



## THE CONSERVATION OF ACCIPITRIDAE VULTURES OF NEPAL: A REVIEW

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ISSN  
Online 0974-7907  
Print 0974-7893

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**Abstract:** Of the nine Accipitridae vulture species found within Nepal the IUCN categorises White-rumped, Indian Vulture, Slender-billed and Red-headed Vultures as Critically Endangered and Egyptian Vulture as Endangered. Dramatic declines have occurred since the mid 1990s with the White-rumped Vulture, Indian Vulture and Slender-billed Vulture population declining by over 97%. The remaining species are listed as Near Threatened or Least Concern. Veterinary use of the non-steroidal anti-inflammatory drug (NSAID) diclofenac has been proven to be a key threat in the region for *Gyps* vultures and appears likely that it may also affect other Accipitridae vultures. The drug is transferred to vultures via consumption of dead livestock carcass. Ingestion of the drug causes visceral gout and kidney failure, which leads to the birds' death. Consumption of diclofenac and the majority of other non-steroidal anti-inflammatory drugs are fatal to individuals. Only one NSAID, meloxicam, has been tested and proven safe for vultures. There are other factors such as food shortage in local scale, habitat loss, climate change and pesticides/poisoning that play some role on population decline. Managing vulture conservation across Nepal can be problematic just as it is throughout the Indian subcontinent due to the variable level of protection afforded to vultures through legislation and enforcement in each political region particularly regarding NSAID regulation and use. However, great gains have been made on removing diclofenac from sale within the Indian subcontinent. Continuing and enhancing the holistic conservation approach between all stakeholders, government and non-government organisations, across the species range is required to conserve them for future generations. Indeed, it is likely that a number of species will become extinct if a greater conservation effort is not forthcoming in the very near future.

**Keywords:** Diclofenac, *Gyps*, Nepal, NSAIDs, threatening processes, vulture.

**DOI:** <http://dx.doi.org/10.11609/JoTT.o2816.3603-19> | **ZooBank:** <urn:lsid:zoobank.org:pub:9B0EB522-E857-44A2-9D33-F6D79244C50F>

**Editor:** Chris Bowden, Royal Society for the Protection of Birds, Sandy, UK

**Date of publication:** 26 February 2013 (online & print)

**Manuscript details:** Ms # o2816 | Received 30 May 2011 | Final received 06 November 2012 | Finally accepted 07 February 2013

**Citation:** Harris, R.J. (2013). The conservation of Accipitridae vultures of Nepal: a review. *Journal of Threatened Taxa* 5(2): 3603–3619; doi:10.11609/JoTT.o2816.3603-19.

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**Funding:** Self funded.

**Competing Interest:** None.

**Acknowledgements:** I wish to thank Dr Hem Baral of Himalayan Nature, Nepal and Dr. Iain Taylor of Charles Sturt University, Australia for their invaluable guidance and advice during the process of researching and writing this manuscript.

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## INTRODUCTION

Nepal supports nine Accipitridae vulture species (Baral et al. 2003; DeCandido et al. 2012; IUCN 2012h; Subedi & DeCandido unpub.). These are Lammergeier *Gypaetus barbatus*, Egyptian Vulture *Neophron percnopterus*, White-rumped Vulture *Gyps bengalensis*, Indian Vulture *G. indicus* (recent visitor), Slender-billed Vulture *G. tenuirostris*, Himalayan Vulture *G. himalayensis*, Griffon Vulture *G. fulvus* (a passage migrant), Cinereous Vulture *Aegypius monachus* (a winter visitor) and Red-headed Vulture *Sarcogyps calvus*. Taxonomy and nomenclature follow BirdLife International (2011).

Three *Gyps* species, White-rumped Vulture, Indian Vulture and Slender-billed Vulture, and one *Sarcogyps* species, Red-headed Vulture, are found across the Indian subcontinent and are in grave danger of extinction. The three *Gyps* species have rapidly declined by more than 97% since the mid 1990s (Gilbert et al. 2002; Cuthbert et al. 2006; Baral & Gautam 2007; Arshad et al. 2009). Recent data suggests that Red-headed Vultures are likely to decline by at least 90% by end 2016 (Cuthbert et al. 2006). The IUCN has classified these four vulture species as Critically Endangered (IUCN, 2012c,f,g,j). Population of Egyptian Vulture (Cuthbert et al. 2006) and Himalayan Vulture (Acharya et al. 2009) is also declining. Little is known about the population trends of other vulture species.

Wild ungulates are not a large part of the diet of these species in Nepal. Their diet consists mainly of domestic livestock (Baral 2010). Population declines were first noticed in India in the early 1990s (Satheeson 1999), while the linking of the deaths to the veterinary use of the NSAID diclofenac did not occur until 2003 (Oaks et al. 2004; Shultz et al. 2004). Between 2000–2003 Oaks et al. (2004) studied the high adult and subadult mortality resultant of renal failure and visceral gout. Their study revealed a direct correlation between renal failure, visceral gout and the diclofenac residue presence in the kidney or liver. Diclofenac is commonly used to treat pain and inflammation in livestock in India, Pakistan and Nepal (Green et al. 2004; Oaks et al. 2004; Shultz et al. 2004). Controlled experiments confirmed the contributory relationship of diclofenac poisoning on both captive Asian and African White-backed Vultures (Oaks et al. 2004; Swan et al. 2006). Vultures are carrion feeders consuming both fresh and putrid dead animals.

Considerable aggregations can form during consumption of carcasses (Gilbert et al. 2006; Jackson et al. 2008). Vultures are exposed to diclofenac when they feed on carcasses of livestock that were dosed with the drug shortly before death. Birds die as a result of visceral gout that subsequently causes kidney failure. Death usually occurs within a few days of exposure (Green et al. 2004; Oaks et al. 2004; Swan et al. 2006).

The use of NSAIDs along with other threats introduced by humans continues to impact on population viability of many vulture species. Vultures play a key role in the wider landscape as providers of ecosystem services (Sekercioglu 2006; Olea & Mateo-Tomás 2009), and were previously heavily relied upon to help dispose off animal and human remains in India, Nepal and Tibet (Rahmani 2004; IUCN 2012c). This review outlines distribution, population status and principal threats to Accipitridae vultures that are resident within, or migrate to Nepal, with emphasis on human induced impacts on individuals and populations. I also outline current conservation efforts in Nepal, some of which I observed during November–December 2010.

### Study Area

Nepal is located between two of the world's most highly populated countries, China to the north and India to the south, east and west. It is located between 26°20'–30°26'N & 80°15'–88°10'E. The majority of Nepal lies in central Himalaya and covers an area of 147,181 km<sup>2</sup> averaging 870 km from east to west with a population of approximately 30 million people (Government of Nepal 2010; RAOonline 2010b).

### Topography

Nepal is generally divided into five broad biogeographic regions (Fig. 1). These are the Terai <750 m, Siwaliks 700–1,500 m, Middle Mountains 1,500–2,700 m, High Mountains 2,200–4,000 m, and High Himalaya 4,000–8,000 m. Eight of the highest peaks in the world and the world's deepest gorge (5,791 m) in the Kali Gandaki Valley, are located in this region. The snowline varies from 5,000 m in the east to 4,000 m in the west (RAOnline 2010b). All five bioregions parallel each other, from east to west, as continuous ecological belts, occasionally bisected by the country's river systems (RAOnline 2010c).

**Abbreviations:** BCN - Bird Conservation Nepal; DDT - Dichlorodiphenyltrichloroethane; DFZ - Diclofenac Free Zone; GIS - Geographic Information System; IUCN - International Union for Conservation of Nature; NGOs - Non-government Organisations; NSAIDs - Non-steroidal Anti-inflammatory Drugs; SAVE - Saving Asia's Vultures from Extinction; VDC - Village Development Committee; VSZ - Vulture Safe Zone.

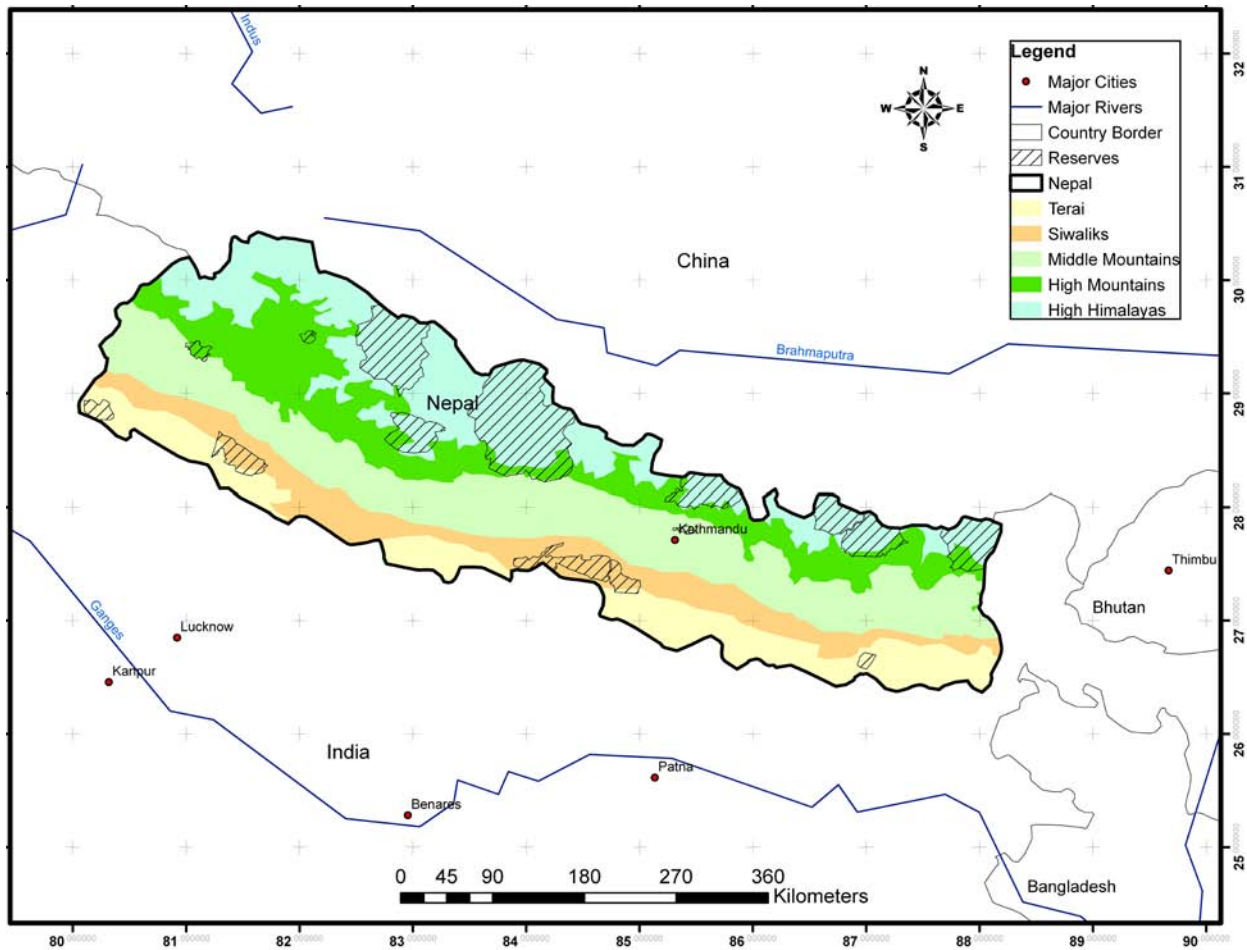


Figure 1. Biogeographic regions of Nepal. Adapted from (RAOnline, 2010c)

**Climate**

Nepal has a great deal of variation in climate with five identified climatic zones (Table 1) based on altitude (Savada 1991; Vetaas & Grytnes 2002). The significant differences in climatic conditions are principally correlated with the enormous variation in altitude from the south to the north of the country (Savada 1991; RAOnline 2010a).

Table 1. Climatic Zones of Nepal. Adapted from (Savada 1991; RAOnline 2010a; Vetaas & Grytnes 2002)

Zone	Minimum altitude (m)	Maximum altitude (m)
Tropical and subtropical	70	1,200
Cool temperate	1,200	2,400
Cold zone	2,400	3,600
Subarctic	3,600	4,400
Arctic	4,400	>4,400

**CONSERVATION STATUS OF NEPAL’S VULTURES**

There has been a catastrophic decline in the populations of three *Gyps* species in the Indian subcontinent, White-rumped Vulture, Indian Vulture and Slender-billed Vulture (Table 2) (Gilbert et al. 2002; Prakash et al. 2003). Red-headed Vulture has also suffered catastrophic declines in the Indian subcontinent including Nepal (Cuthbert et al. 2006) believed to be primarily due to diclofenac poisoning (Green et al. 2004; Meteyer et al. 2005; Cuthbert et al. 2006; Swan et al. 2006; Cuthbert et al. 2007; Naidoo & Swan 2009). This has resulted in the reclassification of these species (Table 3) to Critically Endangered (IUCN 2012h).

Egyptian Vultures are a long-lived species, which are classified as Endangered because of recent and extremely rapid population declines in India and Nepal. The suspected cause is poisoning by the veterinary drug diclofenac. Severe long-term declines have also occurred in Europe and West Africa, plus ongoing declines throughout much of the rest of this species

**Table 2. Estimated Rates of Decline of White-rumped Vulture, Indian Vulture and Slender-billed Vulture in Nepal<sup>(N)</sup>, India<sup>(I)</sup> and Pakistan<sup>(P)</sup>.** Adapted from available data (Gilbert et al. 2006; Prakash et al. 2007; Pain et al. 2008; Chaudhary et al. 2012)

Species	Annual Decline Rate	Decline 1995–2007	Decline 1995–2011
White-rumped Vulture	13.7% (8–19 %) <sup>(N)</sup>	83%	91%
	43.9% (33–56 %) <sup>(I)</sup>	99.9%	
	48–50 % <sup>(P)</sup>	>99%	
Indian Vulture	16.1% (6–30 %) <sup>(I)</sup>	88%	
	25% <sup>(P)</sup>	97%	
Slender-billed Vulture	18.7% (11–25 %) <sup>(N)</sup>	92%	96%
	16.1% (6–30 %) <sup>(I)</sup>	88%	

range in Africa (IUCN 2012i).

Cinereous Vultures qualify as Near Threatened. They have a moderately small population that appears to be suffering an ongoing decline in its Asiatic strongholds, even though in parts of Europe numbers are now increasing (IUCN 2012a).

Himalayan Vulture, Griffon Vulture and Lammergeier are listed as Least Concern. They do not meet the definition for Vulnerable under range size criterion (Extent of Occurrence <20,000km<sup>2</sup> combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation) (IUCN 2012b,d,e). Population trends of Himalayan Vulture and Lammergeier show declines through much of their range (Acharya et al. 2009; IUCN 2012b) while Griffon Vulture appear to be increasing (IUCN 2012d).

### Species Distribution

All species maps below except for the Indian Vulture were derived from GIS polygon shape files supplied by Birdlife International (Birdlife International & NatureServe 2011). The Indian Vulture record was obtained from location data recorded by Tulsi Subedi and Robert DeCandido during their visit to a vulture feeding station near Pitauli, Nepal in December 2011 (Subedi & DeCandido unpub.)

### White-rumped Vulture (Fig. 2)

White-rumped Vultures range from Myanmar in the east through to Pakistan and India in the west (IUCN 2012c). The global population is estimated to be from 2,500 to 10,000 mature individuals (Birdlife International 2012; IUCN 2012c).

In Nepal, this species occurs mostly below 1,000m in the Terai plains and less frequently in hilly regions up to

**Table 3: Conservation Status of Nepal's Vultures.** Adapted from (BirdLife International, 2011; DeCandido, et al., 2012; Government of Nepal, 2009; IUCN, 2012h; Subedi & DeCandido, unpub.)

Common name	Scientific name	Status 2012 IUCN Red List category	Breeding status
White-rumped Vulture	<i>Gyps bengalensis</i>	CR	Resident breeder
Indian Vulture	<i>Gyps indicus</i>	CR	Recent visitor
Slender-billed Vulture	<i>Gyps tenuirostris</i>	CR	Resident breeder
Himalayan Vulture	<i>Gyps himalayensis</i>	LC	Resident breeder
Griffon Vulture	<i>Gyps fulvus</i>	LC	Passage migrant
Red-headed Vulture	<i>Sarcogyps calvus</i>	CR	Resident breeder
Egyptian Vulture	<i>Neophron percnopterus</i>	EN	Resident breeder
Cinereous Vulture	<i>Aegypius monachus</i>	NT	Winter visitor
Lammergeier	<i>Gypaetus barbatus</i>	LC	Resident breeder

CR - Critically Endangered; EN - Endangered; NT -Near Threatened; LC - Least Concern

1,800m over summer where it frequents light woodland, human habitation, and open areas (Grimmett et al. 2000; Prakash et al. 2003). Communal roost sites are also regularly used (Gilbert et al. 2006). It breeds in colonies in tall trees such as *Bombax ceiba* and *Ficus religiosa*, often near human habitation (Paudel 2008; Baral 2010; IUCN 2012c). It is a social species, usually found in conspecific flocks. Movements are poorly known, although Gilbert et al. (2007) showed that a satellite-tagged individual can forage over a vast range. The degree of connectivity of seemingly separate populations and conspecific flocks is not known (IUCN 2012c). The total population has dramatically declined since the mid 1990s to the point that it is highly threatened with extinction (Prakash et al. 2003).

### Indian Vulture (Fig. 3)

Until recently, this species had not been recorded in Nepal. Two individuals were observed in December 2011 near Pitauli, Nepal. This species may have been overlooked previously due to its similarity to Slender-billed Vulture (DeCandido et al. 2012; Subedi & DeCandido unpub.). Indian Vultures normally range through southeastern Pakistan and peninsular India south of the Gangetic plain. The global population is estimated to be about 45,000 mature individuals (Birdlife International 2012).

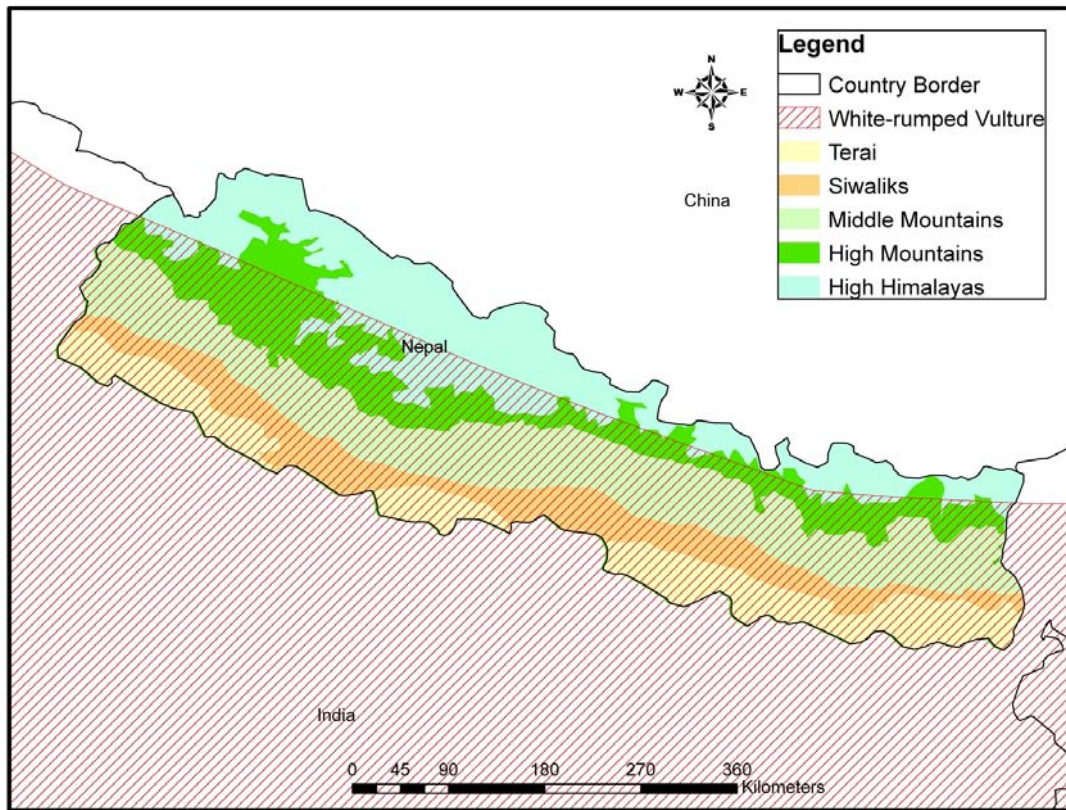


Figure 2. White-rumped Vulture distribution in Nepal. Adapted from (Birdlife International & NatureServe 2011).

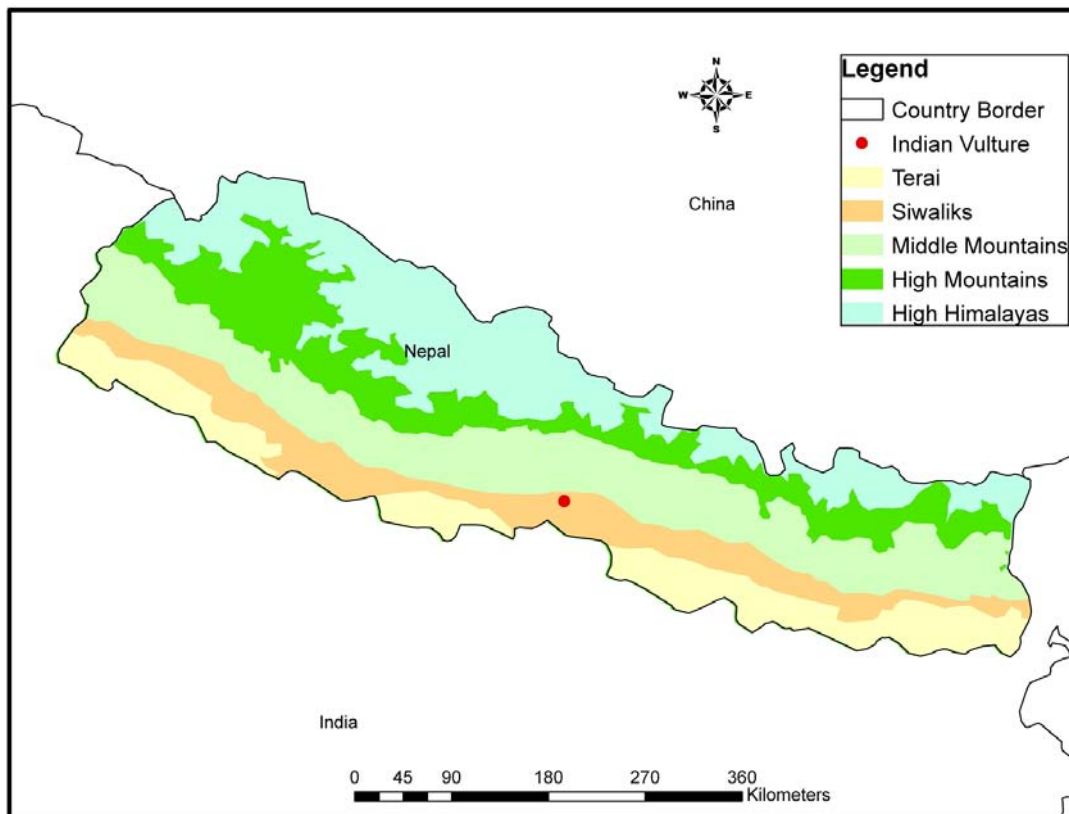


Figure 3. Indian Vulture distribution in Nepal. (DeCandido et al. 2012; Subedi & DeCandido unpub.).

Indian Vultures are found within cities, towns and villages associated with cultivated areas. It also inhabits open and wooded areas, and is often associated with White-rumped Vulture when scavenging. Indian Vultures nest almost exclusively in small colonies on cliffs and ruins, rarely in trees (Birdlife International 2012).

#### Slender-billed Vulture (Fig. 4)

Slender-billed Vultures range through southern Nepal. They also occur from Myanmar in the east to northern India in the west. This species formerly occurred more widely in Southeast Asia (IUCN 2012g). Global population of this species is estimated to be from 2,500 to 10,000 mature individuals (Birdlife International, 2012).

Slender-billed Vultures inhabit open forests up to 1,500m in the vicinity of human habitation (Grimmett et al. 2000; IUCN 2012g). It is a carrion feeder often scavenging at rubbish dumps and slaughterhouses. Nesting sites are located in trees usually at a height between 7m and 14m, often near villages (Baral 2010; IUCN 2012g).

#### Himalayan Vulture (Fig. 5)

This species is widespread and locally common in Nepal, usually between 900m and 4,000m (Grimmett

et al. 2000). However, numbers are declining in Upper Mustang, Nepal (Acharya et al. 2009). It ranges from China in the east through northern India to Kazakhstan at the northern extremity of its range (IUCN 2012e). The global population is estimated to be 100,000 mature individuals (Birdlife International 2012). It inhabits grasslands, temperate-grasslands and rocky areas such as cliffs and mountain peaks. Breeding occurs between 600–4,500 m. Non-breeding birds migrate to lower altitudes to spend the boreal winter in the plains (Li & Kasorndorkbua 2008). Numbers of Himalayan Vulture migrating to these areas and into India are increasing (Acharya et al. 2009).

#### Griffon Vulture (Fig. 6)

The Griffon Vulture is a wide-ranging species found from Mongolia and China in the east through Nepal to northwestern Africa. Global population appears to be quite large and increasing (IUCN 2012d) and is estimated to be around 100,000 mature individuals (Birdlife International 2012). It is widespread in Nepal and found frequently below 915m. During summer, individuals have often been observed in higher altitudes up to 3,050m (Grimmett et al. 2000). This species inhabits shrublands, grasslands and rocky areas similar to Himalayan Vulture (IUCN 2012d).

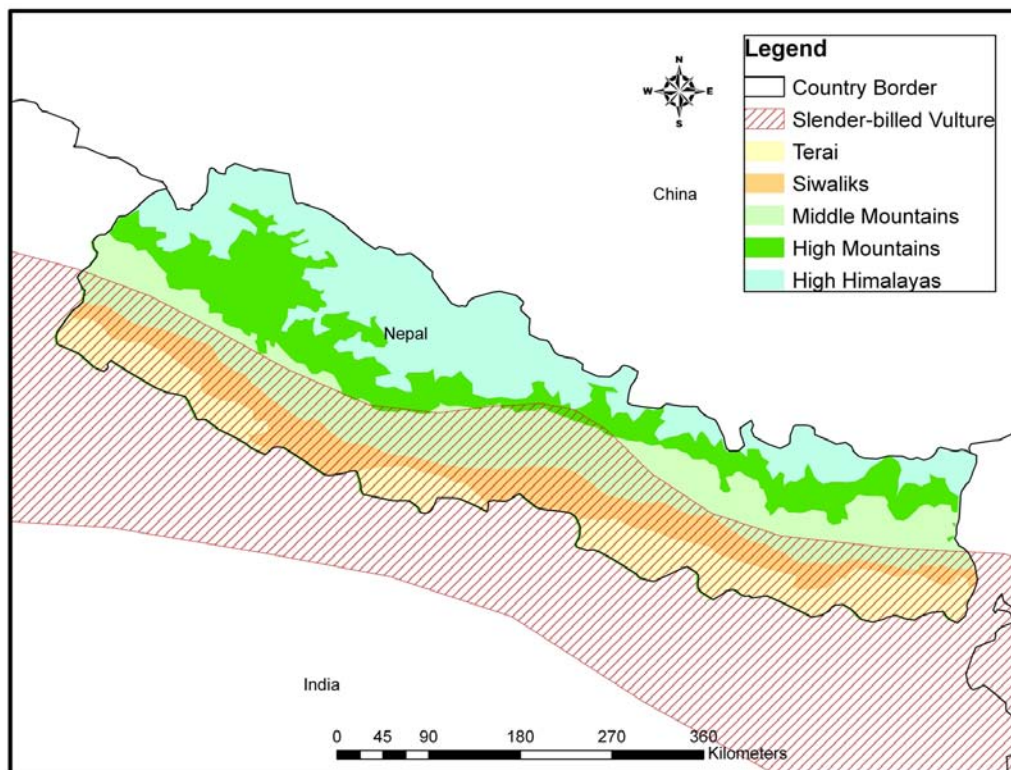


Figure 4. Slender-billed Vulture distribution in Nepal. Adapted from (Birdlife International & NatureServe 2011).

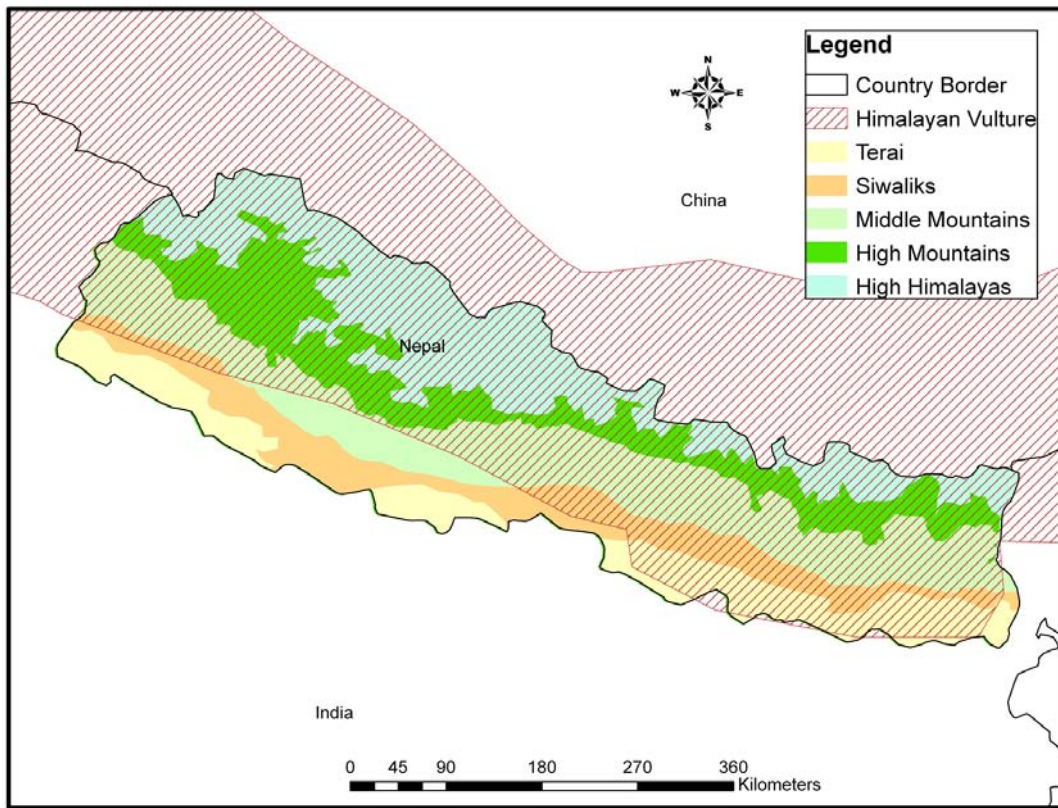


Figure 5. Himalayan Vulture distribution in Nepal. Adapted from (Birdlife International & NatureServe 2011).

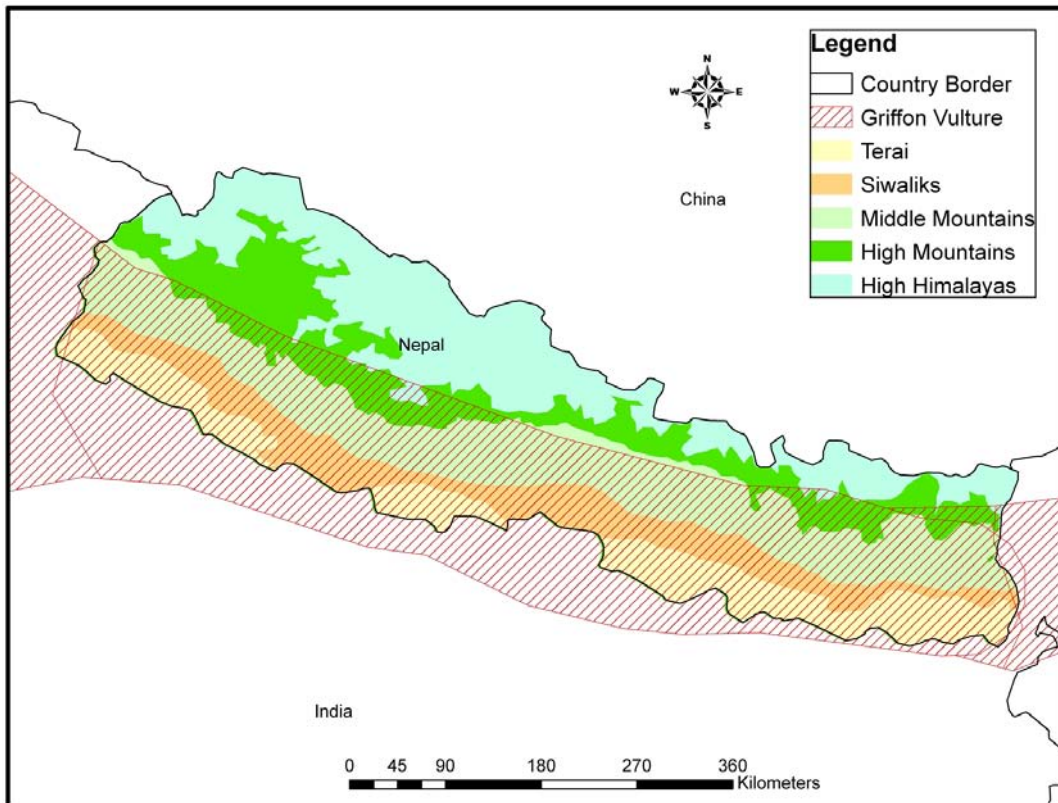


Figure 6. Griffon Vulture distribution in Nepal. Adapted from (Birdlife International & NatureServe 2011).

### Red-headed Vulture (Fig. 7)

The Red-headed Vulture is an uncommon resident in Nepal generally observed below 2,000m in open country near habitation and wooded hills (Grimmett et al. 2000). It is sparsely distributed and declining but still fairly common in the western Himalayan foothills of India (IUCN 2012j). Historical reports indicate that this species was widespread and generally abundant, but it has undergone a population and range decline since the 1990s. Evidence from India indicates that the species started undergoing a rapid decline (41% per year) in about 1999, and declined by 94% between 2000 and 2003 (Cuthbert et al. 2006). The global population is estimated to be from 2,500 to 10,000 mature individuals (Birdlife International 2012).

### Egyptian Vulture (Fig. 8)

Egyptian Vultures are mostly found in open country near habitation. This species has been observed up to 915m in Nepal with excursions to 3,800m during summer (Grimmett et al. 2000). They occupy a large range from India and Kazakhstan in the east through to western Africa. The core population occurs in Ethiopia, East Africa, Arabia and the Indian subcontinent. Global population is likely from 21,000 to 67,200 mature

individuals (Birdlife International 2012). These birds winter within the resident range (IUCN, 2012i).

### Cinereous Vulture (Fig. 9)

Cinereous Vultures range through Nepal principally north of the Terai. They are also found from Mongolia and mainland China in the east through to Turkey in the west. There is also a small population in Spain and France (IUCN 2012a). The global population is decreasing and is likely from 14,000 to 20,000 mature individuals (Birdlife International 2012).

In areas where there are few domestic livestock, populations of Cinereous Vultures are declining. This is likely due to an overall reduction of available food sources (Milner-Gulland et al. 2001). Little is known about population trends on wintering grounds, although wintering populations appear to be declining in Nepal and increasing in India (IUCN 2012a).

### Lammergeier (Fig. 10)

The Lammergeier is a reasonably common resident in Nepal occurring between 1,200–4,100 m (Grimmett et al. 2000) where it inhabits grasslands, shrubland, rocky areas, artificial and urban areas (IUCN 2012b). It ranges from Mongolia and China west to Afghanistan.

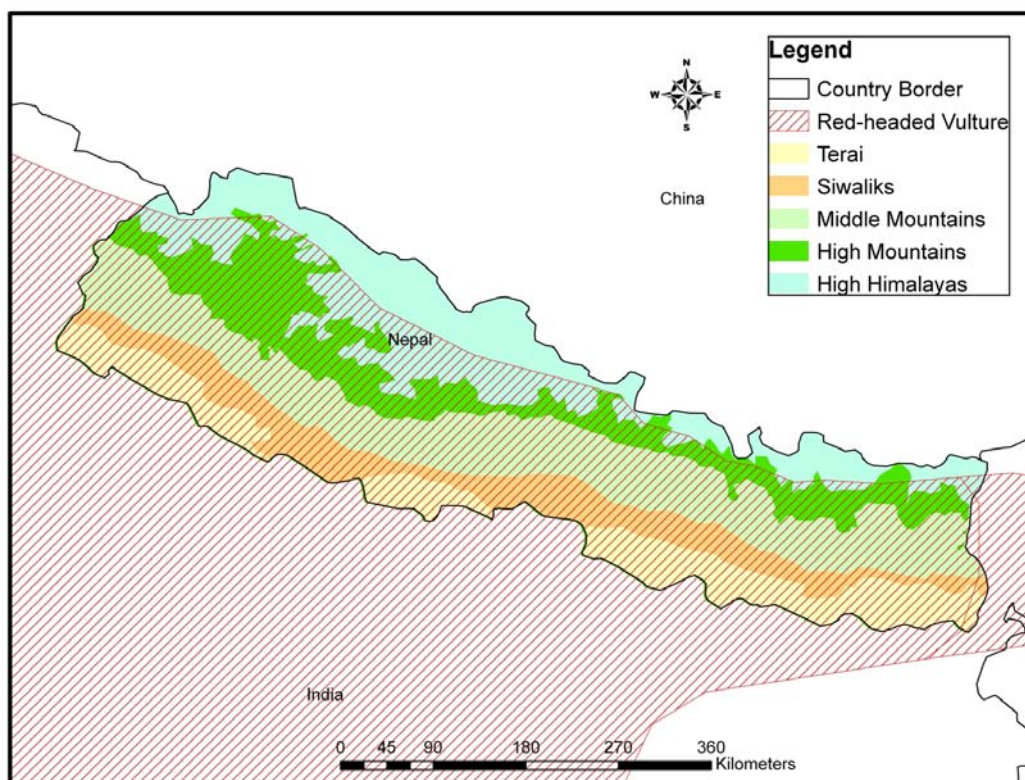


Figure 7. Red-headed Vulture distribution in Nepal. Adapted from (Birdlife International & NatureServe 2011).



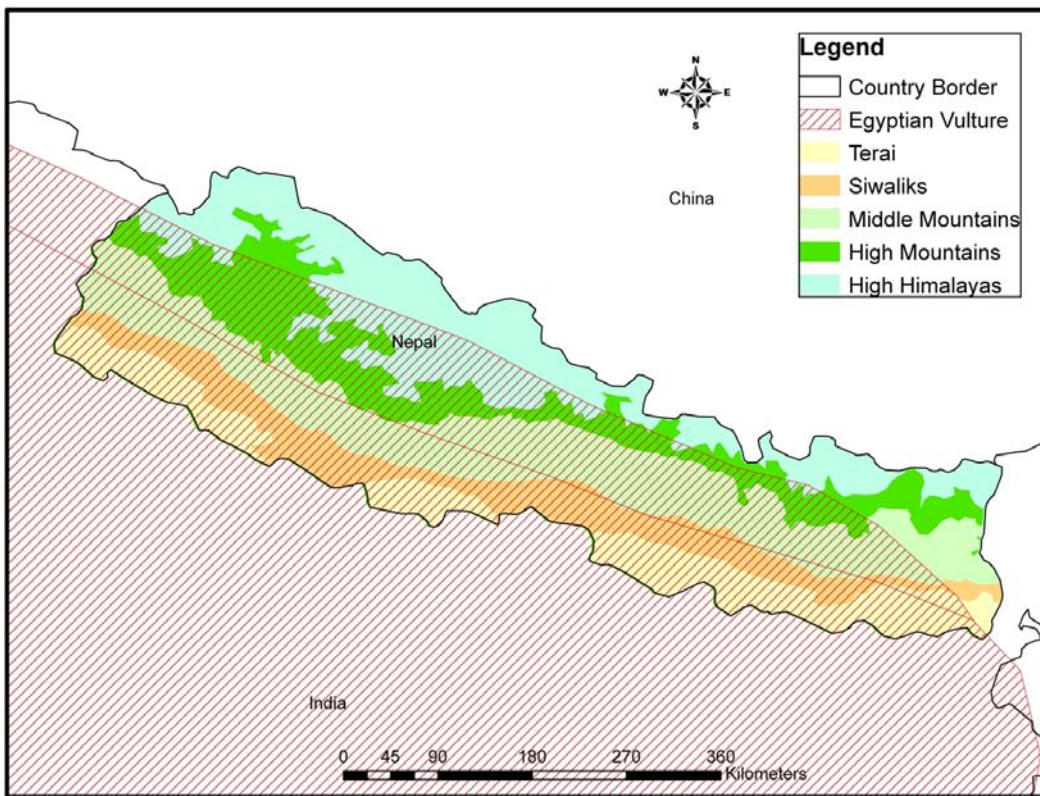


Figure 8. Egyptian Vulture distribution in Nepal. Adapted from (Birdlife International & NatureServe 2011).

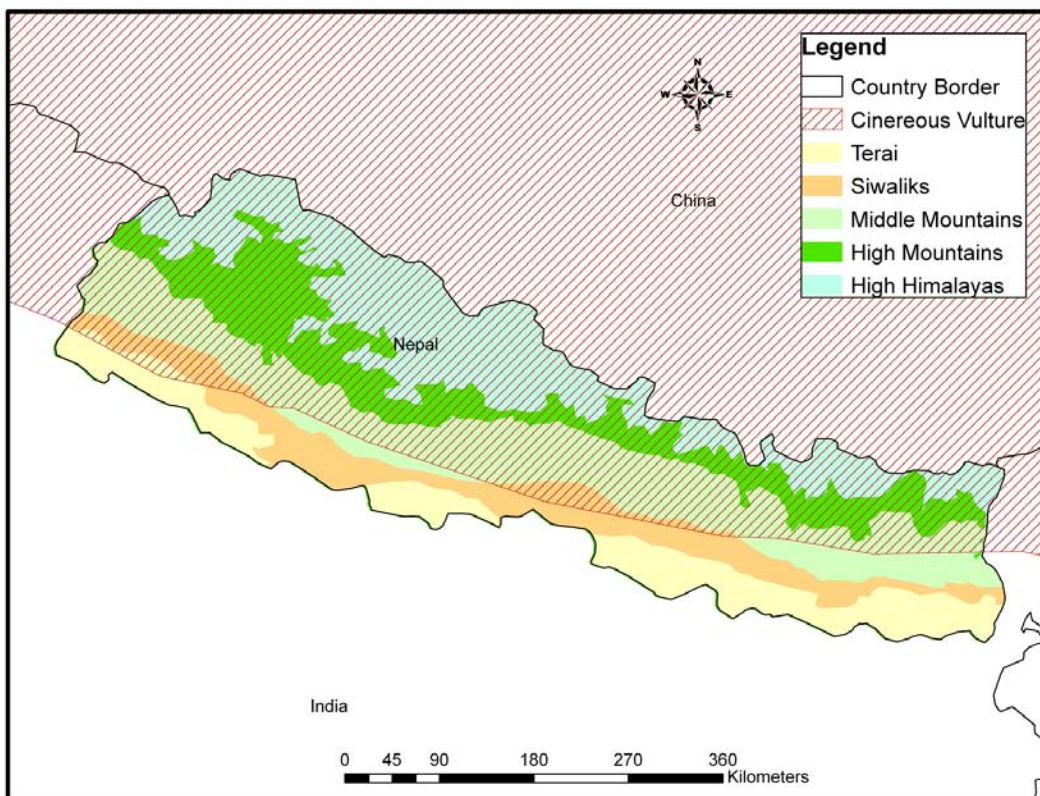


Figure 9. Cinereous Vulture distribution in Nepal. Adapted from (Birdlife International & NatureServe 2011).

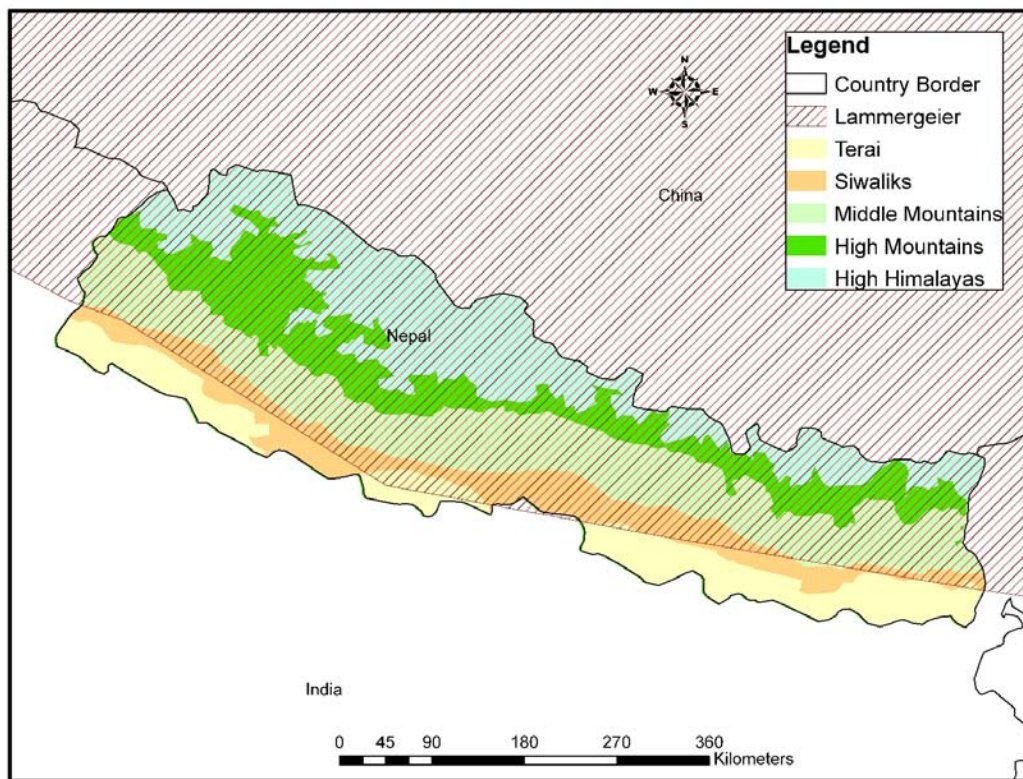


Figure 10. Lammergeier Vulture distribution in Nepal. Adapted from (Birdlife International & NatureServe 2011).

It is also found from Iran to Turkey, eastern and north western Africa and Spain. The global population may be small, approximately 2,000 to 10,000 mature individuals, however at this time does not meet the criteria as a threatened species (Birdlife International 2012; IUCN 2012b).

#### EXISTING AND POTENTIAL THREATENING PROCESSES

The main contributory factor causing declines in many vulture species is the use of the veterinary drug diclofenac (Oaks et al. 2004; Shultz et al. 2004), which has been available and in use since c. 1990 in India (Pain et al. 2008). The population of White-rumped and Slender-billed Vultures are now quite small mostly due to diclofenac.

Lammergeier and Egyptian Vulture are now also declining rapidly but there is no direct evidence that diclofenac is the cause. However, the geographic extent and rate of decline is similar to the *Gyps* populations suggesting diclofenac (Cuthbert et al. 2006). The decline from many other parts of their former ranges may have been exacerbated by food shortages, persecution,

infectious diseases and chemical contaminants (Cuthbert et al. 2006). However, these causes have been ruled out for *Gyps* species (Pain et al. 2003; Prakash et al. 2003).

Further declines have resulted from human impacts such as human population growth and associated deforestation, grazing and cropping and the resulting reduction of traditional food sources (Guzmán et al. 2006; Baral & Gautam 2007; Margalida et al. 2007, 2009; Morán-lópez, Guzmán et al. 2006; Zuberogoitia et al. 2008). Infectious diseases, environmental contamination, deliberate and accidental poisoning along with exploitation and persecution (Rahmani 2004) may also contribute to population declines.

#### 1. Consumption of NSAIDs

Diclofenac is largely regarded as one of the most devastating environmental toxicants in recent times (Naidoo & Swan 2009) and has been found to be highly toxic to at least six of the eight *Gyps* species (Swan et al. 2006; Das et al. 2011). Dead vultures, which were contaminated with diclofenac residues, have been recovered across India, Nepal and Pakistan (Shultz et al. 2004; Oaks et al. 2004). Analysis of 38 kidney samples from White-rumped Vulture obtained from Pakistan during 2000–2002 found that all 25 birds that died with

visceral gout also had detectable levels of diclofenac. Thirteen that died without visceral gout did not have any detectable diclofenac (Oaks et al. 2004). Unfortunately, vultures do not have the biological means to excrete the drug (Baral 2010). Therefore, small quantities of diclofenac may kill an individual or group of vultures.

After accidental exposure to diclofenac through their food chain via the ingestion of tissues from dead livestock treated with the drug, populations of three species of *Gyps* vultures in South Asia, the White-rumped Vulture, Slender-billed Vulture and Indian Vulture have collapsed over the last decade. All are resident in Nepal (Oaks et al. 2004; Shultz et al. 2004; Naidoo & Swan 2009; IUCN 2012c,f,g) except possibly the Indian Vulture which was only recently accepted as authentic sightings by the Nepal Rare Bird Committee (DeCandido et al. 2012). Adding to this alarming trend the Himalayan Vulture is also suffering substantial declines in some areas likely due to diclofenac poisoning (Acharya et al. 2009; Das et al. 2011). In the Annapurna Conservation Area, Mustang, Nepal the Himalayan Vulture is not suffering the same level of decline as other areas have. This is likely due to different foraging behaviours than other *Gyps* species and/or less use of diclofenac (Virani et al. 2008). Other vulture populations, including the Indian Vulture, Red-headed Vulture and Egyptian Vulture, have also recently undergone rapid declines in India (Prakash et al. 2003; Cuthbert et al. 2006; Prakash et al. 2007). Diclofenac has been banned in Nepal, India and Pakistan since 2006, and Bangladesh in 2010 (Pain et al. 2008; Baral 2010). However, illegal use still occurs including the illicit use of human diclofenac on animals (Paudel 2008; Taggart et al. 2009; Baral 2010). Given the overwhelming evidence that diclofenac is the major cause of vulture declines (Green et al. 2004, 2007) and that diclofenac is toxic to all *Gyps* species (Swan et al. 2006; Das et al. 2011), it stands to reason that differences in declines between regions will correspond to differences in diclofenac availability and use.

Cuthbert et al. (2007) pointed out in their study that other NSAIDs are also harmful to other species of scavenging birds. Carprofen and flunixin appeared to carry a high risk of renal damage in birds which backed up previous claims by Klein et al. (1994) and Clyde & Murphy cited in Cuthbert et al. (2007). Naidoo et al. (2010) demonstrated in their study that, ketoprofen is toxic to two South African *Gyps* species at doses that would be encountered in the wild if they consumed flesh from livestock carcasses within hours of their treatment. The symptoms and clinical signs at necropsy, visceral gout and kidney damage, were identical to those found

in *Gyps* species resident in Nepal.

It is of concern that a number of NSAIDs have not been tested and proven safe for vultures. Many are in widespread use within the range of resident and migratory Accipitridae vultures. These include metamizole, phenylbutazone, ibuprofen, naproxen, nimesulide (Taggart et al. 2010) and aceclofenac (Sharma 2012). As the toxicity of these drugs to vultures is unknown, there may well be similar effects on individuals and populations that diclofenac and ketoprofen have demonstrated. At this time, the only NSAID that has been tested and proven safe for vultures is meloxicam (Cuthbert et al. 2007; Naidoo et al. 2007). Research by Prakash et al. (2006) on poultry suggests that nimesulide may be safe for vultures, however rigorous testing is required before this drug is proven safe.

## 2. Ingestion of Chemicals and Lead

Poisoning resulting from chemical contaminants such as agricultural chemicals can be responsible for high mortality rates and reduced reproductive success in many species including raptors (Pain et al. 2003) and thus Accipitridae vultures. Organochlorines such as DDT are responsible for reproductive failure and high mortality rates of avian predators and scavengers in many countries (Provini & Galassi, 1999; Muralidharan et al. 2008; van Drooge et al. 2008; Dhananjayan et al. 2011). Farmers in India use large concentrations of pesticides with their use increasing during the 1980's which may well have affected migrating vultures and the Nepal vulture population along the border regions. However, evidence suggests that over the last decade pesticide use may have reduced slightly (Pain et al. 2003).

Between 2000 and 2002 Oaks et al. (2004) performed 259 post-mortem examinations on adult and sub-adult White-rumped Vultures in Pakistan. Detailed necropsies were carried out on 14 without visceral gout and 28 with visceral gout. Each of these 42 birds was screened for a wide range of contaminants (Table 4).

Most tests resulted in below toxin concentrations

**Table 4. Post-mortem results of 42 White-backed Vultures**  
Adapted from (Oaks et al. 2004)

Contaminant	Number of individuals
Cadmium	39
Mercury	37
Arsenic, copper, iron, manganese, molybdenum, zinc	All
Carbamate and organophosphate pesticides	34
Organochlorine pesticides and polychlorinated biphenyls	13

other than one case of lead toxicity and one of organophosphate poisoning. Further research is required in Nepal to ascertain the level of use and environmental contamination by both agricultural and industrial chemicals and heavy metals. However, it is unlikely that pesticide and herbicide chemical contamination will have the same impact as NSAIDs (Pain et al. 2003). The ingestion and bioaccumulation of lead in bone tissues can also be a major problem in long-living birds of prey including vultures (Mateo et al. 1999, 2001; Gangoso et al. 2009).

Recent research on broad spectrum animal husbandry antibiotics by Lemus et al. (2009) has found that fluoroquinolone residues were obtained from most unhatched eggs sampled in Central Spain. Fluoroquinolone is a commonly used antimicrobial drug, and is the drug of choice for the majority of most common diseases in livestock and poultry. The toxic effects of fluoroquinolone were found to be detrimental to the development of embryos and may thus promote hatching failure. On death, fluoroquinolone treated stocks are often deposited in traditional livestock carcass dumps or vulture restaurants. *Gyps* vultures in this area of Spain, feed at these vulture restaurants and carcass dumps. This results in chemical contamination of those individuals feeding on the carcasses. It is not known if related impacts result in vulture deaths in Nepal. Further research is required to determine if similar contamination is actually occurring.

### 3. Consumption of poison baits

Deliberate and accidental poisoning can have a significant impact on vulture populations, however, it cannot be certain if direct persecution in Nepal is impacting on resident vulture species (Pain et al. 2003; Rahmani 2004). Targeted poisoning of carnivores does occur in Nepal even though it is illegal. This makes it almost impossible to measure the extent or importance of the problem. Considering that vultures feed in a communal manner with large aggregations around carcasses, it is possible that a small number of carcasses could have serious consequences for vulture populations already in decline in a similar manner that diclofenac has impacted (Rahmani 2004). Monitoring the scale and importance of poisoning of vulture populations is required to assist in assessing population impacts.

### 4. Consumption of human made non-food items

Houston et al. (2007) studied the implications of condors and vultures consuming junk material such as indigestible, non-food and other human-made objects.

The material consisted of glass, china, plastic, metal, rocks, sticks, grass, wool, fur and other items. *Gyps* vultures specialise in feeding on muscle and viscera from large mammals (Houston et al. 2007). It is hypothesised that the consumed fragments are mistaken for bone fragments, a source of calcium required in their diet. Females require a higher amount of calcium to produce eggshells and chicks are fed bone fragments to provide calcium for healthy growth. However, the slow growth rate of vulture chicks requires less calcium than other raptors (Houston 1978) therefore ingestion of bone fragments is also likely to be less.

Vultures may also consume junk to help in forming pellets for regurgitating keratin such as hair, hoofs and horn. Indigestible fibrous material, such as grass, leaves, twigs and bark, has been found in pellets along with solid objects (Benson et al. 2004). The normal ingestion of indigestible materials is clearly an adaptive behaviour to assist in regurgitation of pellets. The swallowing of human litter with sharp edges can harm an individual internally and may be life threatening. Similarly, human litter that is toxic to vultures may also be consumed. Some of these junk items are fed to chicks which results in an accumulation in their gut. As chicks' oesophagus muscles are not as strong as their parents they may not have the strength to eject them (Houston et al. 2007).

The level of impact in relation to death rates from ingestion of human made objects has not been sufficiently studied to provide conclusive results. Accipitridae vultures of Nepal may well be affected to some degree by this behaviour.

### 5. Anthropogenic Climate Change

There is overwhelming evidence that modification of the environment by humans will more than likely result in future climate change. Human induced activities such as energy use, industrial processes, solvent and other product use, agriculture, land use change and forestry, and waste are driving increases in greenhouse gas emissions that in turn are drivers of climate change. Climate change is now occurring at a faster rate than has previously occurred naturally. Anthropogenic climate change is likely to involve both changes in average temperature conditions and changes to the frequency of occurrence of extreme events (DECC 2005; Solomon et al. 2007).

Before 1970, the Nepal region's climate consisted of general cooling or constant trends. In the mid 1970s a warming trend started, that continues today. These trends are consistent with the majority of the northern hemisphere. The relatively high rate of warming in

Nepal after the mid-1970s is due predominantly to the high rates of warming in the high elevation areas of the Himalayas and middle mountains (Shrestha et al. 1999). The result is the retreat of glaciers as is being experienced in many places around the Earth (Oerlemans & Fortuin 1992; Dyurgerov & Meier 1997; Joughin et al. 2004).

This process will result in the displacement of many species, populations and communities that can move across the landscape and possible extinction of many others that are restricted in movement. Species at risk include those with poor mobility, narrow ranges, specific host relationships, isolated and specialised species and those with large home ranges and long generations (DECC 2005) such as vultures. Changes in climate allow one to predict that the generalised effects of human induced climate change would increase breeding failure in the future in vulture populations. However, nesting habitats may be extended to higher altitudes as these areas warm (Morán-lópez et al. 2006).

## 6. Deforestation

Deforestation through urbanisation, agricultural practices and logging activities has resulted in extensive fragmentation (Gautam et al. 2004; Bhattarai et al. 2009) and thus a reduction in habitat. Many tree species are exported for commercial gain (Mathew 1987). Communities also harvest most of the mature trees from community managed forests while allowing younger trees to mature for future use. *B. ceiba* provides excellent building material and brings a reasonable price for individuals or communities. In 2002, 40 mature *B. ceiba* trees were harvested in the Rampur area to support a community school (Baral et al. 2007). This type of activity significantly reduces available nesting and roosting habitat for Accipitridae vultures (Baral et al. 2005, 2007).

Baral & Heinen (2007) found in the western area of the Terai that firewood is the main source of energy. This is common throughout Nepal particularly in the low income rural areas (Amacher et al. 1993). Baral & Heinen (2007) also found that thatch is most commonly used as a roofing material, while timber is the dominant choice for housing and furniture. Community based conservation measures have gone some way towards reducing the loss of mature trees and promoting sustainable management (Jones 2007). The unceasing use and decline of these resources, particularly timber, will continue to erode the available habitat for Accipitridae species unless major reforms to industry and community activities occur.

## CONSERVATION PROGRAMMES

In Nepal there are a range of current actions and programmes in process for the conservation of vultures (BCN 2009). Many of these programmes complement each other; however, there are two major limiting features. Within Nepal, human resources are in short supply and/or financial restraints may limit the potential of some of these conservation activities (Government of Nepal 2009). Further efforts are required to enhance conservation outcomes for Accipitridae vultures. There is also a need for continuing and enhancing concentrated unilateral conservation efforts within the Asian and Indian subcontinents, which will strengthen the knowledge base and conservation outcomes.

**(i) Vulture Restaurants:** The establishment of vulture restaurants in Nepal is influencing the recovery of vulture population that are on the brink of extinction. These restaurants provide safe diclofenac-free food sources in close proximity to breeding sites. As a result breeding records have increased for White-rumped Vultures near vulture restaurants (BCN 2009). The restaurants purchase old and unproductive cattle from farmers who are happy to sell them (Baral 2010). The cattle are then treated with a safe drug whenever required and managed at the rescue centre until their natural death. Any diclofenac in their system has sufficient time to be excreted before death. After death, the carcass is left out for the vultures to feed on (Aryal 2010; Baral 2010). Vulture restaurants have now been successfully introduced to Pithouli Village in East Nawalparasi, Gaidahwa Lake, Lumbini, Rupandehi District, Laimatiya VDC and Bijouri VDC of Dang, Kailali and Kaski districts (Government of Nepal 2009). Gilbert et al. (2007) found that vulture restaurants can reduce, but not eliminate, vulture mortality through diclofenac exposure and thus provide a valuable interim measure in reducing population declines locally until diclofenac can be totally withdrawn from use. Vulture restaurants also provide a valuable tool for education by promoting public awareness of the vultures' plight and safe use of NSAIDs. This concept called Vulture Safe Zone (VSZ) comprises of an inner core with a 50km radius and an outer buffer zone, 50–100 km radius, which has been tested free of diclofenac and other veterinary drugs toxic to vultures (SAVE 2011). VSZs have now expanded and combined becoming Diclofenac Free Zones (DFZ) in 16 districts covering an area of 30,344 km<sup>2</sup> (BCN 2011).

**(ii) Captive Breeding:** A vulture conservation breeding centre has been constructed at Kasara, Chitwan National Park through the joint efforts of the Nepal Government and NGOs. Their breeding and holding aviaries house 22

pairs of White-rumped Vultures (BCN 2009). Successful captive breeding programmes have resulted in positive outcomes for vultures. Sarrazin & Babalt (1996) showed that immature released vultures had an equal breeding success rate as wild pairs. During 2010/11, 20 White-rumped Vulture chicks were collected for the captive breeding programme at Kasara, Chitwan National Park. This brings the total number of the captive population to 60, enhancing the future captive breeding programme (BCN 2011). Provided human induced threats are managed successfully, there is a high probability that individuals released from Nepal's captive breeding programme will survive and reproduce.

**(iii) Community Education:** In Nepal, the first International Vulture Awareness Day was held on 05 September 2009. Awareness programmes were held at 35 different districts attracting 8,200 participants from the general public, industry and media through to academics. The media coverage was extensive with over 50 articles in print and electronic media (BCN 2009).

During 2011, 66 awareness programmes were organised in the DFZ districts with the involvement of 26,000 people. In February, SAVE was launched in Kathmandu. Key government authorities, conservation organisations and other stakeholders attended.

In March 2011 in the Kailali District, a meeting was held between government and NGO officials on cooperative trans-boundary conservation between India and Nepal (BCN 2011). Detailed discussion highlighted the need for cooperative trans-boundary conservation and the establishment of VSZs along the border of the two countries.

The Department of Livestock Service now actively undertakes vulture awareness workshops as part of its annual programme. This programme promotes and actively generates awareness on the use of meloxicam rather than diclofenac for livestock treatment to various levels of the government, NGOs, veterinary communities and drug traders (BCN 2011).

Ongoing public education has helped generate positive attitudes towards vulture conservation (BCN 2009, 2011). BCN has also been involved in monitoring and education work promoting the advocacy of using the safe NSAID meloxicam and removing diclofenac from sale.

**(iv) Diclofenac Ban:** Following the ban of manufacturing and import of diclofenac in Nepal in June 2006, efforts have been made to promote the safe alternative meloxicam (Swan et al. 2006; Cuthbert et al. 2007; Naidoo et al. 2007; Swarup et al. 2007; Government of Nepal 2009). Cuthbert et al. (2007)

demonstrated that meloxicam was safe to use on six species of *Gyps* vultures and at least 54 other raptor and scavenging bird species. Meloxicam is widely available throughout Nepal; however, some of the general population are still using diclofenac due to lower cost and possibly non-acceptance. Remaining stockpiles of diclofenac were legally used until stocks were depleted or until the three year shelf life expired in May 2009. All veterinary diclofenac appearing in the market from May 2009 has been illegally obtained. Diclofenac is currently a legal pharmaceutical for human use and has been used on cattle as an alternative to the veterinary drug. The open border policy with India allows the uncontrolled importation of diclofenac (Aryal 2010; Baral 2010).

In 2008, Paudel (2008) surveyed 12 agro-vet shops in the vicinity of Lumbini and found that 75% had diclofenac for sale. Currently, regular up to date monitoring of agro-vets and pharmaceuticals within the DFZs has demonstrated that there is now no veterinary diclofenac available in these markets. However, there has been a small amount of human diclofenac reported. The use of human NSAIDs must be prohibited in veterinary practice while existing laws need to be strictly enforced. Government officials are alerted to and continue to work on this issue (BCN 2011). It is important to emphasise that ongoing education of the industry, workforce and their end users on the negative impacts of this drug has resulted in positive outcomes (BCN 2011).

## FUTURE NEEDS

Currently there are two relevant action plans that cover India and Nepal (Government of India 2006; Government of Nepal 2009). Both these plans cover all species mentioned in this document however do not provide in depth biological and ecological data and species management information that would enhance recovery prospects for each individual species. There is a need for individual recovery plans tailored for each of these threatened species. Examples of this format of recovery plan can be viewed from various government web sites (Australian Government 2012; New Zealand Government 2012). It would be beneficial to these species if governments and NGOs within the range of each species jointly participated in formulating recovery plans. This would facilitate species-specific outcomes complimenting existing action plans. Individual countries may have greater impact issues than others, necessitating the need for a unilateral approach.

A holistic approach is required that provides education

for the general public, government and NGOs through these plans. Utilisation of as many media avenues as possible would enhance education outcomes. Education should encompass ecosystem services that vultures provide for the human population while recognising and providing direction on the impacts that people have on vulture ecology. People need to understand that if vulture populations decrease, other consumers of carcasses such as feral dogs, jackals and rats will increase. This in turn brings with it human health issues such as rabies. Further research is required to facilitate the effective education of society particularly on how society will be affected if vulture populations decline further or disappear from Nepal's ecosystems.

Research is also urgently required to determine the principle threat or cumulative threats causing the declines of Red-headed Vultures and Egyptian Vultures. Diclofenac may be the principle cause, as with other Accipitridae vultures, however at this time it is not conclusively known. If further research is not conducted on these two species and effective management plans are not put in place, I fear that Red-headed Vultures and Egyptian Vultures in particular, and indeed a number of other Accipitridae vultures may well be faced with extinction in the very near future.

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