DISTRIBUTION, ABUNDANCE AND HABITAT EVALUATION OF ASIAN VULTURES IN KALIGANDAKI CORRIDOR, NEPAL

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Submitted to

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August, 2021

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

Date: 16 August, 2021

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LETTER OF APPROVAL

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This thesis work submitted by Punam Ghimire entitled "Distribution, abundance and habitat evaluation of Asian vultures in Kaligandaki Corridor, Nepal" has been accepted as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper Ecology and Environment.

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LIST OF ABBREVIATIONS

Abbreviated form		Details of abbreviations
BCN	-	Bird Conservation Nepal
BV	-	Bearded Vulture
CV	-	Cinereous Vulture
DBH	-	Diameter Breast Height
DNPWC	-	Department of National Parks and Wildlife Conservation
EV	-	Egyptian Vulture
GIS	-	Geographic Information System
GLM	-	Generalized Linear Model
GoN	-	Government of Nepal
GV	-	Griffon Vulture
HG	-	Himalayan Griffon
IUCN	-	International Union for Conservation of Nature
MoFSC	-	Ministry of Forests and Environment
RHV	-	Red-headed Vulture
SBV	-	Slender-billed Vulture
VSFs	-	Vulture Safe Feeding Sites
VSZ	-	Vulture Safe Zone
WRV	-	White-rumped Vulture

ABSTRACT

This study was conducted aiming to assess the distribution, abundance and habitat evaluation of Asian vultures in Kaligandaki Corridor, Nepal. Method includes point observation using the birding route, visit of nesting/roosting sites and fixed point survey. Questionnaire survey was also done to identify people's perception towards the status and threats on vultures. A total of 99 vulture individuals of five species were observed in total 19 points along the Kaligandaki River Corridor (57 individuals in twelve different points during the summer visit and 42 individuals in nine different points during the winter visit). Remarkably only the two species, White-rumped vulture and Red-headed vulture were recorded at Khaireni Community Forest with total of 63 individuals (37 individual in summer and 26 in winter). Vulture sightings and abundance were relatively higher during summer than in winter. White-rumped Vulture was the most abundant species and Red-headed Vulture was least abundant species recorded in both seasons in the study area. Only the nests of *G. bengalensis* were observed at Khaireni Community Forest. *Bombax ceiba* was found to be the most commonly used tree species. Vultures were found highest in the forest habitat and least in the rocky/barren land habitat. Distance to water, distance to forest and distance to agricultural land showed positive association with abundance of vulture in summer whereas distance to settlement land and distance to VSFs showed positive association to abundance of vulture during winter. Food scarcity and habitat loss were major threats for population decline of vultures in the area. For the long term vulture conservation, community based conservation programs, awareness campaigns and provision of economic incentives to local people should be carried in all of its range areas by government authority and concern organization.

1. INTRODUCTION

1.1 General background

Nepal is endowed with rich biological diversity. Nepal's biodiversity strength is well reflected with high number of bird species due to its unique geographic position as well as altitudinal and climatic variations. Vultures are the primary consumers of carrion in Asia and Africa, with an individual *Gyps* species vulture consuming around 1 kg of tissue every three days (Mundy et al. 1992). Vultures are medium to large sized scavenging birds, feeds mostly on the carcasses of dead animals making the environment clean and free from disease, pollution and are found on every continent except Antartica and Oceania (Del Hoyo et al. 1994). They belong to the family Accipitridae and order Falconiformes. Distribution of different species of vulture ranges from 200 to 4100m of elevations from sea level (Grimmett et al. 2003).

Among twenty-three species of vulture in the world, Nepal supports nine species namely- White rumped *Gyps bengalensis* (WRV), Slender-billed *Gyps tenuirostris* (SBV), Red-headed *Sarcogyps calvus* (RHV), Indian vulture *Gyps indicus* (IV), Egyptian vulture *Nephron percnopterus* (EV), Bearded vulture *Gypaetus barbatus* (BV), Himalayan Griffon *Gyps himalayensis* (HG), Cinerous vulture *Aegypius monachus* (CV) and Griffon vulture *Gyps fulvus* (GV) (BCN and DNPWC 2016). Among these six (WRV, SBV, RHV, EV, BV and HG) are resident breeders, CV a winter migrant, GV a passage migrant and IV a vagrant species (BCN and DNPWC 2011). Four species (WRV, SBV, RHV and IV) are listed as Critically Endangered, one species (EV) is listed as Endangered and another three species are listed as Near Threatened (BV, CV, HG) by The International Union for Conservation of Nature (IUCN 2016).

Vultures are known to inhabit tall trees in forests, open areas, rocky cliffs and old monuments (Thakur and Narang 2012, Harris 2013, Haenn et al. 2014). Vultures are known to colonize wooded as well as open habitats with agriculture and tree cover (Robinson 1994, Donazar et al. 2002a, b). Selection of nesting cliffs and foraging areas by Bearded and other vulture species depend on a combination of climatic, geographical, and other environmental factors including food availability and human disturbance within the territory (Donázar et al. 1993).

For the population decline of vultures during 1997 to 2007, veterinary pharmaceutical retailers in South Asia and different scientists concluded the diclofenac as the major cause (Oaks et al. 2004, Shultz et al. 2004). After identifying diclofenac as a major cause of decline, use of Meloxicam was identified as safe alternatives (Swan et al. 2006). Other accessory causes that accelerated this declination are habitat destruction, indirect poisoning, electrocution and electric collisions, food shortage and superstitious beliefs of rural people (Ghimire 2018, Chaudhary et al. 2019). Other sources of mortality include poisoning through feeding on deliberately poisoned carcasses that are placed out to kill other animals (e.g. dogs), felling of nesting trees, disturbance and destruction of nests to prevent vultures nesting above agricultural land and dwellings, exclusion from feeding sites through disturbance or alternative carcass disposal methods (burial), and direct persecution and hunting of vultures either for medicinal purposes (DNPWC/MoFSC/GoN 2009). Decline of vultures has many associated impacts such as economic effects for those engaged in industries such as cattle skinning and bone collecting, and for villagers who have to find alternative means of disposal of carcasses; human, livestock and wildlife disease effects; and cultural/religious effects (Prakash et al. 2004). Further, declination of vultures' population favor increase in feral dogs and facultative scavengers (Cunningham et al. 2001) which could have serious consequences for human and wildlife health, as dogs are carriers of several diseases like rabies, distemper, and canine parvovirus (Pain et al. 2003).

Moreover, recent studies suggest that the declination rate of vulture population have slowed and probably reversed (Paudel et al. 2016, Galligan et al. 2019). Participatory conservation initiatives, in-situ and ex-situ conservation measures along public awareness and provision of diclofenac free food through establishment of Vulture Safe Feeding Sites (VSFS), Vulture Safe Zone (VSZ) and federal concern to declare Nepal as diclofenac free country are critical steps adopted for ceasing the catastrophic decline of vulture population in Nepal (Paudel et al. 2016, Bhusal 2018). A group of governmental and non-governmental organizations tried to establish vulture restaurants since 2000. Nepal also established first vulture breeding Centre at Casara of Chitwan National Park and launched its first vulture restaurants in 2006, in Pithauli, Nawalparasi and the country has now seven Vulture Safe Feeding Zone. Until 2010 sixteen districts (Jhapa, Ramechhap, Dhanusa, Nawalparasi, Palpa,

Rupandehi, Kapilbastu, Argakhachi, Pyuthan, Dang, Banke, Bardia, Kailali, Kanchanpur, Kaski and Myagdi) of Nepal have been declared as Diclofenac Free Zones.

However, population of all vulture species in Nepal is still small for their sustainable recovery. Therefore, identification of new habitat ranges and regular monitoring of population throughout these ranges is crucial. In this scenario, this research work presents the distribution of vultures in Kaligandaki Corridor which is fully untouched with any kind of conservation approaches. Detail study of these threatened species in new and potential habitats is crucial for their long term conservation.

1.2. Objectives of the study

1.2.1 General objective

To explore the distribution, habitat use and threats of Asian vulture species in Kaligandaki Corridor, Nepal.

1.2.2 Specific objectives

1. To determine the distribution and abundance of Asian vultures
2. To evaluate nesting, and roosting habitats of Asian vultures in the study area
3. To assess existing and identify possible threats based on people's perception towards vulture

1.3 Significance of study

Kaligandaki River Basin has pristine and intact forest coverage and water resources with rich in biodiversity and harbors many vulture species. Out of nine, four species are listed as critically endangered and one as an endangered, this study will help to predict the distribution and habitat evaluation of the vulture in mid-hill regions of Kaligandaki River Corridor. Due to the absence of scientific data, limited studies and research in mid-hills, there is lack of an effective protection, management and monitoring of many species and its habitat. Through this research work, nesting habitat, distribution, abundance and threats to vultures will be known where locals or national conservation organization can use the research findings to conserve these critically endangered species in their current habitat. The study will collect baseline

data on the current population status, finding nesting sites and assessing nesting habitat and understanding the distribution of the vulture species in the study area. Also this study helps for assessing threats and conservation status and sensitizing locals on conservation importance of these species. This will have massive conservation contribution by filling up the existing knowledge gap. The law enforcing agencies, conservation stakeholders and policy makers may use the information to take mitigation measures, conservation initiatives and strategies from the study.

2. LITERATURE REVIEW

2.1 Distribution

Vultures have a wide distribution and are found in wide range of habitats. There are twenty-three species of vultures found in the world that exist for the most part in the tropics and subtropics. The Vultures of the world has been divided into two basic categories that are Old World Vulture and New World Vultures. Sixteen Old World Vultures found in Africa, Asia, Europe belong to family Accipitridae and seven New World Vultures (including the two condors) found in America belong to family Cathartidae (Purohit and Saran 2013). Except Antarctica and Australia vultures occur on all continents. Nepal supports all nine Accipitridae species of vultures that are found in Indian sub-continent (DNPWC 2015). A total of 203 individuals belonging to five species of vulture (HG, EV, RHV, WRV, BV) from 22 districts were extracted from the 75 photographs which were taken during different field visit from May2013-June2019 across the Nepal (Basnet et al. 2019) whereas during the opportunistic observation in the field from 2012 to early 2020, vultures were recorded from 63 of the 75 districts across the country, with 4879 total individuals of all nine species of vulture being observed (Rana et al. 2020). Eight species of vulture with total 29 nests were recorded in Chitwan-Annapurna Landscape (CHAL) of study sites (Palpa, Kaski and Manang) with elevation of 300m to 2000m and area of 2,162 km **(**Shah et al. 2019**).** Four different species were recorded (RHV, EV, BV, HG) in Salyan District with elevation of 457m – 3049 m (Ghimire et al. 2019) and two species of vulture with 24 individuals (HG and BV) were found in elevation of 1020 m - 8463 m, Sankhuwasabha (Karki et al. 2019). Four vulture species (WRV, EV, HG, Lammergeier) were recorded in Arghakhanchi District of elevation 305- 2525 meter above the sea level (Bhusal and Dhakal 2014).

2.2 Habitat

Vultures are known to inhabit tall trees in forests, smaller trees in open areas, rocky cliffs, old monuments and the countryside (Thakur and Narang 2012, Haenn et al. 2014). Vultures are known to colonize wooded as well as open habitats with agriculture and tree cover (Donazar et al. 2002a, b). Knowledge of ecological factors in the habitat affecting large scale distribution and abundance of endangered species is an important tool for defining management recommendations (Sutherland and Green

2004). Selection of nesting cliffs and foraging areas by Bearded and other vulture species depend on a combination of climatic, geographical, and other environmental factors including food availability, and human disturbance within the territory (Donázar et al. 1993). White-rumped Vulture frequents cultivation, open country and around human habitation, Cinereous Vulture inhabits open country, Lammergeier as well as Himalayan Griffon inhabits mountains and trans-Himalayan Tibetan steppe desert (Inskipp et al. 2016) whereas Slender-billed Vulture frequents cultivation, open country and around habitation, especially villages. The species is resident subject to altitudinal movements (Inskipp and Inskipp 1991). Egyptian Vulture is a scavenger that frequents the neighbourhood of towns and villages (Inskipp and Inskipp 1991). Red-headed Vulture inhabits open country near habitation (Inskipp and Inskipp 1991), also well-wooded hills (Grimmett et al. 1998). Subedi et al. (2020) provide significant responses for cliff selection with the variables: cliff aspect, distance to water/river, distance to village, length of road, the percentage of agricultural land cover and the percentage of area facing SW within 1- km radius from the nest. Vultures normally prefer nesting site outside of forest edge, untie grasslands with scattered trees or found in colonies in tree top at 2-10 meter far above the ground (Khatri 2015). They avoid human disturbances by placing their nests during breeding period at least 100 meters left from human interruption (Chomba et al. 2013). The White-rumped Vulture usually prefers the tall trees with greater diameter for nesting, roosting and perching (Rana et al. 2019)**.** White-rumped Vulture nests in flat terrain mostly in trees at riverbanks, at close distance from water-body with mean distance of 186 meters and mean height of 22 m which may be for protection from threats and in forested landscape and found maximum nests were in center and eastern side, for early warming from eastern sun to maintain body temperature to take for soaring (Ghimire et al. 2019). Major habitat types found in Suklaphanta National Park favoring the vulture habitat selection were Sal dominated forests, mixed forests, riverine forests, wetlands/marsh areas, grassland/phanta with tree species *Shorea robusta*, *Terminalia tomentosa*, *Syzygium cuminii*, *Plerocarpus marsupium* and tall grasses (Giri et al. 2002).

2.3 Threats

Vultures inhabiting varying habitats have declined from many parts of their former ranges owing mainly to food shortage and loss of habitat (Pain et al. 2003).Vulture

populations have declined severely in many parts of the world. In Asia, more than 95 % declines have been reported while an average decline of 62% during the last 30 years is reported for continental Africa (Ogada et al. 2016). Many vulture populations face a variety of threats, notably from unintentional poisoning particularly with the veterinary drug diclofenac (Green et al. 2004, Swan et al. 2006) and from negative effects of other numerous human activities in their environment including use of their body parts in traditional medicine, loss of breeding sites and direct persecution (Kuvlesky et al. 2007). Unavailability of food (Margalida et al. 2010) and electrocution (Ogada et al. 2012), hunting, trapping, logging and wood harvesting, electrocution, ecosystem degradation, fishing (McClure et al. 2018). Unavailability of material for nest disturbance at place noise pollution, splitting of stone, decline of population are mainly a cause of contamination of carcasses with veterinary drugs (Green et al. 2006), illegal poisoning (Margalida et al. 2012), poisoned when they feed on deliberately poisoned carcasses (Buechley and Şekercioğlu 2016), carcass burying activity, vultures have become victim of deliberate or unintentional poisoning of carcasses. Besides diclofenac, there are other threats to vultures in Nepal such as accidental poisoning, electrocution, human persecution, and localized shortage of food (Bhusal 2018). Remaining small population of vulture in Nepal is threatened by the carcass scarcity i.e. increased carcass burying practices, use of harmful drugs, secondary poisoning, habitat destruction, habitat loss, deforestation (Phuyal et al. 2016, Subedi et al. 2018).

3. MATERIALS AND METHODS

3.1 Study Area

The study area lies in southern part of Palpa District, northern part of Syangja District, north east part of Tanahun District and eastern part of Nawalparasi- East District. The study area covers total of 38 km with latitude of 27.86477°- 27.84177° and longitude of 83.85203°- 84.16805° within elevation of 303-455 m from sea level. More than half of the area lies in Rampur Municipality, Palpa District. A community managed vulture safe feeding site (Khaireni Community Forest) 27.8793° N and 83.84788° E, elevation of 333 m from sea level was also included in the study area. It lies by the side of Kaligandaki River with a large number of matured trees of *Bombax ceiba* in which vultures roost and build nests. The site consists of two blocks viz. western and eastern separated by a flood channel.

Kaligandaki River is very important for its bio-diversity along this landscape. The Kaligandaki River severs through Nepal's varied geographical zones and thus presents an excellent opportunity to examine the bird, fish and flora distribution. There are various forest patches on both sides of river with cliffs and scattered human settlements, which provides favorable habitat for different vulture species.

The landscape also includes biodiversity important areas including protected areas and protection forests (Gautam et al. 2013). These areas provide refuge for globally significant wildlife species, endemic flora and serve as watersheds and micro-organisms. The area has been included in the list of Important Bird and Biodiversity Areas of Nepal (Baral and Inskipp 2004).

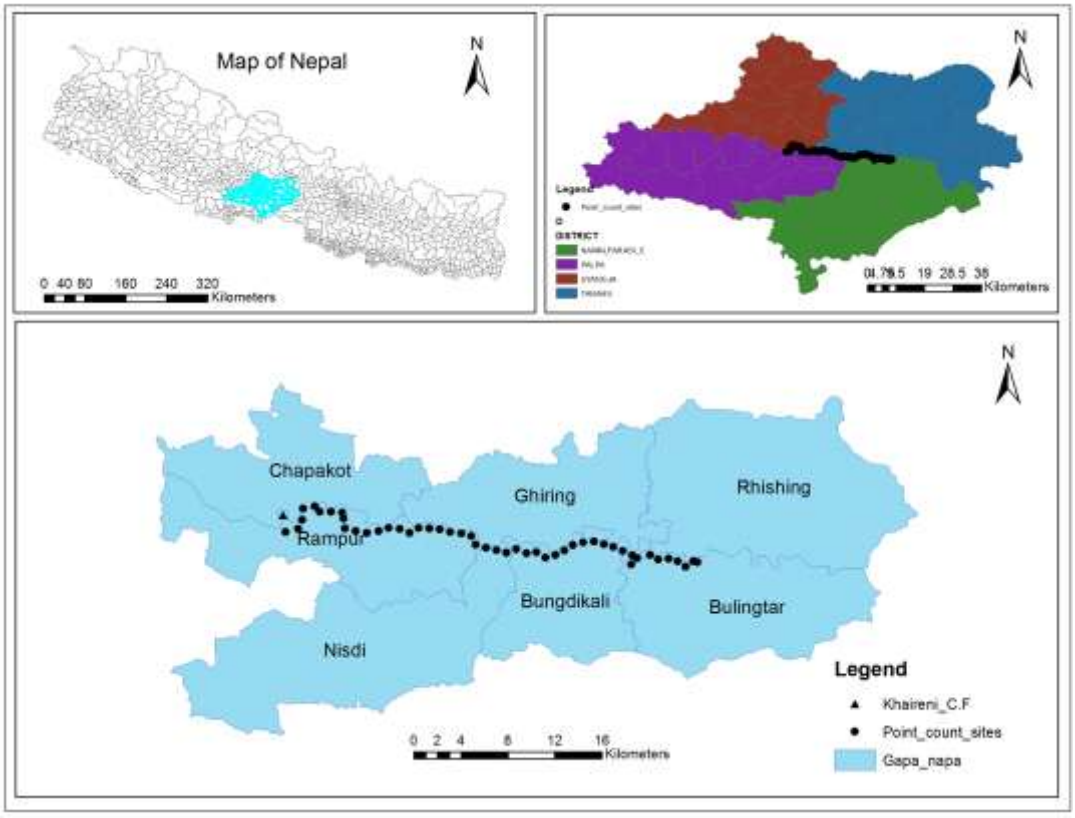

Figure 1. Location map of study area

3.1.1 Climate

The area has subtropical monsoon climate. The study area comprises temperate, dry winter and hot summer; hot dry from February to May, monsoon from June to August and cool-dry from September to January. The climate of the districts varies from sub-tropical in lower hills and valley to sub-humid in the mid-hills and gets temperate in high hills (Gautam et al. 2013).

3.1.2 Vegetation

The major dominant vegetation comprises Simal (*Bombax ceiba),* Khair (*Acacia catechu*), Karma (*Adina cordifolia*), Sal (*Shorea robusta*), Katus (*Castanopsis indica*), Chilaune (*Schima wallichi*), Tuni (*Toona ciliata)* and Saaj (*Terminalia tomentosa*).

3.1.3 Fauna

Mammals like Jackal (*Canus aureus*), Clouded Leopard (*Neofelis nebulosa*), Wild Boar (*Sus scrofa*), Porcupine (*Hystix indica*) and Hare (*Lepus nigricollis*) are found in the area.

3.2 Methods

Direct observation was done to determine the distribution of different species of vulture in study area. The total of 48 point counts were undertaken two times (seven days in November 2019 and seven days in June 2020) using GPS (Garmin 64s) in two different seasons: summer and winter. Only single time observation was done in each site. The surveys were also done alongside of the streams and riverbank to search for vulture nests and carcasses. When spotting vultures, the number of individuals, the activity of the birds and the major vegetation type in the surrounding area were noted. Number of various species, number, nesting sites, GPS location and time was noted on each site on each season. The field guide book 'Birds of Nepal' (Grimmett et al. 2016) was used for identification of birds.

3.2.1 Point observation

In each birding route, point observation /count method was used. Point count method was widely used for surveying birds in different land use types (Waltert et al. 2004) and to study the species-habitat relationship (Alldredge et al. 2007). Point count method (Bibby et al. 2000) was used to survey bird diversity and abundance. Point count sites (n = 48) were set up with about every 400 m along the both sides of the river which was recorded by Garmin Etrex 10 GPS. In each point station, vultures seen were noted for 20 minutes. Area was scanned with the help of binoculars (Bushnell 8*10) to observe, count and to identify vulture species. Photographs were taken with Camera (Nikon P900). The observation was done from 7:00 in the morning to 17:00 in the evening. To avoid the bias caused by differential detection of species due to visibility distance, observations of vultures recorded at distances beyond 1 km were discarded because of variation in visibility between sites and heat shimmer. Distance was recorded based on the relation to habitats over which vultures were flying and roosting and not altitude.

3.2.2 Habitat and nesting tree preference

During the survey, habitat types were recorded along with the species recorded. The nest information was collected along with DBH (Diameter at Breast Height (m)) using DBH tape, height of tree (m) using clinometer, nesting height (height of nest above ground (m)), tree type on which nesting is build. Preference of tree species by vulture was recorded by identifying the species where vultures rest, roost, and build nests.

Table 1: List of variables used for collecting habitat preference data

Variables	**Description**
GPS location	Latitude and longitude
Habitat type	Forest, Settlement area, Agricultural land, Rocky and barren land, River bank
Tree species	Trees used by vultures for nesting and roosting purpose
Tree DBH	Diameter at breast height of both nesting and roosting trees
Tree Height	Height of nesting and roosting trees
Distance to water	Distance to the nearest river measured from each point count sites
Distance to settlement area	Distance to the nearest inhabited buildings measured from each point count sites
Distance to farmland/agricultural land	Distance to nearest farming/agricultural area measured from each point count sites
Distance to forest	Distance to nearest forest area measured from each point count sites
Distance to VSF	Distance to nearest community managed vulture safe feeding site (Khaireni Community Forest) measured from each point count sites
Presence of carcass	Presence of dead livestock

3.2.2 Fixed point survey

To evaluate the vulture feeding habitat and sites, community managed vulture safe feeding site (Khaireni Community Forest) was observed.

3.2.3 Questionnaire survey/ Interaction

A sample questionnaire survey was carried out in the vicinity of vulture colonies to understand inhabitants' perception about vulture, carcass disposal practices, and livestock holdings. For household surveys, a community managed vulture safe feeding site was taken as the center point and marked the 34 households near to the area as site one. Thirty three households within five km and thirty three households within 20 km from vulture safe feeding sites were surveyed and marked as site two and three respectively. The households in each site were selected based on Random Selection Method (Gupta 2005).

3.3 Data analysis

3.3.1 Distribution

Thematic maps providing roosting and nesting location of vulture population and species distribution were prepared by using geographical locations. Arc GIS 9.3 was used for the conversion of GPS reading to spatial data layer (point features providing the location). Vulture occurrence was overlaid on the district map and local unit map.

3.3.2 Habitat evaluation

The vultures were classified based on following habitat types (i.e. forest, river banks, agricultural land, settlement area and rocky/barren land) and were analyzed using MS-Excel and PAST version 3.25. All types of forest were included in forest type habitat; meadows, grassland; mainly the riverbank were included as water dependent land; the agricultural/farmland and settlement area habitat; also rocky and barren land were also analyzed.

Generalized linear model (McCullagh and Nelder 1983), that allowed not only to fit a log-linear model, but also to make the very reasonable assumption, given that the data are counts, that the error distribution is Poisson and not normal (there were large number of zero counts and considerable fluctuations in vulture density) was used for measuring the distance from the nearest water source; distance to forest; distance to agricultural land; distance to settlement area and distance to VSFs in relation to vulture abundance.

3.3.3 Threats and people's attitudes

The attitudes of the respondents towards vulture were measured through questionnaire and combined to form a single attitude scale. Each answer was graded with a number and summed response for each question as positive, negative and neutral. The non-parametric test, Chi-square test with 95% confidence interval was used for the association between these variables.

4. RESULTS

4.1 Vulture species distribution and abundance

Five species (WRV, EV, HG, RHV and SBV) of 57 individuals were recorded in twelve different points (point 2, 14, 15, 19, 22, 26, 30, 31, 32, 37, 42 and 47) during the summer visit whereas 42 individuals of five species (WRV, EV, HG, RHV and SBV) were recorded in nine different points (8, 13, 14, 16, 23, 28, 32, 44 and 48) during the winter visit. At the points 14 and 32, vultures were recorded in both seasons. Remarkably only the two species, White-rumped vulture and Red-headed vulture were recorded at Khaireni Community Forest with total of 63 individuals (37 in summer and 26 in winter).

Vulture sightings and abundance were found relatively higher during summer of total 57 individuals of five species *Gyps bengalensis* (42), *Nephron percnopterus* (7), *Gyps himalayensis* (3), *Sarcogyps calvus* (2) and *Gyps tenuirostris* (3), as compared to winter season of total 42 individuals with *Gyps bengalensis* (29), *Nephron percnopterus* (5), *Gyps himalayensis* (6), *Sarcogyps calvus* (1) and *Gyps tenuirostris* (1) in point count sites. White-rumped Vulture was the most abundant species followed by Egyptian Vulture, Himalayan Griffon and Slender-billed Vulture. Red-headed Vulture was found least abundant in point count sites during summer season. During the winter, White-rumped was most abundant followed by Himalayan Griffon, Egyptian Vulture. Both the Red-headed and Slender-billed were least recorded vultures in point count sites. During the summer, vulture abundance was seen highest in point 26 and at point 28 in winter. In Khaireni Community Forest vultures were found more abundant during summer with 37 individuals of *Gyps bengalensis,* than in winter with total 26 individual of two species *Gyps bengalensis* (24) and *Sarcogyps calvus* (2). In summer, only *Gyps bengalensis* was recorded with no records of *Sarcogyps calvus.*

Table 2. Total counts of the five vulture species during summer at point count sites

Vulture Species	Total no. of sightings	Total no. of individuals
WRV	7	42
EV	3	7
HG	1	3
RHV	1	2
SBV	1	3

Table 3. Total counts of the five vulture species during winter at point count sites

Vulture Species	Total no. of sightings	Total no. of individuals
WRV	5	29
HG	1	6
EV	4	5
RHV	1	1
SBV	1	1

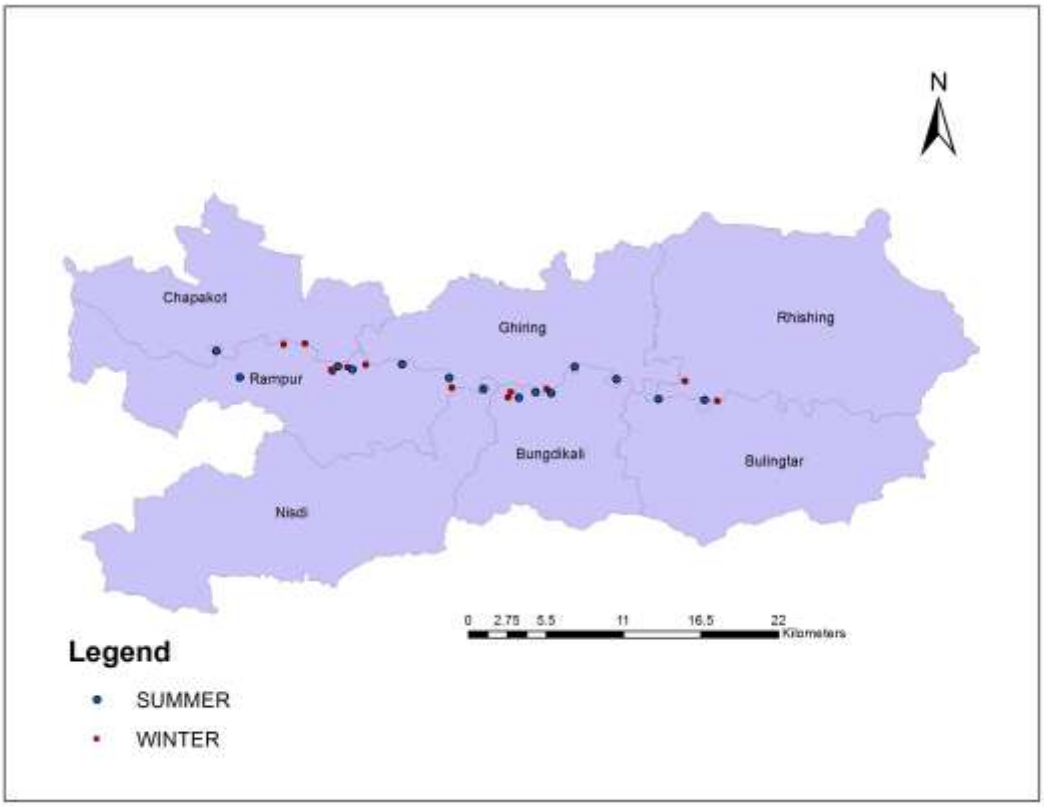

Figure 2. Distribution of vultures recorded in study area during summer and winter

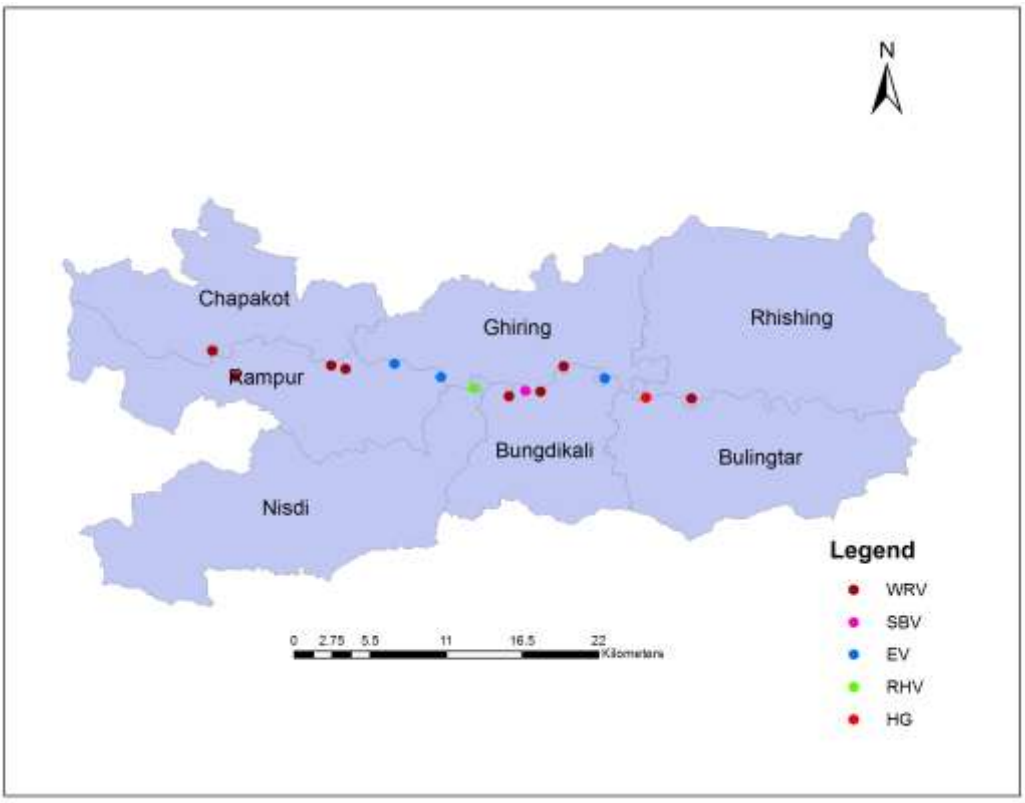

Figure 3. Distribution map of vulture species in summer

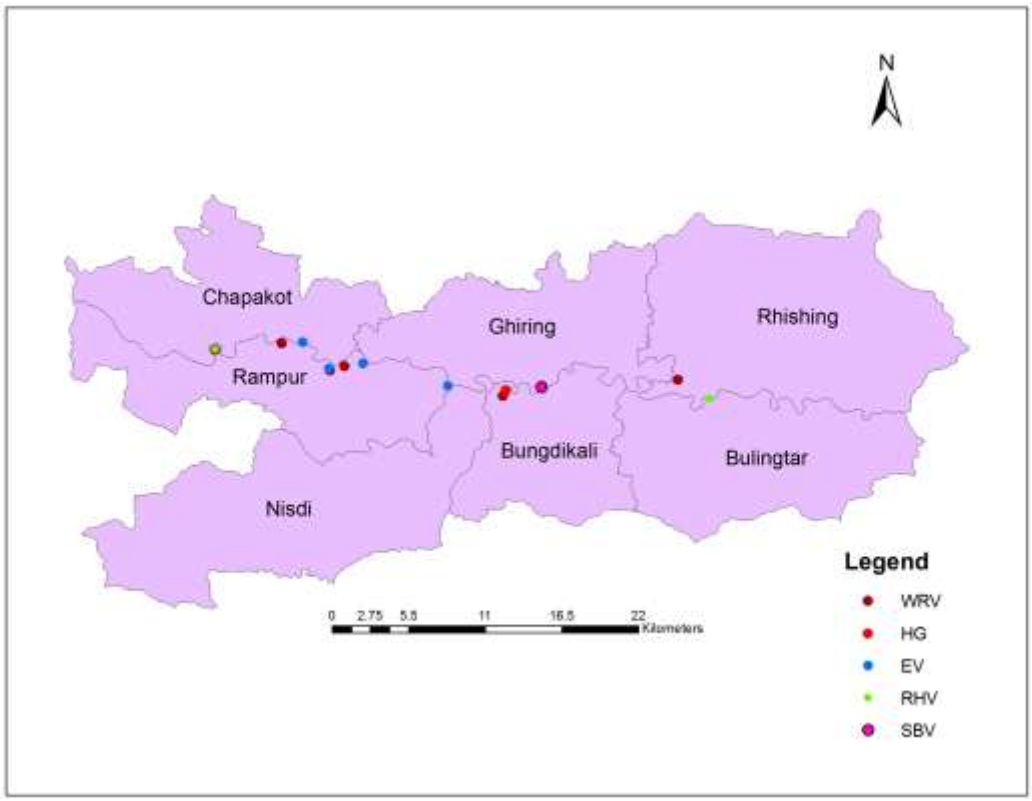

Figure 4. Distribution map of vulture species in winter

4.2 Habitat

4.2.1 Nesting and roosting preferences

The total of twenty four nests of WRV (three passive nests and twenty one active nests) was recorded in Khaireni Community Forest during winter and summer visit. Also there was no evidence of nests of vultures from remaining other points during the survey. In Khaireni Community Forest, the vultures were seen roosted and nested on tall and large trees of *Bombax ceiba*. Nests were in almost top of the tree with average of 28 m with a tree height of average 32 m. The average DBH of nesting trees were found to be 4m. Approximately, 57 trees of *B. ceiba* were found around nesting area of vulture however, nest was found to be prepared mostly in a single tree and four nests on two trees. While the roosting trees were of average 17m height with DBH of 1.3m.

4.2.2 Tree species preference

Vultures were observed roosting and resting in total seven tree species. Trees that were used by the vultures for roosting and resting purpose had the average height of 19m with DBH of 2.1m and canopy cover of 35% in other sites. The most favored tree species used for both nesting and roosting was found to be *Bombax ceiba* followed by *Ficus religiosa*, *Toona ciliata* (Table 4).

Table 4. Tree species used by vulture for roosting

Tree Species	**Roosting**
Simal (*Bombax ceiba*)	54%
Peepal (Ficus *religiosa*)	18%
Tuni (*Toona ciliata)*	11%
Khair (*Acacia catechu*)	9%
Mango (*Magnifera indica*)	8%

4.2.3 Season wise habitat association of vultures

At point count sites, most vulture sightings were recorded in forest (n=23), followed by river bank (n=13), agricultural land (n=11), settlement area (n=8) and least in

rocky and barren land (n=2) during summer. In winter, most vulture sightings were recorded in forest (n=18), followed by agricultural land (n=13), river bank (n=8), settlement area (n=2) and least in rocky and barren land (n=1).

In summer, WRV were found abundant in forest (n=18) followed by riverbank (n=12), agricultural land (n=1) and settlement area (n=1). During winter, WRV were seen abundant in forest area (n=17) followed by agricultural land (n=11) and settlement area (n=1) with no records on riverbank and rocky/barren land. HG were recorded only in forest area (n=3) in summer and in riverbank habitat (n=6) during winter. EV were recorded more in settlement area (n= 4) during the summer followed by rocky and barren land (n=2), riverbank (n=1) with no records in forest and agricultural land. In winter, EV was found abundant in riverbank followed by settlement, agricultural habitat. EV was the only vulture species recorded in rocky and barren land in both seasons. RHV was recorded from forest in both summer (n=2) and winter visit (n=1). SBV was found in settlement area during summer (n= 7) and during winter (n=2) in farmland habitat (Figure 5).

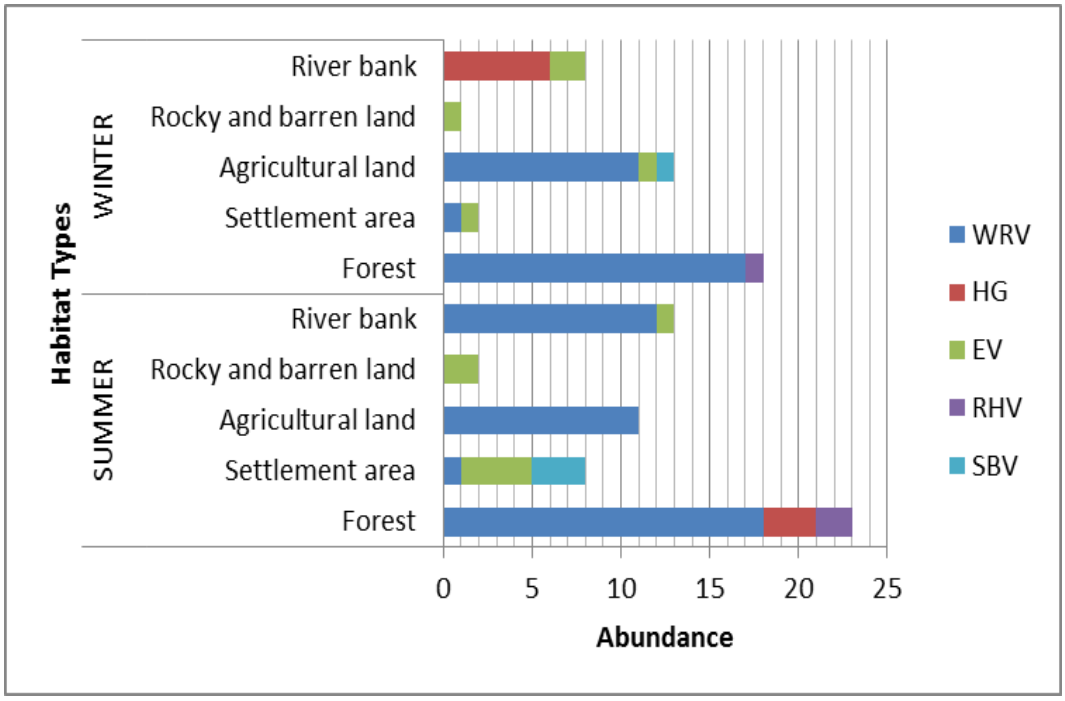

Figure 5. Habitat-wise vulture species abundance for the two seasons recorded at point count sites

In Khaireni community forest, most vulture sightings were recorded in forest areas (n=26), followed by river bank (n=11) in summer season whereas during winter,

vultures were found in forest area which is near to the water bank (n=26). Both RHV (n=2) and WRV (n=24) were found roosting inside the forest area in winter. Also, WRV were recorded basking near the river bank (n=11) during early morning and were resting in forest habitat (n=26) in summer.

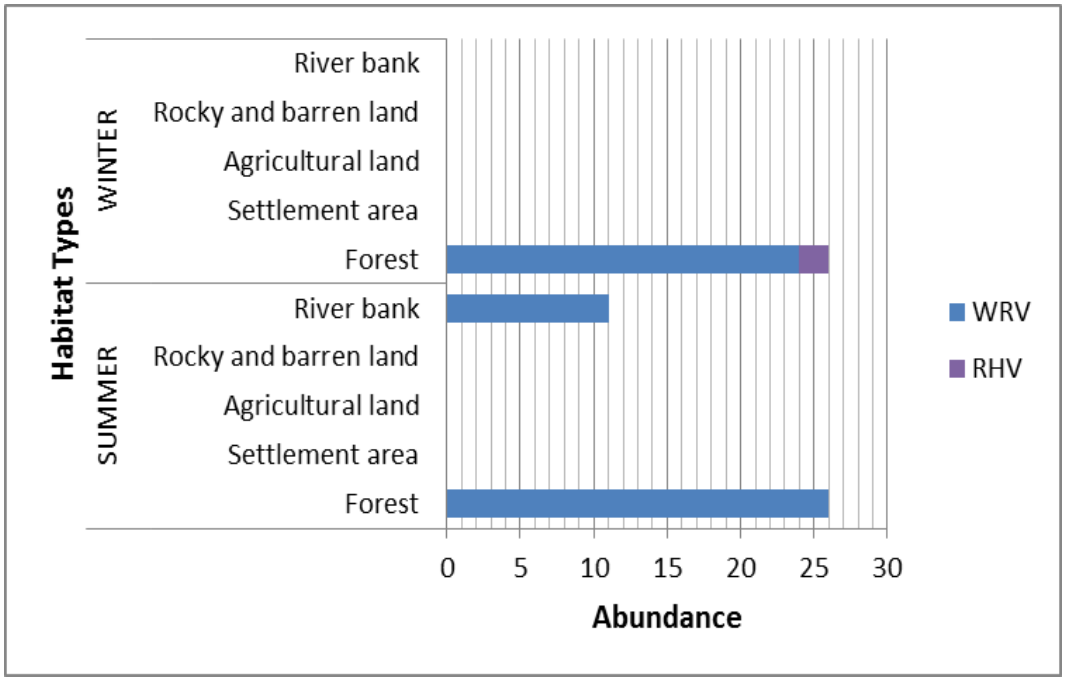

Figure 6. Habitat-wise vulture species abundance for the two seasons recorded in Khaireni community forest

Table 5. Generalized linear model (GLM) showing relation between the abundance of vulture with different environmental variables during summer

Model Parameters	**Estimate**	**Std.Error (S.E.)**	**Z-value**	**(Pr(>|z|)**	**Significance**
Distance to water (DW)	-0.001082	0.0005587	-1.934	0.05	*
Distance to settlement area (DS)	-0.001442	0.0008102	-1.780	0.0751	
Distance to agricultural land (DA)	-0.01295	0.00451	-2.872	0.004073	**
Distance to forest (DF)	-0.003972	0.001440	-2.758	0.005813	**
Distance to Vulture Safe Feeding Site (VSF)	1.429e-05	6.781e-05	0.211	0.833	

Table 6. Generalized linear model (GLM) showing the relation between abundance of vultures with different environmental variables during winter

Model Parameters	Estimate	Std.Error (S.E.)	Z-value	(Pr(>|z|)	Significance
Distance to water (DW)	0.0008413	0.0006481	-1.298	0.194	
Distance to settlement area (DS)	-0.031871	0.007864	-4.053	>0.001	***
Distance to agricultural land (DA)	0.0003545	0.0017487	0.203	0.839	
Distance to forest (DF)	0.0003905	0.0007155	0.546	0.585	
Distance to Vulture Safe Feeding Site (VSF)	2.711e-04	5.602e-05	4.840	>0.001	***

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Generalized linear model showed that distance to forest and distance to agricultural land were the important variable along with distance to water in estimating the abundance of vultures in summer as most of the vulture species with their high number of individuals were recorded in forest, agricultural land and riverbank. Among the five variables, distance to settlement and distance to vulture safe feeding site showed highly significant relation to vulture abundance in winter. Therefore, these variables are more important in comparison to other variables when predicting vulture presence in the surveyed area.

4.3 Carcass availability

Only the remaining skeletons of four carcasses of community managed vulture safe feeding site was recorded. Recorded carcasses were of two different mammalian species; cattle (50%) and unknown (20%). At point count sites no any carcasses were observed.

4.4 Demography of the respondents

Among the total 34 respondents from the Khaireni Community Forest users (site one), 49% were male and 51 % were female. In site two, 43% were male and 57% were

female out of 33 respondents. And in site three, out of 33 repondents, 52% were male and 48% were female. During the survey, one adult person (>30 years old) in each household was interviewed.

4.5 Livestock description

Around 75% of the respondents reared the livestock near the community forest**.** The most preferred livestock species was goat, followed by buffalo, cow and ox. It had been found that general insight about livestock farming had been declining with increasing modernization. Also within the past seven years, 16 % of households lost livestock to disease and 58% household said they use veterinary services to treat their livestock.

Of the respondents at site two, it had been found that only 56% reared the livestock. The most preferred livestock species was buffalo and cow. Also within the past seven years, 11 % of households lost livestock to disease and 43% household said they use veterinary services to treat their livestock.

Among the respondents from site three, 91% reared the domestic animals of which preferences of livestock was buffalo, cow, goat and ox. Within the past seven years, 72 % of households lost livestock and 69% household said they use veterinary services to treat their livestock.

4.6 Carcass disposal practices

After the death of the livestock, the users and the households nearer to Khaireni Community Forest (site one) managed the carcass by taking it to the vulture safe feeding site (100%). In site two, 34% of the carcasses were buried while 24% were thrown on river and remaining percent of the carcasses were given to skin tanner (16%) and community managed vulture safe feeding site (7%). The carcass was dumped in various places based upon the easy access of dumping sites. Besides, the households far from vulture safe feeding site (site three), carcasses were disposed by throwing in river banks (57%), open areas (31%) followed by burying practices (12%).

The carcass disposal practice applied by respondents after the death of the livestock in site two and three has been illustrated in (Figure 7**)** where burying practices and throwing in river banks were seen higher.

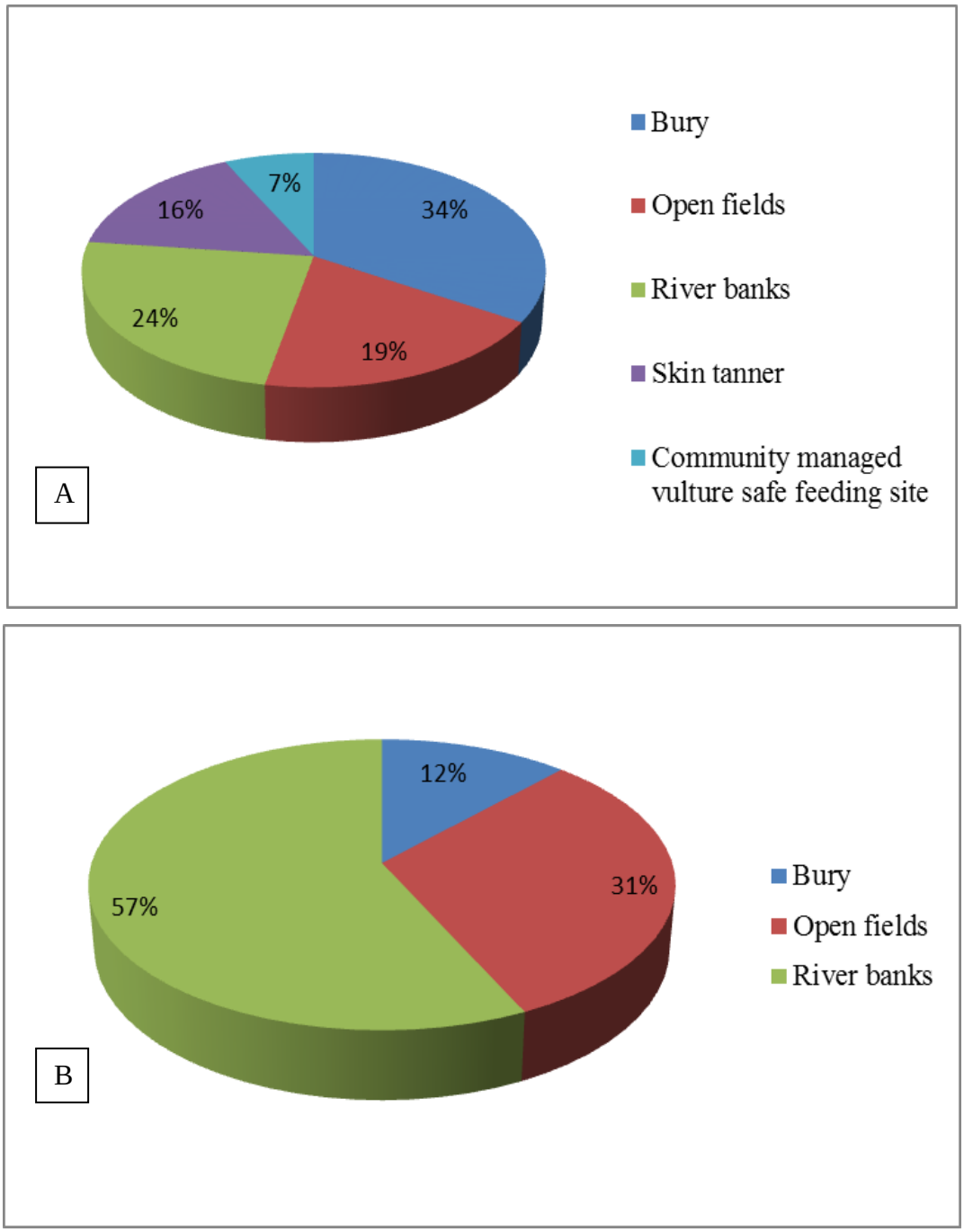

Figure 7. Carcass management practices done by respondents in A) site two B) site three

4.7 Attitude of respondents towards vulture

During the survey, almost all respondents were known about the vultures in their area. The respondents had various perceptions regarding the status of vulture population within seven years of interval. Among the thirty four respondents from Khaireni Community Forest users (site one), twenty five respondents said the decrease in vulture population and seven respondents thought vultures are increasing and remainining one respondent had no idea on increasing or decreasing vulture population. Similar types of result was found in remaining two sites. Among the respondents of site two, thirty respondents had viewed on decreasing of vulture population and remaining had no perception on increasing or decreasing vulture population in their area. Among the respondents from site three, thirtyone respondents had said that vultures were decreasing in their area. Besides two respondents had no views on increasing or decreasing population of vulture.

The Chi-square test was applied to compare the status of vulture population within seven years in different sites, as respondents answer showed there was a significant difference in people perception of three different sites on vulture population status (Table 7).

Table 7. Comparing the people's perception of three different sites on vulture population

Site	**People's perception on vulture population**	**Respondents(%)**	χ^2	**p-value**
Site one (n=34)	Increasing	20.6	29.6	0.05
	Decreasing	73.5		
	Neutral	5.9		
Site two (n=33)	Increasing	0	8.7	0.05
	Decreasing	90.9		
	Neutral	9.1		
Site three (n=33)	Increasing	0	9.5	0.05
	Decreasing	97		
	Neutral	3		
	Grand Total	300	47.6	0.02

4.8 Local opinion on population decline/ threats on vultures

According to the respondents of site one, 67.64% said food scarcity (less carcass amount) as a major reason for decreasing the vultures followed by deforestation (20.58%) of large and nesting trees as second major threats. Among the participants, 8.83% of respondents said decline due to use of chemicals and pesticides with remaining 2.94% on lack of conservation awareness. In site two, food scarcity (45.45%) due to the practice of burying the carcass, providing carcass to skin tanner, modernization was found as a major threats on decline of vulture population followed by habitat loss/destruction (30.30%). Lack of conservation awareness(12.12%), use of chemicals and pesticides (12.12), were also the reason behind the decline of vulture population in site two. Among the participants at site three, food scarcity (51.51%) due to low livestocks rearing practices, lack of conservation awareness (18.18%), hunting (12.12%), habitat loss (12.12%) and poisioning with use of chemicals and pesticides (6.060%) were the major cause for decline in vulture population and consider as a major threats.

The Chi-square test was applied to compare the response of participants of three different sites regarding on threats for vulture species. The Chi-square test showed that the estimated value was greater than tabulated value (Table 8) which means there was a significant difference in people perception of three different sites on threats of vultures.

Table 8. Comparing the people's perception of three different sites on threats for vultures

Sites	Threats	Respondents(%)	χ^2	p-value
Site 1 (n=34)	Food scarcity	67.6	13	0.049
	Habitat loss	20.6		
	Lack of conservation awareness	2.9		
	Use of chemicals and pesticides	8.8		
	Illegal hunting	0		
Site 2 (n=33)	Food scarcity	45.5	10.9	0.049
	Habitat loss	30.3		
	Lack of conservation awareness	12.1		
	Use of chemicals and pestticides	12.1		
	Illegal hunting	0		
Site 3 (n=33)	Food scarcity	51.5	25.8	0.049
	Habitat loss	12.1		
	Lack of conservation awareness	18.2		
	Use of chemicals and pesticides	6.1		
	Illegal hunting	12.1		
	Grand Total	300	49.7	0.05

4.9 Local people's perception on vulture conservation

Among the respondents from site one, 100% thought vultures are useful for the environment. When the respondents were asked about the efforts for conservation of vultures, maximum respondents (81%) asked for the management of vulture safe feeding sites through governmental aid and increasing the food availability and

community participation. Also the respondents from site two, asked for the provision of carcass disposal along with habitat conservation effort as maximum respondents (>93%) have positive response on usefulness of vulture in environment. Also 45% of the respondents from site three had positive response towards the vultures as they thought as useful bird. Remaining 30% of the respondents, thought vultures as a bad sign and are dirty birds while 25% respondents do not have any such perception. For the conservation efforts, the respondents asked for the management of carcass disposal practices through community participation along with governmental aid.

5. DISCUSSION

5.1 Vulture species abundance and distribution

Altogether, 172 vulture individuals of five species were recorded in total of 19 different points at point count sites and in Khaireni Community Forest with total of 63 individuals of two species in winter and one species in summer. Vultures were found distributed in total thirteen different points during the summer visit whereas in twelve different points during the winter visit. In Khaireni Community Forest, two species (WRV, RHV) of vultures were found during winter and only presence of White-rumped Vulture in summer. The absence of RHV in Khaireni Community Forest during summer may be the overlapping time between observation and foraging time of vulture. The presence of vultures in these point count sites might be accounted partly due to the availability of food and water on the edges of Kaligandaki River and partly to the availability of suitable habitats for nesting, roosting and perching. As most of the vultures were recorded during soaring, basking and flying, there might be the possibility of migration of vulture from other points. Khaireni Community Forest is mostly being preferred for nesting and roosting since more than decade (Gautam et al. 2014) which supports findings of the study. Also many mature *Bombax ceiba* trees along the periphery of the forest, easy access of food and water, fewer disturbances within the area may provide suitable habitat for nesting and perching the bird. The presence of vultures at same points in both seasons may be the dumping sites or presence of nests in that area..

Vulture abundance was recorded more in summer than in winter in both point count sites and Khaireni Community Forest. The reason behind the less abundance of vultures in winter may be the breeding season of the vulture species. Manandhar et al. (2019) recorded 96 vultures in summer including *G. himalayensis* (27), *G. fulvus* (26), *N. percnopterus* (22), *G. bengalensis* (7), *G. tenuirostris* (2) and *S. calvus* (12) and 46 vultures in winter including *G. fulvus* (18), *N. percnopterus* (9), *G. bengalensis* (12) and *S. calvus* (7) during the study period in Tanahun district which shows similar finding and suggest that more abundance in summer than in winter season. Also during the study period in and around the vulture restaurant, five species of vultures were recorded except *G. fulvus* at Pithauli, Nawalparasi (Adhikari and Bhattarai

2017), which is the closest habitat of vulture that lies in the eastern part of study area which shows similar findings on vulture species.

Vulture abundance was seen highest in point 26 (Siun) in summer and at point 28 (Siun) in winter as the area is rich with tall and large trees such as *Bombax ceiba, Schima wallichi, Magnifera indica, Ficus religiosa* for roosting and nesting with easy access of food and water resources.

The reason behind the abundance of White-rumped vulture seen higher might be its relatively high density in Khaireni Community Forest or its migration from near vulture restaurant and safe feeding zone in point count sites. Communal roost sites are also regularly used by WRV (Gilbert et al. 2006). Richness of nesting and roosting trees (*Bombyx ceiba, Ficus religiosa, Terminalia tomentosa*), open dumping sites are some other reasons for the greater presence of WRV in study area. Baral and Gautam (2007a) also found 92 and 51 were the maximum and minimum population of *G. bengalensis* recorded in the months of October and March respectively in the Palpa District (Rampur valley) which occupies half of the area of our study and provides similar findings to our study. The occurrence of least number of Red-headed vultures in study area could be due to their restricted habitat and were rarely seen congregating in groups.

5.2 Habitat

5.2.1 Nesting and roosting preferences

Khaireni Community Forest holds highest nesting sites with total of 24 nests (21 active nests and 3 passive nests) during the study period. Ghimire et al. (2019) recorded the 21 nests of White-rumped Vultures in Khaireni Community Forest in which 17 (81%) nests were active and 4 (19 %) nests were passive in that breeding season with all nests found in *Bombax ceiba* trees except one which was in *Toona ciliata* tree which is similar to our finding. The average height of nest on the tree was found to be 31.5 meter (Subedi 2008) which shows similar height (32m) of nesting tree in our study. According to Rana et al. (2019) White-rumped Vulture usually prefers the tall trees with greater diameter for nesting, roosting and perching and mostly nests were observed in the canopy of trees usually recorded the single nest on each tree however observed up to five active nests in a single tree. The survey also

showed that the average estimated nest height was 26.80 m whereas the average estimated tree height was 32.07m from the ground level which shows similar findings to the study. Vultures have large territory and traveled far for feeding that may be the reason for not finding the evidence of nest in the other sites of the study area. Keeping this in view, the present status is confined to have very less number of nests which might be the data taken during the pre-breeding time as vultures started to prepared nest.

5.2.2 Tree species preferences

Bombax ceiba is found to be the most commonly used tree species to build nest and to roost followed by *Ficus religiosa*, *Toona ciliata*. This may be due to the unavailability of highest nesting trees of other species. Vulture normally prefers nesting site at the edge of forest, open grassland with scattered trees or in *Bombax ceiba* and lightly wooded old forest. The reason behind the selection of these trees could be the different geographic region and the availability of tall and large trees in the area. As the study area falls under subtropical region and having a good coverage of broadleaved forest, provides favorable habitat for many of the species including these endangered vulture species. Besides this, *Gyps* vultures are known to nest in a variety of trees viz *Shorea robusta*, *Ficus religiosa*, *F. bengalensis*, *Albizzia species*, *Mangifera indica*, *Tamarindus indica*, *Dalbergia sissoo*, *Azadirachta indica*, *Eugenia species, Terminalia arjuna* (Birdlife International 2006) which provide similar findings to the study. Silk cotton tree is observed to be the preferred tree species by vultures, heavily utilized as roosting, perching and nesting sites. Tall forest trees (>10 m) and elevated ledges/caves/crevices (≤ 25 m) offered refuge from predators, and foraging platforms (Campbell 2015). Large trees (Chhangani 2007, Dhakal et al. 2014) provided predator avoidance, suitable microclimates (Campbell 2015) and increased mobility (Wright et al. 1986) for vultures.

5.2.3 Season wise habitat association of vulture species

Although vulture sightings were seen highest in forest followed by agricultural land, river bank, settlement areas and rocky and barren land during the study period, all such habitats were being used for nesting and roosting purpose by different species of vulture. In summer, at point counts, abundance of vultures were found in forest

habitat followed by river bank habitat as roosting and nesting occurred on trees (forest) and cliffs, while water bodies were used for drinking. Likewise, in winter, abundance was found higher in forest followed by agricultural land, human settlement area and rocky and barren land. In Khaireni Community forest, vultures were also found resting and roosting inside the forest areas which lies near the river banks. Vultures were also found basking near the river banks during summer visit whereas during the winter, most of the vultures were resting and roosting on the trees and caring the nests. Vultures are also known to colonize wooded as well as open habitats with agriculture and tree cover (Donazar et al. 2002a, b) which supports the similar result to our study. Vultures preferred areas associated with rivers, agriculturalfields and grasslands, and open forest, when these were at relatively low elevations (<1000 m) and were close to paths, water and settlements. Baral (2004) found that vultures prefer habitat with combination of outskirt of village, dumping site, tall and strong trees and enough sources of water which supports similar result to the study.

WRV were found abundant in forest areas followed by riverbank and least in agriculture and settlement land areas with no occurrence in rocky and barren land in summer at point count sites. White-rumped Vulture frequents cultivation, open country and around human habitation (Inskipp et al. 2016). WRV breeds in colonies in tall trees such as *Bombax ceiba* and *Ficus religiosa* and often near human habitation (Paudel 2008, Baral 2010, IUCN 2012c). HG 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 and Kasorndorkbua 2008). Egyptian vultures were found more in settlement areas due to the proximity of dumping sites near the human settlement. Egyptian vultures in the mid-hills of Nepal, preferred sites near to settlements reason for this association was them being attracted by available livestock carcasses, one of the main sources of food (K.C. et al. 2019). Also only the Egyptian vultures were recorded at rocky and barren land preferring the cliffs for roosting and nesting purpose. Slender-billed Vulture frequents cultivation, open country and around habitation, especially villages. RHV are mostly found in open country near habitation, wooded hills, and dry deciduous forest with rivers (Birdlife International 2016). Bhusal et al. (2019) also found that Slender-billed Vulture uses open country mixed with some wooded patches to forage, feed, roost and nest and 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. KC et al. (2019) found that vultures preferred the areas near to the distance to water, distance to settlement because of the easy access of food and water which shows similar finding to the study. Also for the roosting purpose they select the nearest forest habitat. The reason behind the association of vulture with distance to VSF might be the easy and higher chance of carcass availability in the vulture safe feeding site. Many studies support the impact of feeding stations in facilitating recolonization of scavenging raptors (Mundy et al. 1992, Oro et al. 2008, Lieury et al. 2015). The possible reasons for the correlation of presence of active nests with distance from the feeding station could be reduction in the foraging time due to proximity to the feeding station and also the availability of food at feeding stations which reduces the risk of mortality (Snyder and Snyder 2005).

5.3 Carcass availability

The carcasses of domestic and wild animals are the main source of food for the vulture but due to the scanty of the carcasses, the number of vulture sighting in the study area was rarely recorded. The practices of burying the carcass rather than throwing at open land, ultimately lessens the possibility of food provision for the vultures. Also the declining livestock practices in the area due to modernization in agriculture had limited the carcasses amount. Ghimire et al. (2019) also found similar findings of decreasing carcasses due to modernization. Generally, it was reported that when livestock die locals used to bury in order to prevent the potential spread of disease to their remaining livestock and surrounding areas. This caused the scarcity of food for vultures. However, the practice of throwing out carcass in open field usually near river bank because of easy access to manage the dead carcasses was reported as favorable to the vulture welfare.

5.4 Threats and attitude of respondents towards vulture

Food scarcity and habitat loss was regarded as the major reason in population decline in all sites whereas lack of conservation awareness was seen more in site three followed by site two as no any conservation practices are done in that areas. Ethnicity, age, education, gender, occupation, etc. are the significant factors that govern the

conservation attitudes (Baral and Gautam 2007). The association between attitude of people and their view on conservation proves that people having the positive attitude towards vulture wants to conserve vulture. Also due to the awareness program and conservation strategies, users of Khaireni Community Forest had more positive attitudes in comparison to other sites. It was found that Khaireni Community Forest played significant role in changing the perception of people towards vulture conservation. So, education regarding to the importance of vulture in the environment and the impact in the environment without vultures should be given to local people in other two sites.

Although people around the Khaireni Community Forest were seen aware about vulture conservation, low number of carcasses and uneven management of the feeding site were regarded as the major threats and reason of vulture declining in the area. According to Ghimire et al. (2019) food scarcity, habitat loss, electrocution were consider as the threats of vultures and found good level of awareness towards vultures and their declining population and asked for similar conservation strategy by the locals at core breeding area of Rampur IBA, Palpa, Nepal. The reason for decline in vulture population was seen similar with food scarcity and habitat loss; however effect of electrocution was not seen as a major cause during the study period which could be the difference of respondents view and survey sites. Use of chemicals and pesticides were seen more on site one as the people on this site rely more on agriculture than the other sites. According to the respondents from site three, hunting practices were recorded as major threats along with food scarcity and habitat loss. Due to the lack of conservation awareness hunting practices were recorded. Use of veterinary drugs, ingestion of chemicals and lead, poisoned bait, anthropogenic climate change, nonfood items, low food availability and deforestation threatened the vultures (Richard 2013). Although, most of the previous studies showed the use of diclofenac as the main threats for the vultures, there was no any record of use of diclofenac in the study area. The absence of diclofenac impact may be due to the ban on import and production in Nepal. The absence of diclofenac impact may be due to the ban on import and production in Nepal. Besides these, excessive use of chemicals and pesticides in the agriculture, lack of conservation awareness and hunting are creating unfavorable condition for vulture's existence in the area which shows similarity with others result.

6. CONCLUSION

Five species of Asian vultures were recorded in Kaligandaki River Corridor. i.e. *G. bengalensis*, *G. himalayensis*, *G. fulvus*, *N. percnopterus*, *G. tenuirostris* and *S. calvus* in which all were recorded in both summer and in winter. Two species i.e. *Gyps. bengalensis* and *Sarcogyps calvus* of vultures were recorded in Khaireni Community Forest. The distribution of vultures in study area was scattered and it seems that the area was mostly used as a roosting and foraging sites. Only the nest of *G. bengalensis* was observed at Khaireni Community Forest at vulture's habitat. *Bombax ceiba* was found to be the most commonly used tree species to build nest and to roost. The overall vulture's abundance was seen highest in the forest and least in rocky land habitat. Distance to water, distance to forest and distance to agricultural land showed positive association with abundance of vulture in summer. Distance to settlement area and distance to VSF showed positive association to abundance of vulture during winter. The study showed a significant difference in people perception of three different sites on vulture population status and on threats. The overall attitudes of local people towards the vulture was satisfactory. Food scarcity and habitat loss were seen as the major threats for population decline of the vultures. The vulture conservation program, awareness based education campaigns, provision of economic incentives to local people in managing carcasses should be included for a long term survival environment for vultures with involvement of the local people in all of its range areas along with its ecological aspects.

7. RECOMMENDATIONS

Kaligandaki River is potential for vulture nesting, roosting and foraging so need the intensive surveys to protect them and to prevent them from being extinct in near future. As the river serves as a suitable habitat for various vulture species, following consideration should be made to conserve them along with their habitat.

1. Regular vultures monitoring of all seasons should be carried out to best find the population dynamics over the periods to know the resident and migratory species in that area.

2. Establishment of carcass dumping sites to provide sufficient food is highly recommended.

3. Providing economic incentives to local people to bury/manage all contaminated carcasses may help to secure uncontaminated food for vultures, their viability and long term conservation.

4. There might be other potential nesting sites in the nearby area so the efforts should be made to identify those areas and to protect it.

5. For the long term conservation success, it is required to focus on their habitat management, including protection of nesting and roosting sites.

6. Vulture safe feeding site need to be well protected and managed in order to prevent food scarcity for the resident vultures.

7. Conservation awareness program and people's participation on carcass management should launch to mitigate the conservation indulgence for such critically endangered species in future.

8. The favored tree species used for both nesting and roosting should be conserved.

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APPENDIX I

Table 1: Distribution of vulture species during summer visit

S.N.	GPS points	Point count sites	Location	Species recorded
1	27.86111°N 83.86472°E	2	Ratomata	WRV
2	27.86817°N 83.92726°E	14	Gandakidhik	WRV
3	27.86613°N 83.9366°E	15	Nisdi river bridge	WRV
4	27.86941°N 83.96839°E	19	Veltar	EV
5	27.86065°N 83.99841°E	22	Puttarghat	EV
6	27.8536°N 84.01998°E	26	Damaraphat	RHV
7	27.84814°N 84.04271°E	26	Siun	WRV
8	27.85176°N 84.05356°E	30	Bhantar bazar	SBV
9	27.86782°N 84.07832°E	31	Dedgaun	WRV
10	27.85097°N 84.0633°E	32	Dedgaun	WRV
11	27.85977°N 84.10491°E	37	Machedi	EV
12	27.84717°N 84.1317°E	42	Ramjakot	HG
13	27.84651°N 84.16135°E	47	Bulingtar	WRV

Table 2: Distribution of vulture species during winter visit

S.N.	GPS points	Point count sites	Location	Species recorded
1	27.88294°N 83.90641°E	8	Sakhar	HG
2	27.88236°N 83.89286°E	8	Tilakpur	WRV
3	27.86472°N 83.92389°E	13	Sadawarta	WRV
4	27.86576°N 83.92315°E	13	Sakhardi/Sakharkhola	EV
5	27.86758°N 83.93343°E	14	Nisdi river	WRV
6	27.86912°N 83.94511°E	16	Baidi pul	EV
7	27.85444°N 84.00015°E	23	Puttarghat	WV
8	27.85177°N 84.03776°E	28	Khukuritar	HG
9	27.84819°N 84.03587°E	28	Siun	WRV
10	27.8536°N 84.06053°E	32	Dedgaun	SBV
11	27.85882°N 84.14876°E	44	Bhirkot	WRV
12	27.84599°N 84.16933°E	48	Bulingtar	RHV

APPENDIX II

Questionnaire for Local People

Questionnaire Code No:

Name of the Respondent:

Age: Gender:

Address:

Socio-economic condition

Occupation: Education:

1. Do you have livestock?
   a) Yes b) No
2. How many livestock do you have? ……
   Cow …….. Buffalo …….
   Goats …… Others ……
3. Within 7 years, have your livestock died?
   a) Yes b) No
   If Yes, how many? …….
   Which livestock? …….
4. If any livestock die, what will you do?
   a) Bury b) Sell c) Throw d) Give it to safe feeding site e) If other what will you do?

5. When your livestock become sick, will you check-up by veterinary doctor/ JTA?
   a) Yes b) No
6. Do you know about diclofenac?
   a) Yes b) No c) No idea
7. Do u know the side effects of using diclofenac on vulture decline?
   a) Yes b) No c) No idea
8. Have you ever seen vulture in your area?

a) Yes b) No

If yes, how long ago have you seen vulture? …….

Which species? ……

9. Do u think the vulture ugly?

a) Yes b) No c) No idea

10. Do you think vultures are of bad sign?

a) Yes b) No c) No idea

11. Is there any change in vulture number compared to past seven years?

a) Increasing b) Decreasing c) No idea

12. If increasing, what could be the reason?

a) Community managed vulture safe feeding site b) Awareness programmes

c) Carcass amount d) Ban of use of diclofenac e) Don't know f) Others…….

13. If decreasing, what could be the reason?

a) Food scarcity b) Poisoning c) Habitat loss d) Hunting e) Lack of conservation awareness d) Others….

14. Have you seen dead vulture?

a) Yes b) No

If yes, how many? .....

What have you done for those dead vulture ……

15. Have you ever killed vulture? a) Yes b) No

16. Have you ever used the vulture parts as medicines? a) Yes b) No

If yes, for what purpose? ……..

17. Are vultures beneficial or harmful?

a) Beneficial b) Harmful c) Don't know

18. Do you believe the vultures have important role in the environment?

a) Yes b) No c) No idea

19. Do you think vultures should be conserved?

a) Yes b) No c) No idea

If yes or no, why?……

PHOTOPLATES

Egyptian Vultures

White-rumped Vulture

Himalayan Griffon Vulture

White-rumped Vultures at river bank

White-rumped vulture on branch of *Bombax ceiba.*

Nest of WRV in Khaireni Community Forest.

Group of vultures at the bank of Kaligandaki River.

Carcasses in Khaireni Community Forest.