13	0.26	0.17	0.22	0.15	0.24
Palothar[a]			0.24	0.32	0.26	0.44	0.25	0.38
Mhhad[b]					0.88	0.50	0.88	0.50
Barnera[b]					0.83	0.33	0.83	0.33
Total	**0.31**	**0.22**	**0.40**	**0.20**	**0.40**	**0.25**	**0.43**	**0.24**

[a] Site first found in 2010–2011.
[b] Site first found in 2011–2012.

the course of the study. Gilbert et al. (2004, 2006) reported a decline in Pakistan in the breeding success of this species, a decrease from 59% in 2000–2001 to 40% in 2003–2004. However, the present study differed from that situation in an important way because diclofenac was completely banned in India in 2006, 3 yr before my study began, and the effects of that drug might have stabilized somewhat during that time. Indeed, in some parts of Himachal Pradesh, there was a slight increasing trend in the number of successful nests in the years 2009 to 2011 (Thakur and Narang 2012).

All the nests I found were built in pine trees. Nesting in pine trees would likely reduce the chance of breeding success, as pine forests are very prone to forest fires, which are one of the main causes of nesting failure in White-rumped Vultures in Cambodia (Clements et al. 2012). Nesting habitat of this species is dominated by large trees such as *Ficus benghalensis*, *Ficus religiosa*, *Mangifera indica*, and *Dalbergia sissoo*, which are important nesting trees of this species in its breeding range (Ali and Ripley 1983). Recently, Gilbert et al. (2004) reported that sheesham (*Dalbergia sissoo*) and kandi (*Prosopis cineraria*) were the main nest trees of White-rumped Vultures in Pakistan. Thus, presence of all the nests in pine trees in this study may be unusual.

The phenomenon of migration of immatures in a different species of vultures (i.e., Himalayan Griffons [*Gyps himalayensis*]; Virani et al. 2008) was not observed in the present study. However, at five sites (Dolla, Karnola, Baroh, Mhhad, and Barnera), I

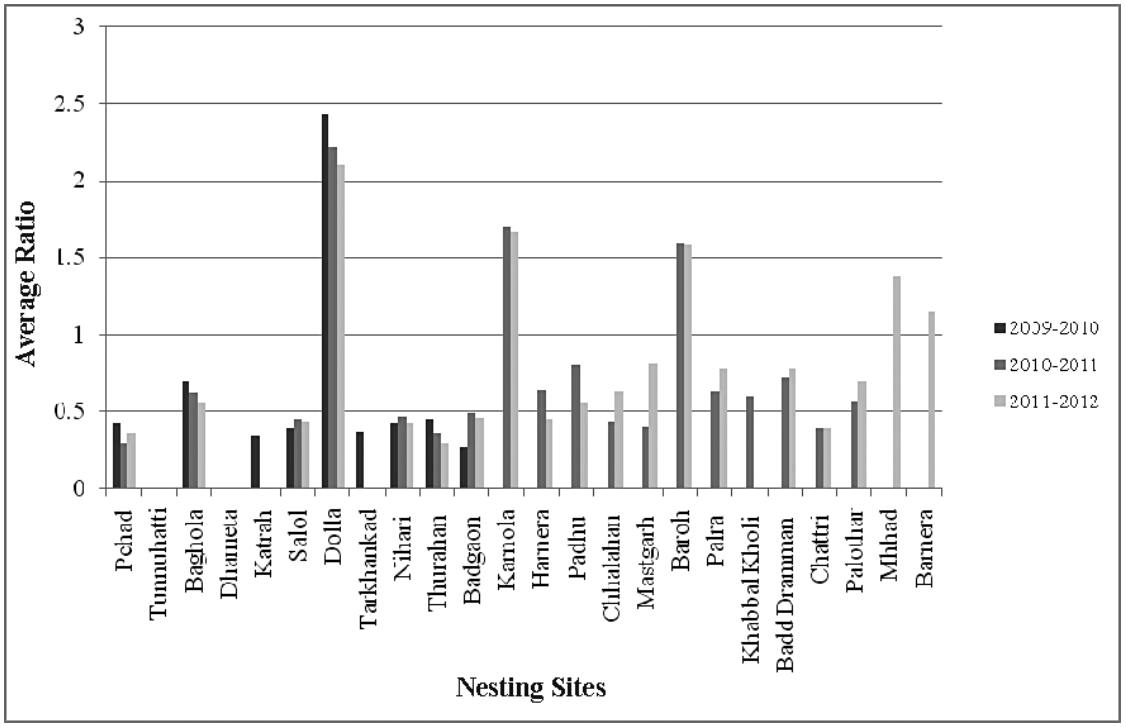

Figure 2. Ratio of immature/adult White-rumped Vultures in Himachal Pradesh, India.

observed populations with age structures that might reflect a phenomenon analogous to the migration of immature Himalayan Griffons to lowlands: a high ratio of subadults/adults. Relatively high ratios of immature/adult vultures in my study likely resulted from the presence of both juveniles and 2–3-yr-old nonbreeding individuals that were all tallied as ''immatures''; such ratios may not be directly comparable to those of Virani et al. (2008) for immature/adult Himalayan Vultures.

Nesting success of 50% has been reported for White-rumped Vultures in Rampur valley of Nepal (Baral et al. 2005) for October 2002 to May 2003. Nesting success rate in Himachal Pradesh in the present study was a little higher than reported for Nepal (Baral et al. 2005), likely due to the ban on the manufacture, sale, and use of diclofenac in 2006.

Vulture populations in a very large part of their natural distribution range have been extirpated due to the catastrophic declines in their populations starting in 1990s; therefore, information on ecological parameters and potential conservation threats is important for the continued survival of these critical species in their ecosystems. Most of the nest sites of White-rumped Vultures in Himachal Pradesh were near the roads; therefore, disturbance by human activity and vehicular traffic is a possible concern. I found no direct evidence that these factors hindered successful breeding of vultures. However, monkeys and baboons reportedly interfere in the normal breeding of African vultures (Mundy et al. 1992, Emmett 2003, Roche 2000, 2006). Recently, Clements et al. (2012) also reported monkeys as one of the primary disturbances for nesting White-rumped Vultures in Cambodia.

Continuous and uninterrupted availability of food, especially during breeding season, is important for vultures; therefore, many vultures are attracted to easily available food sources, such as the cattle sheds. Mundy et al. (1992) proposed that vultures have coevolved with large herds of migratory ungulates and Pain et al. (2008) reported that with the disappearance of these herds from most of the world range of vultures, the food supply formerly provided by wild ungulates was replaced by domesticated animals. Therefore, in the formulation of conservation strategies (especially *in situ*), the role

Table 3. Ratio of immature/adult White-rumped Vultures in Himachal Pradesh, India.

Period	Number of Observations or Sites	Immatures		Adults		Ratio of Immatures/ Adults
		Total No. of Individuals	Mean Number per Observation	Total No. of Individuals	Mean Number per Observation	
Nov. 2009	11	45	4.09	102	9.27	0.44
Jan. 2010	9	64	7.11	89	9.89	0.72
Mar. 2010	9	64	7.11	93	10.33	0.69
May 2010	9	59	9	81	9	0.73
Oct. 2010	18	171	9.5	227	12.61	0.75
Dec. 2010	18	181	10.06	229	12.72	0.79
Feb. 2011	18	185	10.28	228	12.67	0.81
Apr. 2011	18	187	10.39	223	12.39	0.84
Oct. 2011	19	261	13.74	270	14.21	0.97
Dec. 2011	19	257	13.53	269	14.16	0.96
Feb. 2012	19	252	13.26	257	13.53	0.98
Apr. 2012	19	255	13.42	264	13.89	0.97

of cattle sheds cannot be underestimated. Although scarcity of food did not seem to play a significant role in the ecology of vultures in the valley, the sociocultural practices of carcass disposal need urgent attention in future research.

Although some permanent source of water was present in or around most of the nesting sites in the study, I found no direct indications of dependence of this vulture species on water sources near nesting sites. However, water bodies were important in the selection of nest sites in its normal range of distribution (Ali and Ripley 1983). In addition, nest sites were typically located in trees near water bodies, with the nest placed in a prominent fork in African vultures (Irwin 1981, Mundy 1982, Steyn 1982, Tarboton and Allan 1984, Mundy et al. 1992, Steyn 1996, Tarboton 2001, Roche 2006); therefore, placement of nests in pine trees by White-rumped Vultures in Himachal Pradesh was not dissimilar, in that these pines have very fine canopy with a number of forks suitable for nest building.

In the current study, I found 24 breeding colonies of White-rumped Vultures, mainly in the Kangra District of Himachal Pradesh; I also found that ratios of immature/adult vultures did not consistently increase or decrease, and that the rate of nest success was relatively high and possibly increasing. However, given the catastrophic decline of this species in the last decade and the level of the existing population, consistent monitoring of these nesting sites is needed to assess any substantial change that might adversely affect these breeding populations, and to establish baseline data for future studies.

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