POPULATION ESTIMATION, IDENTIFICATION OF STOPOVER SITES AND DOCUMENTING PEOPLE'S PERCEPTION TOWARDS DEMOISELLE CRANE Anthropoides virgo (LINNAEUS, 1758) DURING THE AUTUMN MIGRATION FROM KALIGANDAKI VALLEY, NEPAL



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A Thesis submitted in partial fulfillment of the requirements for the award of degree of the Masters of Science in Zoology with special paper Ecology

Submitted to

Central Department of Zoology Institute of Science and Technology Tribhuvan University, Kathmandu Nepal May, 2018

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 authors.

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RECOMMENDATION

This is to recommend that the thesis entitled "POPULATION ESTIMATION, IDENTIFICATION OF STOPOVER SITES AND DOCUMENTING PEOPLE'S PERCEPTION TOWARDS DEMOISELLE CRANE *Anthropoides virgo* (LINNAEUS, 1758) DURING THE AUTUMN MIGRATION FROM KALIGANDAKI VALLEY, NEPAL." has been carried out by Mr. Seejan Gyawali for partial fulfillment of the requirement for Master's Degree in Zoology with the special paper of Ecology. This is his original work and has been carried out under my supervision. To the best of my knowledge, this work has not been submitted for any other degree in any institutions

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This thesis work submitted by Mr. Seejan Gyawali entitled "POPULATION ESTIMATION, IDENTIFICATION OF STOPOVER SITES AND DOCUMENTING PEOPLE'S PERCEPTION TOWARDS DEMOISELLE CRANE *Anthropoides virgo* (LINNAEUS, 1758) DURING THE AUTUMN MIGRATION FROM KALIGANDAKI VALLEY, NEPAL" has been accepted as a partial fulfillment for the requirement of Master's Degree of Science in Zoology with special paper Ecology.

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CONTENTS

DECLARATION	i
RECOMMENDATION	ii
LETTER OF APPROVAL	iii
CERTIFICATE OF ACCEPTANCE	iv
ACKNOWLEDGEMENTS	v
CONTENTS	vi
LIST OF FIGURES	viii
LIST OF TABLES	ix
LIST OF ABBREVIATIONS	X
ABSTRACT	xi
1.INTRODUCTION	1
Backgrounnd	1
1.1.1 Global Distribution	2
1.1.2 National Distribution	3
1.1.3 Migration Ecology	4
1.2 Objectives	4
1.2.1 General Objective	
1.2.2 Specific objectives	4
1.3 Significance of the study	5
1.4 Limitations	5
2 LITERATURE REVIEW	б
2.1 In National Context	6
2.2 In Global Context	7
3. MATERIALS AND METHODS	9
3.1 Study Area	9
3.1.1. Climate	

3.1.2 Flora and Fauna	11
3.1.3 Intensive observation area	11
3.2 Materials	12
3.3 Methods	12
3.3.1 Reconnaissance survey	12
3.3.2 Direct Observation and flock photograph	12
3.3.3. Questionnaire Survey	12
3.3.4 Data Analysis	12
4 RESULTS	13
4.1. Population status	13
4.2 Stopover sites	15
4.3 Perception and Conservation Threats	16
4.3.1 Respondent's Perception towards Migration of Demoiselle Crane	16
4.3.1 Respondent's Perception towards Migration of Demoiselle Crane4.3.2 Conservation Threats	16
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	16
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	16 18 19 19
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	
 4.3.1 Respondent's Perception towards Migration of Demoiselle Crane 4.3.2 Conservation Threats	

LIST OF FIGURES

Figure 1:	Global distribution of Demoiselle Crane	3
Figure 2:	Distribution of Demoiselle Crane in Nepal	4
Figure 3:	Study area	9
Figure 4:	Average monthly rainfall recorded at the meteorological station located at	
	Mustang (2016) (Source: DHM Government of Nepal)	10
Figure 5:	Average monthly temperature recorded at the meteorological station located	ed
	at Mustang (2016) (Source: DHM Government of Nepal)	10
Figure 6:	Observation site	11
Figure 7:	Number of the Crane and flocks with time	13
Figure 8:	Linear relation between No of flocks, individuals and wind speed	14
Figure 9:	Cloud cover and flock number	14
Figure 10:	Cloud cover and direction of flights	15
Figure 11:	Stop over sites	16
Figure 12:	Peoples view regarding Demoiselle Crane status	17
Figure 13:	People's perception in migration of Crane	17
Figure 14:	Threats for Demoiselle Crane	18

LIST OF TABLES

Table 1:	Migration Days of Demoiselle Crane observed from Samar	13
Table 2:	Stopover site and habitat type used by crane	15
Table 3:	Stopover sites and number of the Cranes stopover in 2017	16

LIST OF ABBREVIATIONS

DNPWC:	Department of National Parks and Wildlife Conservation
NTNC:	National Trust for Nature Conservation
BCN:	Bird Conservation Nepal
NRBC:	National Biodiversity Resource Book
VU:	Vulnerable
ACAP:	Annapurna Conservation Area Project
ICF:	International Crane Foundation
DHM:	Department of Hydrology and Meteorology
RADAR:	Radio Detection and Ranging

ABSTRACT

Monitoring of birds that migrates from the migratory corridor provides the information on status of the birds and its movement ecology. The Kaligandaki valley is one of the major migratory route for the Demoiselle Cranes. The autumn migration counts of Demoiselle Crane (*Anthropoides virgo*) was carried out in Upper Mustang from September to October 2017. Migration counts were conducted during the day using by photographing each migrating flock and by direct visual counts. Crane stopover sites were recorded by direct observations and through semi-structured survey. A total of 8,166 individuals were counted in the month of September and October 2017 in 40 different flocks. The arrival of the Crane in the study area was from 9am to 12 noon only to avoid the strong headwinds that generates after noon. The local impacts such as time, wind speed and cloud cover made impact on number of Demoiselle Cranes. The overhead cloud cover changes the flight direction of migrating Cranes. The area at Damodarkunda, Lomangthang, Chaile, Chuksang, Kagbeni, Tukuche and Marpha were the stopover sites used by Demoiselle Cranes. The stopover areas were mainly wetland, farmland and river banks. The major threat identified was habitat destruction, change in agricultural practices, free-ranging dogs and hunting.

1. INTRODUCTION

1.1 Background

Migration is defined as the passage between locations each with sufficient resource to support breeding and non-breeding activities (Gauthreaux, 1982). Avian migration is a regular, endogenously controlled, seasonal movement of birds between breeding and nonbreeding areas. Therefore, migration always includes two trips: from breeding grounds to non-breeding grounds and back (Newton, 2003; Salewski and Bruderer, 2007). There are eight major bird flyways across the globe (Boere and Stroud, 2006). Majority of the bird migration movement in Indian subcontinent and South Asia occurs through the central Asian flyway (Birdlife International, 2018). The Central Asian Flyway encompasses some of the most exciting places on earth, and the vast stretches of land between the Arctic Ocean and the Indian Ocean are awe-inspiring. It is one of the most vulnerable Flyways in the world, and it needs urgent protection measures (Lama, 2017). Nepal is a small mountainous country with an extremely varied topography, climate and habitat that supports a high diversity of flora and fauna. This is reflected in Nepal's avifauna: a high total of 871 bird species have been recorded within the country. This number is exceptionally high if compared to land area covered by Nepal, only 0.03% of the global land area. Among Nepal's avifauna four are species of crane; Sarus Crane, Black-necked Crane, Common Crane and Demoiselle Crane (Grimmett et al., 2011; BCN and DNPWC, 2011; Grimmet et al., 2016). There are 15 species of the Cranes they all belongs to the one family-Gruidae and they are found in 5 continents (Harris et al., 2013). The Demoiselle Crane (Anthropoides virgo Linnaeus, 1758), 90-100 cm tall bird, has a wide global distribution. Breeding population is distributed in six main populations North West Africa/Atlas, Black Sea, Turkey, Kalmykia, Kazakastan/ Central Asia and Eastern Asia (Meine and Archibald, 1996). East Asian breeding population is distributed in Mangolia, Siberia and China. It is the smallest Crane and second most abundant of the world's Crane (Johnsgard, 1983; Meine and Arcibald, 1996). It is commonly known as Karayang-kurung in Nepali and Jhyalong in Tibetan language (Inskipp et al., 1989; Suwal, 2003). The species is listed in CITES Appendix II and on Appendix II of Convention on the Conservation of Migratory Species of Wild Animals (CMS), and requires international cooperation for its conservation. Considering its wide range of distribution and high number of estimated populations, Birdlife International has evaluated this bird as Least Concern in its IUCN RedList (Birdlife International, 2018). According to Birdlife International (2018) the species population trend is increasing, although some populations are decreasing, stable or have unknown trends. However according to the International Crane Foundation this species is declining throughout its range and the North Africa and Turkey populations are near extinction. On the basis of some partial studies (Fujita, 1994; Kovshar; 1995, Bold; 1995), 70-100,000 individuals are estimated for East Asia and the population is stable to declining (Meine and Archibald, 1996). However; there is little evidence from detail studies or systematic population monitoring on Demoiselle Crane to support any of these assessments. Demoiselle Cranes are long distant migrants, birds from western Eurasia wintering whilst the birds from Mongolia, China and Siberia (East Asia) spend the winter in the Indian subcontinent (spread through Nepal, India, Bangladesh and Pakistan), some

population join with Kazakhstan/Central Asian population (Meine and Archibald, 1996). In Nepal the species winters in the lowlands of terai. Many bird species migrating from the Himalayan have been documented (Higuchi and Minton, 2017; John et al., 2017; Namgail et al., 2017). Research on migration has been undertaken in a number of countries, including Mongolia, Kazakhstan, Nepal, Pakistan, and Saudi Arabia (Martens, 1971; Gavrilov, 1977; Bankovics, 1987; Kovshar and Neufeldt, 1991; Ahmad and Shah, 1991; Newton and Symens, 1993). Demoiselle Cranes take one of the toughest migrations in the world, crossing the Himalayas between their breeding and wintering grounds. Their autumn migration occurs in late August -September through the narrow Himalayan valleys and they then disperse in various locations in southward. The best way to know the status of the population is monitoring them during migration in known migration route. Kaligandaki Valley is a major migratory route for the population of Eastern Asian demoiselle cranes that winter in the Indian subcontinent (Johnsgard, 1983). Previous partial observations (Martens, 1971; Thiollay, 1979; Bijlsma ,1991; Suwal, 2003) also suggest that the population of Eastern Asian Demoiselle Cranes breed in China, Siberia and Mongolia, winter in the Indian subcontinent, crossing the Dhaualagiri (8,167 m)-Annapurna range(8,091 m) in north-western Nepal. This enormous range in the Annapurna Conservation Area is bisected by the Kaligandaki River, the deepest river of Nepal, creating the Kaligandaki Valley, the deepest gorge in the world. Other migratory routes for the eastern population are not well identified, and therefore this narrow corridor is likely to be the major migratory route for all of the demoiselle cranes breeding in China, Siberia and Mongolia. Thus, systematic counts throughout the migration for some years in the area would be of great value in estimating the current numbers in the eastern population, and population trends in this species.

Millions of soaring bird migrates along with from their natal area to the wintering ground following a specific pathway (Lott, 2002; Farmer *et al.*, 2007). These pathways are generally defined by weather conditions (Titus and Mosher, 1982; Hall *et al.*, 1992, Allen *et al.*, 1996) and geographical features, such as large bodies of water and ridgelines (Kerlinger, 1985; Bildstein, 2006). When facing different weather conditions, migrants show a high degree of plasticity in their behavior (Klaassen *et al.*, 2011, Vardanis *et al.*, 2011).During winter Demoiselle Cranes occur in winter crop fields, paddy, stubble, sandy riverbeds, grassland and wetlands (Ali and Ripley 1969, Grimmett, *et al.*, 2011). Since these are the most threatened habitat on the Indian subcontinent, their loss may be greatly affecting the species. Acharya (2005) has identified this bird has been hunted and harassed by local people during its stopover in the Kaligandaki Valley.

1.1.1 Global Distribution

The global population is estimated to number c.230, 000-261,000 individuals (Birdlife International, 2015). There are six main populations of Demoiselle Crane. They are as follows:

1. Atlas Population: This Population probably numbers no more than 50 individuals. The migratory nature of these populations are unknown

2. Black Sea Population: This Population numbers approximately 500. The Population migrates across and around the Black Sea through Turkey, Egypt and Cyprus to Sudan and Ethopia (Meine and Archibald, 1996)

3. Turkey Population: The Population is believed to have fewer than 100 individuals. (Kasparek, 1988)

4. Kalmykiya Population: The Population numbers 30,000 to 35000 individuals which migrates Ethopia, Sudan and other East African Countries. (Meine and Archibald, 1996)

5. Kazakhstan/Central Asian Population: The estimated population of Demoiselle on this range is 100,000. The Population migrates through Afgansthan and Pakistan to wintering grounds in the western part of Indian Sub-continent mainly the flocks are concentrated in the Gujrat State (Meine and Archibald, 1996)

6. East Asian Population: The estimated population on this region is between 70,000 to 100,000 (Fujita *et al.*, 1994; Bold *et al.*, 1995; Khokhlov, 1995; Meine and Archibald, 1996).



Figure 1: Global distribution of Demoiselle Crane Source: ICF, 2017)

1.1.2 National Distribution

Demoiselle Crane was first recorded in Nepal in the19th Century (Hodgson, 1844). It is a passage migrant and sometimes winters in the lowland Nepal. (Meine and Archibald, 1996; Inskipp *et al.*, 2016). There are no any exact Population estimation of Demoiselle Cranes in Nepal however they have been observed migrating from Himalayan region of Nepal from Solokhumbu, Gorkha, Mustang, Dolpa and Mugu districts of Nepal (Basnet, 2004; Inskipp *et al.*, 2016)



Figure 2: National Distribution of Demoiselle Crane (Source-Inskipp *et al.*, 2016) **1.1.3 Migration Ecology**

Demoiselle Cranes are a fully migratory species (Del, 1996). The autumn migration begins in late summer, August-September (Meine and Archibald, 1996) with the species returning in flocks from its wintering areas to breed in March and April (sometimes as late as early-June in the north) (Johnsgard, 1983; Del, 1996). During the migration period, many large birds like Crane, Pelicans, Swans, Geese, Cormorants and others minimize their energy costs by flying in line or V formation (Newton, 2010). Flock migration following up the leaders or the experienced adult helps to increase the accuracy of the direction, improving the direction finding of their destination often exceeds the navigation abilities of inborn responses of a single individual (Thorup and Rabol, 2001; Simons, 2004). Each individual flies behind and to the side of the one in front, benefiting from its slipstream, gaining lift and reduced drag (Rayner, 1979). They can complete their migration journey in a week in an average of 350 km a day with very few stopover sites (Kanai, 2000). The Central Asian/Kazaksthan population migrates via Pakistan and Afganstan to Indian Subcontinent mainly in Gujarat state of India. Wintering flock size varies in response to the monsoon pattern (Perennou and Mundkar, 1991). The East Asian Populations migrating through Himalayan ranges and Kaligadaki valley is one of the major migratory route (Martens, 1971). During migration Demoiselle Cranes have to face many challenges, including predators, head winds and high mountains (Ydenberg, 2017)

1.2 Objectives

1.2.1 General Objective

- To estimate the population, identify stopover sites and documenting people's perception towards Demoiselle Crane
 1.2.2 Specific objectives
- To estimate the population of Demoiselle Crane
- To identify the stopover sites of the Demoiselle Crane
- To document the people's perception and conservation threats to Demoiselle Crane

1.3 Significance of the study

Demoiselle Crane has been assessed nationally as Vulnerable based on the criteria A2ad. It is a fairly common passage migrant to Nepal, which occurs chiefly on passage in September/October and in much smaller numbers in March/April. The numbers of birds recorded flying down the Kaligandaki appear to have significantly decreased. Illegal hunting is a major threat; also disturbance, habitat loss and degradation, and possibly agrochemicals. The Kaligandaki Valley in Nepal is part of the important migratory corridor for East Asian population wintering in the Indian subcontinent. In order to get updated information on their population status and movement ecology, counting through the bottleneck area such as through kaligandaki valley gives the accurate information.

1.4 Limitations

Temporal Limitation: The survey was unable to conduct the upward migration of the Demoiselle Crane in summer migration time.

Topographic Limitation: The stopover sites of the Demoiselle Crane in some of the areas were not able to document because of the topography and short period of the time

2. LITERATURE REVIEW

2.1 In National Context

Scully (1879) described the bird as common in the central terai and Hetauda dun in winter during the 19th century.

Meine and Archibald (1966) described the major migratory route for the population of east Asian demoiselle crane that winter in the Indian sub-continent crosses the Dhaulagiri-Annapurna range in north of the central Nepal. The fall migration in the Kaligandaki valley provides a major means of access for Cranes wintering in north and north-eastern India.

(Martens, 1971) estimated 31,351 number of Demoiselle Crane from Mustang in 1969 from October 1st to October 11.

Beaman (1973) led an ornithological cambridge expedition into the Kaligandaki and counted 2200 birds from 27th September to 14th October.

Thiollay (1979) noted 63,000 Demoiselle Cranes in September and October 1978 from Mustang though aerial scanning and visual encounter. He reported that during ground weather conditions many birds were seen flying and that they were really concentrated in the valley only during conditions of strong winds and clouds.

Bijisma (1984) used the visual encounter method and observed 8,228 demoiselle crane during 13-21 October along the kaligandaki valley. The strong southerly winds. Forced down Hundreds of Demoiselle Cranes near Marpha, Jomoson and Kagbeni.Some flocks frequented small agricultural plots, where they ran the risk of human predation. Seven Demoiselle Cranes killed were juvenile. Most birds sought refuge in the upper parts of the Kaligandaki between Jomoson and Kagbeni. The number of juveniles was low, for example 21% and 9% in two flocks of 29 and 22 birds respectively near Jomosom on 19th October.

Suwal (2003) estimated 30,000 Demoiselle Cranes flew south from the Kaligandaki valley in between 1992 and 1995. The unfavorable weather condition such as storm and rain hampers their migration journey and they have to stopover in the Kaligandaki valley where sometimes they stay in the crop field and feed on buckwheat crop.

Suwal (2004) recorded 20,000 Demoiselle Cranes that migrated through Kaligandaki valley in the month of September and October.

Acharya (2005) has identified that Demoiselle Crane has been has been hunted and harassed by local people during its stopover in the Kaligandai Valley.

Demoiselle Crane have been observed migrating down the western part of Nepal from Rara National park (Giri, 2005)

BCN (2016) conducted the Demoiselle Crane Migration survey in the month of September and October and counted 14,678 Cranes they were migration south from Upper Mustang. The peak migration was from September to October and the timing of migration was in the month of October. It is planned to monitor migration for some years.

Lama (2017) reported about the declining field observations of the Cranes crossing the Himalayas. The surveys in 1995, 2012 and 2013 have shown 20,870 Cranes, 805 Cranes and 5500 Cranes respectively. The potential for variability in counts probably due to the shifts in timing if the migration and any particular day of observation can result in varying numbers

2.2 In Global Context

Dementiev and gladkov (1968) have summarized the autumn migration in the USSR stating that the flocking begins as early as august and at times the flock size reaches 400 or more birds. The most of the birds depart by late August and all my mid-September.

Alerstam and Bauer (1973) conducted a radar study of the spring migration of the Crane (*Grus grus*) over the southern Baltic area in 1972. The migration time of crane was after sunrise till the noon. There were no any Cranes noted migrating at nights. However, in late afternoon, time some flocks were observed but they roosted overnight and continue their flight next morning

Richardson (1978) reviewed the timing and amount of bird migration in relation to weather. The relationship of short-term weather to daily migration intensity are reviewed, with sections for each weather variable for waterfowl, shorebirds and hawks. The maximum numbers migrate with fair weather, with tail winds and with temperature, pressure and humidity conditions that accompany tailwinds. Correlation with weather differ among populations with different fly directions.

Johnsgard (1983) described the major wintering area of Demoiselle Crane which occured on the Indian subcontinent, which probably provides wintering the major breeding population of Mongolia and adjacent areas.

Gole (1993) mentioned that the wintering birds in India forage in agricultural fields, stubble and riverbeds and roost in sandbanks and mudflats surrounded by water.

Landfried *et al.*, (1995) have combined studies of the impact of hunting on migrating cranes in Pakistan with efforts to involve local hunters and conservationists in future crane research.

Newton (1996) conducted the monitoring programme for the African wintering population

of Demoiselle Crane during their spring migration through Saudi Arabia. A total of 4,500 and 6,000 Demoiselle Crane were recorded in 1992 and 1993 respectively. The majority of the migration occurred in March

Kanai (2000) used the radio-tracking for Demoiselle Crane. It reveals that compared to other migratory birds, they complete their migration relatively quickly crossing both desert and mountains within one week

Sarwar *et al.*, (2013) examined the Diet of the Demoiselle Crane in Pakistan Diet composition of the Demoiselle Crane migrating through Pakistan. The Analysis of gizzards and faecal samples of spring season showed that the bird was vegetarian and fed on plants such as wheat, sorghum, chickpea, Egyptian clover and garlic, chickpea, mustard and spinach.

3. MATERIALS AND METHODS

3.1 Study Area

Mustang District a part of Province No. 4 in Dhawalagiri Zone of northern Nepal is one of the seventy-seven districts of Nepal. The district lies in Annapurna Conservation Area (ACA), the largest protected area in Nepal and one of the Important Bird Area (IBA) of Nepal (Baral and Inskipp, 2005). The Mustang district covers 3,639 sq. km (Bhattarai *et al.*, 2010). The Kaligandaki River Valley is about 100 km long and descends from the Tibetan Plateau to the midland of West Nepal. The north end of the valley narrows at Jomsom at 2800 m before continuing south at 2600 m between two mountain peaks Dhaulagiri (8,167 m) and Annapurna (8,091 m) that create the deepest gorge in the world. Most of the area remains under snow from November to March, and total annual precipitation is 200 mm, half of which is winter snow (Chetri and Gurung 2004; ACAP, 2010).



Figure 3: Study Area

3.1.1. Climate Rainfall

The upper Mustang consists of two major habitat zones namely; Tibetan Steppe and Alpine Meadows. November and December is a dry season and minimum amount of rainfall occurs in October (2mm) is since the regions lies beyond the mountain, minimum amount of rainfall is measured. The highest rainfall occurred in July (76.7mm). Maximum Rainfall occurs between May to September (Figure 4)



Figure 4: Average monthly rainfall recorded at the Meteorological station located at Mustang (2017) (Source: DHM Government of Nepal)

Temperature

The average minimum temperature is in the month of February (1.130c) and the average maximum temperature is in the month of June (23.410c) (Figure 5). After monsoon season, the temperature starts gradually to drop down and the winter season starts.



Figure 5: Average monthly temperature recorded at the Meteorological station located at Mustang (2017) (Source: DHM Government of Nepal)

3.1.2 Flora and Fauna

Mustang is rich in trans-Himalayan biodiversity and has recorded five species of zooplankton, seven nematode species, two mollusc species, one annelid species, 25 insect species (7 aquatic and 18 butterfly species), one spider species, 11 amphibian species, eight lizard species, five snake species, 105 bird species and 29 mammal species. Mustang is the habitat for Snow Leopard (*Uncia uncia*), Musk Deer (*Moschus leucogaster*), Tibetan Wild Ass (*Equus kiang*) and Tibetan Gazelle(Procapra picticaudata) (DCM, 2014). The mustang districts is an habitat for threatened wildlife such as Tibetan Gazelle (*Procapra pictcaudata*), Kiang (*Eqqus kiang*), Argali (*Ovis ammon*) and Snow Leopard (*Panthera Unica*) (Jnawali, *et al.*, 2011). The upper Mustang hold 96 bird species and is one of the significant migratory corridors for wintering birds (Grimmet *et al.*, 2000; Suwal 2003). The Kaligandaki valley is a migratory route mainly for Demoiselle Crane, about 20 raptor species and other birds (Inskipp and Inskipp, 2003).

3.1.3 Intensive observation area

Present study was focused in Upper mustang which covers the northern half of Mustang District (Ale, 2002; Acharya *et al.*, 2009) extended up to the Tibetan autonomous region of China to the northeast, Dolpo district to the west and by peaks reaching more than 6000 m (Pandey, 2006). Most of the area of upper mustang remains under snow from November to March, and total annual precipitation is ,200 mm, half of which is winter snow (Chetri and Gurung, 2004; Paudel, 2010). The observation point was chosen in a place called Samar (3700masl) in Upper Mustang. A total of 96 birds species have been recorded in Upper Mustang where high diversity of bird's species were observed in Samar with 32 species (Suwal, 2003).



Figure 6: Observation Site

3.2 Materials GPS Anemometer Spotting Scope Binocular Camera Topography Map

3.3 Methods

3.3.1 Reconnaissance survey

A reconnaissance study was made in September 2016 for identifying the best observation sites where there is minimum chances to miss the migratory flocks of the crane. The observation sites was chosen from Direct Observation, and Ornithologists from Nepal.

3.3.2 Direct Observation and flock photograph

Direct observation or visual detection method (Bibby *et al.*, 1992; Bibby *et al.*, 2000) was made at observation site from early morning time (06.00 hrs.) to late afternoon (16.00 hrs) throughout the migration period. The time of all Demoiselle Cranes arriving and crossing the valley was noted down using a data collection sheet. The local time, wind speed, cloud cover were also noted. Flocks of Demoiselle Crane were photographed, recorded with code number and counted later in the projector. The photography method (Watson, 1969; Gilmer *et al.*, 1988; Bibby *et al.*, 2000) was used for capturing the flocks of the Cranes. The repeated count for 3 times was done for each photographs to minimize the counting error. Monitoring was conducted from 20 September, 2017 to 25 October, 2017 to cover the whole migration period

3.3.3. Questionnaire Survey

A semi-structured questions were made and asked to the local peoples, trekking and mountaineering guides to understand the historical records, migration trend, the stopover sites, threats, religious and cultural belief.

3.3.4 Data Analysis

Kruskal-Wallis chi-squared test was performed to test the relation between migration of crane and time. The Linear regression was applied to test relation between Wind speed, Cloud Cover and Direction of Demoiselle Crane. The analysis was done in R-studio software. ArcMap 10 was used to make the map for the study area, intensive study area and stopover sites of Demoiselle Crane in the study area.

4. **RESULTS**

4.1. Population status

A total of 8,166 number of Demoiselle Crane were counted from the 28 September, 2017 to 18 October, 2018 in 16 days. The peak migration was observed on the 17th September where 2779 (34% of the total number) in nine flocks (out of 40 flocks) were counted migrating towards south (Table: 1).

Date	Flocks	Number
28-Sep	1	20
29-Sep	1	28
2-Oct	1	24
3-Oct	2	469
5-Oct	2	404
6-Oct	3	557
7-Oct	4	797
8-Oct	2	334
10-Oct	2	568
11-Oct	2	484
14-Oct	1	256
15-Oct	2	363
16-Oct	1	215
17-Oct	9	2779
18-Oct	4	661
19-Oct	3	207
Total	40	8166

Table 1: Migration Days of Demoiselle Crane observed from Samar

The Crane migration time was observed between 9 am to 12 noon and the peak migration time was between 10 am to 11am (Figure 7) where 50% of the total flock and 45.5% of the total number migrated. (Figure: 7)



Figure 7: Number of Cranes and flocks with arriving time

Kruskal-Wallis chi-squared test was performed to test the relation between Migration of crane and time. It was found that migration was significantly associated with time ($X^2 = 51.908$, df = 5, p-value = 5.634e-10). The time was significantly associated all the flight was observed between 9am to 12 am. There was no any flight recorded after 1 pm.The linear regression between wind velocity and individual number of migration was significant. (F=5.534, p-value: 0.03654). Linear regression between wind velocity flock was also significant. (F=5.463, p-value: 0.03757)



Figure 8: Linear relation between number of flocks and individuals with wind speed

There was significant linear relation between cloud cover and migration of flock (F=9.195 P=0.00436). The highest windspeed recorded was 75 km/hour which was after 12 noon. The increase in wind speed decreased the rate of migration. On increasing cloud cover, the percentage number of flock migration from northeast direction was decreased but migration from northwest direction was found increased and vice versa.



Figure 9: Cloud cover and flock number



Figure 10: Flocks direction of flight with respect to the Cloud Cover No. of Flocks

4.2 Stopover sites

The present study documented the stopover sites at kaligandaki valley. They are; are at Lomangthang, Damodar Kunda, Chaile, Chuksang, Kagbeni and Tukuche. The Damodar Kunda is the remote Tibetan steppe grassland with a many smaller and wetlands where Crane usually stopover and rest of the other places are basically along the kaligandaki river bank and farmland.

Stopover Site	Habitat type
Damodar Kunda	Wetland and Grassland
Lomangthang	Wetland and Farmland
Chaile	Farmland
Chuksang	River bank and Farmland
Kagbeni	Riverbank
Tukuche	River bank and Farmland
Marpha	River bank and Farmland

Table	$\gamma \cdot$	Sto	nover	site	and	habitat	type	used	hv	crane
1 aute	∠.	310	pover	SILE	anu	naunai	type	useu	Uy	crane



Figure 11: Stopover sites

In 2017, three stopover sites were used by Demoiselle Crane. They are Damodar Kunda, Chaile and Chuksang. The stopover at Damodar Kunda was found to be highest with a 150 individuals followed by Chuksang and Chaile. (Table 3).

Stopover	No. of				
sites	Cranes		Date	Remarks	
Damodar					
Kunda		150	6-Oct		
				Golden Eagle	
Chaile		5	11-Oct	Attack	
Chuksang		56	17-Oct		

Table 3: Stopover sites and number of the Cranes stopover in 2017.

4.3 People's Perception

4.3.1 Respondent's Perception towards Migration of Demoiselle Crane

Among the total respondents of 100 peoples, 80% told the number of migrating Demoiselle Cranes are decreasing, while only 10% believe the number of the Cranes are increasing and remaining told they had no idea about the threats on Demoiselle Crane while migration.

80%		
80%		
	10%	10%
Decreasing	Increasing	No idea

Figure 12: Peoples view regarding Demoiselle Crane status

Among the 100 respondents, 88% of them had seen the Demoiselle Crane. Almost 74% of the people have seen the autumn migration of the Crane whereas only few respondents (14%) has seen the summer migration of the Crane. There were 12% of respondents however who didn't saw any Crane migration. The majority of the respondents who observed the migration said very few flocks migrate upward during the summer migration of the Crane.



Figure 13: People's perception towards Crane's migration

4.3.2 Conservation Threats

The respondent's identified habitat destruction at stopover sites, hunting and free-ranging dogs as a threats. The attack by Golden Eagle and bad weather are natural phenomenon however these factors make the Crane to stopover and thus harassed by other anthropogenic threats. There is a traditional belief that the Cranes carries expensive pearls and people hunt them while stopover during night time with the use of focus light. The free-ranging dogs also harass the Cranes during the stopover sites.



Figure 14: Threats for Demoiselle Crane

5. DISCUSSION

5.1 Population status of Demoiselle Crane

The present study monitored the autumn migration of Demoiselle Crane and counted a total of 8,166 individuals in 40 flocks in sixteen days from Samar, Upper Mustang. BCN (2016) monitored the migration of demoiselle crane in 2016 and estimated 14,448 individuals in 42 flocks in 11 days from Samar, Upper Mustang. The flock's size compared to the study made by (BCN, 2010) was similar however the total number of individuals vary by 43.48%. The number of vast fluctuations in number is probably due to the presence of alternative flyway route of the Demoiselle Crane. (Kanai et al., 2000; Higuchi and Minton, 2017) also found alternative migratory route for Demoiselle Crane through Satellite tracking to the Demoiselle Cranes. Giri (2005) reported the migration of Demoiselle Crane from Rara National Park which is further west from Kaligandaki valley. Demoiselle Cranes have also been observed migrating from Sagarmatha National Park and Manaslu Conservation Area (Basnet, 2004; Inskipp et al., 2016). The migration of Demoiselle Crane is also dependent on the local weather, it is assumed that during the worst weather condition such as at the time of rain, snow or precipitation, they might use an alternative ways. The Peak migration time of Crane was from 10am to 11 am and the migration. Similar observations were made in the study carried by (BCN, 2016). The migration of Demoiselle Crane were observed from the last week of September to the middle week of the October. Similar result was obtained during the partials study conducted back (Martens, 1971; Beaman, 1973; Thiollay, 1979; Bijlsma, 1991; Inskipp and Inskipp, 1991; Suwal, 2003; BCN, 2016). These partial study also shows that the autumn migration population of the Crane were more than 30,000 individuals whereas the study conducted after 2000 A.D shows the autumn migration of the Crane are less than 20,000 individuals and confined to less than 10,000 in 2017. The overall trend of the Population count conducted from 1969 to 2017 shows it's been declining (BCN, 2016). Higuchi and Manton (2017) illustrated that the declining number of observations of the Cranes is probably because of the construction activities going in Kaliganadaki Valley.

Impact of Local Weather on migration

The local weather system on particular migratory corridor control the flux of migration (Marra *et al.*, 2005). The present study have determined the impact on the migration of Demoiselle Crane with wind speed and cloud cover and flight direction of the Crane. The linear regression inferred there is a negative relation between wind speed and number of migrants and the flocks. Parslow (1969) statistically signified increasing wind speed has a paramount negative effect on the volume of migratory birds. Much of the previous research, based on direct observation and radar detection indicated that the migration were affected by wind speed (Leichti and Bruderer, 1998; Sharanens and Baramnes *et al.*, 2003). All the flight was observed between 9 am to 12 noon. The wind speed measured after noon was more than 70km/hour. The valley wind up to 100km/hour have been recorded (Ohlmann, 2017).Thus, it might be very default to cross the strong headwinds for the migrating Cranes. Headwinds can affect the timing or duration of flights as well as numbers aloft. Birds sometimes take off later than normal in the day or evening when winds are unfavourable

or improving; they may also descend or land earlier than normal when winds are unfavourable or deteriorating (Bloch et al., 1981; Kerlinger and Gauthreaux 1985; Helbig and Laske, 1986). There was no any flight recorded after 1 pm however few number of flocks were observed migrating after 1 pm in 2016 and it was assumed they stopover in the Kaligandaki valley and flew on the next day (BCN, 2016). The reason of very few or less migration observed afternoon and more chances to do stopover in the Kaligandaki valley by the Cranes probably because of the strong winds against their flying direction. Cranes are categorized birds with a mixed strategy i.e. Circling and Flapping Winds and they need thermals and lifts generated by winds in the mountains (Ohlmann, 2017). The thermal from the ground raise up as the sunlight hits the ground. It was assumed the Cranes stopover close to Tibet or Border area and next morning as soon as they get thermal starts migrating and reach to the study area in an hour time (BCN 2016). Strong South westerly winds blows afternoon in kaligandaki valley (Ohlmann, 2017). Alerstam and Bauer (1973) conducted a radar study of the spring migration of the Crane (Grus grus) over the southern Baltic area in 1972 and observed the migration time of crane was after sunrise till the noon. Similar result was observed by (Hilgerloh, 1977; Rabol and Hansel, 1978; Titus and Mosher, 1982) in migration of birds. Previous studies also identify the negative impact of wind speed and cloud cover on bird migration (Richardson 1978; Swanberg 1987). Lack (1960) mentioned that migration occur mainly on fair weather than on cloudy and rainy weather.

The cloud cover was found to be negatively associated with the amount of the Crane migration (Fig: 10).Similar findings were observed on different studies on the raptors by (Lack, 1962; Mueller and Berger, 1967; Trowbridge, 1895). Richardson (1974) reported that soaring raptors prefer to migrate when there was little rain or cloud. For many species and groups the cloud reduce the numbers of birds aloft (Alerstam 1978; Zalakevicius 1984; Hussell, 1985; Helbig *et al.*, 1987) Very low cloud height not only inhibits the genesis of the thermal but also reduce the visibility (Tholin, 2011) thus creating hindrances to migration moment. The migration during high concentration of the cloud also increases the chances to miss the count. On a Sunny clear day, the flying direction of the Cranes were from northeast with a distance from the Samar Mountain whereas the flight direction of the Crane were towards northwest Close to the Samar Mountain (Fig: 11). As the thermal develops, the Cranes have to face strong headwinds, sometimes some the flocks blown back (Higuchi and Minton, 2017). This could be the reason that Cranes make a distance from the Samar mountain on sunny days or with less cloud cover and migrate from the northeast direction.

5.2 Stopover Sites

Demoiselles Cranes have one of the most difficult migrations, as they pass through desert and high mountains which offer very few feeding or safe roosting sites (Newton, 2010). They accomplish their migration relatively quickly, crossing both desert and mountains within one week (Kanai *et al.*, 2000). The present study documented the 6 stopover sites of Demoiselle Crane in Mustang district and these stopover sites have been regularly used by the migrating Demoiselle Crane since 2013 (Fig:13). BCN (2016) also found all these stopover sites except in Chaile. The stopover at chaile is not a proper habitat for the Demoiselle Crane. However; they stopover at Chaile due to the attack of Golden Eagle and had to do emergency landing .The stopover sites at Lomangthang and Damodar Kunda are steppe grassland and wetlands. Similarly, the stopover sites at Chuksang, Kagbeni, Chaile, Tukuche and Marpha are river bank and agricultural field.However, all these stopover sites are used only for a short duration of one or two days. Similar obervations were done by (BCN, 2016) and (Higuchi and Minton, 2017) on the Tibetan Plateau, and at high elevations within the Himalayas. The Cranes Cranes are large wetland obligate birds, requiring large areas for breeding, stopover and wintering (Johnsgard, 1983), so migration routes should ultimately be determined by the distribution of relatively large wetlands in the arid regions that the cranes cross. Therefore, identifying and conserving wetland habitats used by cranes could also conserve habitats for numerous other wildlife species dependent on wetland resources (Higuchi and Minton, 2017).The stopover sites at Chuksang, Kagbeni, Tukuche and Marpha are highly disturbed through construction activities, changes in agricultural practices and roads. These could be the reason why very few Cranes stay in the Kaligandaki valley in the recent years (BCN 2016; Higuchi and Minton 2017).

5.3 People's perception and conservation threats

The questionnaire survey and direct observation showed some threats to the Crane during the migration period. Results shows the number of Demoiselle Crane are decreasing (80%). Similar study was made by (BCN, 2016) where 87% respondent believes the migrating number of the Cranes were decreasing too. Majority of the peoples observe the downward migration (74%). A survey made by BCN (2016) also shows that 75% respondents have observed the downward migration. Similarly, 15% of the total respondents have observed the upward migration. Demoiselle Crane appears in few numbers with the smaller flocks during the upward migration. The summer migration of Demoiselle Crane starts from the last week of March to the May. The summer migration of Demoiselle Crane from Nepal have been observed from April to May (Flemming *et al.*, 1976, Inskipp and Inskipp, 1991). The least number of population is observed in summer migration time probably most of the Cranes use alternative route to fly back to their breeding ground.

The present study has identified the threats such as habitat destruction (60%) followed by the changes in agricultural practices (25%), free-ranging dogs (5%) and hunting (5%) respectively, free-ranging dogs (5%), and hunting (5%) in Kaligandaki valley and other migratory routes The previous studies also identified hunting and habitat destruction as a major threats at stopover sites at the Kaligandaki river banks (Inskipp et al., 2016; Higuchi and Manton 2017). BCN (2016) study at Kaligandaki valley found habitat destruction at stopover sites (50%) and changes in agricultural practices (30%).Many migratory habitats have been lost or altered in recent decades, primarily through the building of dams and the drainage of wetlands (Jan and Ahmad, 1995).The stopover sites at Lomangthang and Damodar Kunda area have very few impact of the above mentioned threats mainly because of its remoteness. However, the stopover sites at Chuksang, Kagbeni, Tukuche and Marpha are highly disturbed. The threats such as construction activities, change in cereals crop farmland to apple farmland, and hunting might be the reason why very few Cranes stopover in recent years (BCN, 2016). Many cranes now seem to avoid this area, and it may be a result of the construction impacts on this crucial link in the migration route (Higuchi and

Minton, 2017). The time of arrival of the Demoiselle Crane corresponds with the harvesting time of Buck-wheat. During the stopover of the Cranes, they also feed on the Buck-wheat farmland and get chased away by the farmers. However, no any persecution or hunting were observed in recent years. The hunting and killing of Demoiselle Crane used to be in the past for a traditional belief such as Demoiselle Crane carries expensive pearl and the hunter used to visit the stopover site during night time with the help of focus light (BCN, 2016). However, Cranes are shot or poisoned in other areas (Khachar *et al.*, 1991; Inskipp *et al.*, 2016). During the field visit, a free-ranging dog were harassing the landed Crane at Chuksang by chasing them and the Cranes were in stress and disturbed. Free-ranging dogs may impact native wildlife through predation, competition, disturbance, hybridization and disease transmission (Young *et al.*, 2011)

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Kaligandaki valley is an important migratory corridor for Demoiselle Crane. A total of 8,166 number of Demoiselle cranes were counted migrating south ward in a total of 40 flocks. The migration of Demoiselle Crane was affected by wind speed and cloud. To avoid the strong head wind, the migration time was between 9am to 12 noon.

The major stopover sites for Demoiselle Crane were recorded in Lomangthang, Damodar Kunda, Chuksang, Kagbeni, Tukuche and Marpha.The Cranes stopover site during the study period was in Chaile,Damodar Kunda, and Chuksang.

The major threats identified are the habitat destruction, changes in agricultural practices, free-ranging dogs and hunting.

6.2 Recommendations

Based on the results of this study following recommendations have been made.

- The study was focused on autumn migration of Demoiselle Crane. The survey of the Cranes during spring migration is also necessary to understand the population ecology and migration ecology of the Demoiselle Cranes. More robust technique such as use of RADAR to count the migrating birds is recommended. Similarly, systematic counts for long-term should be carried.
- There might be other stopover sites of Demoiselle Crane in the Kaligandaki valley close to the border of Tibet. Identification of other stopover sites should be done.
- The historical stopover sites of the migrating Demoiselle Crane should be protected so that the migrating flyways remain safer. Similarly, the superstition beliefs such as the Crane carries expensive pearl should be discouraged. Participatory community conservation and public awareness should be conducted for conservation of Demoiselle Crane.

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APPENDICES

Appendix 1: Questionnaire Survey Data Sh	eet
Survey number: - 1. Do you Know Demoiselle Crane?	Name of Respondent:
2. Have you seen migration?	
3. When do you have seen?	
4. What was the estimated number?	
5. Have you also seen upward migration? Which M	Aonth?
6. What is the estimated number? (In which year)	
7. Have you seen any stopovers sites? If yes, when	re?
8. Is the stopover sites is same or changed?	
9. What time usually Demoiselle Cranes comes wh	nen they land?
10. Is there any religious/historic beliefs of Demoi	selle Cranes?
11. Is the flock size of Demoiselle cranes declinin	g/increasing? Why?
12. What are their threats?	
	•••••

Date	Time	Flock	Cloud	Wind	Flight	Rema
		Photo:-	Cover	Speed	Directi	rks
		Number			on	

Appendix 2: Demoiselle Crane Survey Data Sheet

PHOTOPLATES



Photo 1: A flock of Demoiselle crane migration.



Photo 2: Demoiselle Crane migrating by "V" formation



Photo 3: Demoiselle crane observation site at Samar, Upper Mustang.



Photo 4: A flock of Demoiselle Crane migrating below the cloud



Photo 5: Stopover site at Lomangthang



Photo 6: Demoiselle Crane landed at Chaile due to attack by Golden Eagle