Conservation Science
Translating Knowledge into Actions

Population status, nesting habitat selection and conservation threats of lesser adjutant stork (*Leptoptilos javanicus*) in the eastern lowlands of Nepal

Shantosh Karki[1*], Tej Bahadur Thapa[2]

Summary

Aim This research examines the status of distribution, nesting habitat selection and conservation threats of lesser adjutant storks.

Location Eastern Nepal

Materials and Methods Direct observation along line transects method was used to determine population status, distribution and nesting habitat preference of storks in different habitats of the study area. Questionnaire surveys to local people drawn randomly were used to study the socio-cultural dimensions of lesser adjutant storks conservation.

Key findings There were a total of 98 individuals in pre-breeding and 240 individuals of lesser adjutant stork in post-breeding periods (94 chicks and 146 adults) in the study area. On average, there were 1.29 chicks per nest. Bombax ceiba and Adina cordifolia were found to be the most preferred nesting trees for lesser adjutant storks. Habitat preference of lesser adjutant storks revealed that colonies were more likely to occur in farmlands and swamps. All the nests of lesser adjutant storks were found on trees above 30 m height, the average tree height was 42.5 ± 6.8 m and the average nest height was 34.4 ± 4.3 m. Questionnaire surveys revealed that people were not aware about conservation of lesser adjutant storks. More than 80% of respondents (n=145) opined that forest destruction was the most serious threat to storks followed by human disturbance (79%), poaching (73%), pesticide use (52%), and urbanization/industrialization (43%).

Conservation implications Protection of nesting tree species such as Bombax ceiba and Adina cordifolia should be given a high priority for the conservation of storks in the eastern Nepal. Conservation education programs to control excessive pesticides in the rice fields should also be carried out in the region.

Keywords bird conservation, lesser adjutant storks, population census, nesting sites, threats, wetlands,

Original Article

Article History:
Received 8 January 2013
Accepted 29 June 2013
Published Online 20 July 2013

Edited by -Bishnu P. Bhattarai
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Citation: Karki S, Thapa TB (2013) Population status, nesting habitat selection and conservation threats of lesser adjutant stork (*Leptoptilos javanicus*) in the eastern lowlands of Nepal. Conservation Science 1, 27—35

Funding: EMEM Aves Award, Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal

Introduction

The lesser adjutant stork (LAS) is distributed in Nepal and India including most of the south and south-east Asia (Sharma 2006). It is a vagrant species in south India with scattered occurrence (Taher 1999, King et al.1991, Singh et al. 2002, Sreeker et al. 2010). It occurs in the entire lowland Nepal (Paudyal et al. 2010). This wetland-dependent bird is found mainly in the riverbeds, floodplains, rice (paddy) fields, swamps, lakes and forest pools (Pokhrel 1998, Bhattarai 2012), including in mangrove, mudflats, coastal swamps and marshes, flooded grassland and drying ponds where the fishes are abundant (Fleming et al. 1984).

The LAS is a globally vulnerable species with an estimated population of about 10,000 individuals, and the largest population was reported from the East Sumatra (Elliot 1994). Previously, the global population of this species was estimated to be 5000 individuals. However, more extensive survey effort in recent years has led to the upward revision of some national totals. Cambodian population, for example, has been estimated at 2500–4000 individuals rather than the previous estimate of 1000 individuals (Bird Life International 2011). Hence, the global population probably ranged between 6500 and 8000 individuals or possibly more. Despite being categorized as a vulnerable species, LAS has not been protected in the National Parks and Wildlife Conservation Act of 1973 in Nepal (Baral 2004).

The LAS becomes mature for breeding between three to five years (Grimmett et al. 2000) and it only stay in couple during the breeding season (July to October). Nesting sites are usually close to the human settlements (Baral and Inskipp 2004). The nests are generally located on the topmost parts of the canopy of tall trees, such as Karam (*Adina cordifolia*) and Simal (*Bombax ceiba*) (Tamang 2003).

Habitat destruction, over-hunting, and human disturbance are the contributing factors for population decline of LAS. However, it has not been received sufficient attention for conservation. A major problem for the LAS conservation is a lack of scientific information (Baral 2004, Chaudhary 2007). Few studies have been done on habitat characteristics, population size, and threats to LAS. Similarly, conservation efforts are not adequate and almost no conservation action has been taken outside the protected areas especially in Jhapa, Sunsari and Morang districts where most of the nests of LAS located in community forests. Therefore, this study was designed to understand distribution, nesting habitat selection, population size, and conservation threats on the lesser adjutant storks in the eastern lowland of Nepal.

Materials and Methods

Study area

This study was conducted in the southeastern lowland (elevation range: 57 – 500 m)of Nepal between (26°29' N and 26°39' N/87°0' E and 87°51' E) with an area of about 4818 km^2 (**Figure 1**). The study was mainly focused in the eastern districts–Sunsari, Morang and Jhapa districts including Koshi Tappu Wildlife Reserve (KTWR). These areas represented the three out of 27 important bird areas of Nepal—Koshi Tappu Wildlife Reserve, Dharan Forest and Urlabari Forest Grove. Urlabari Forest Grove, the smallest important bird area (IBA) of Nepal with an area of 100 ha, is the nesting site of about 2% of the total world population of lesser adjutant storks (Baral and Inskipp 2005). Dharan forest (50000 ha) is an unprotected forest that lies in the tropical and subtropical zones (elevation range 100-1300 m) in the Sunsari and Morang districts of eastern Nepal (26° 49'N/87° 17'E).

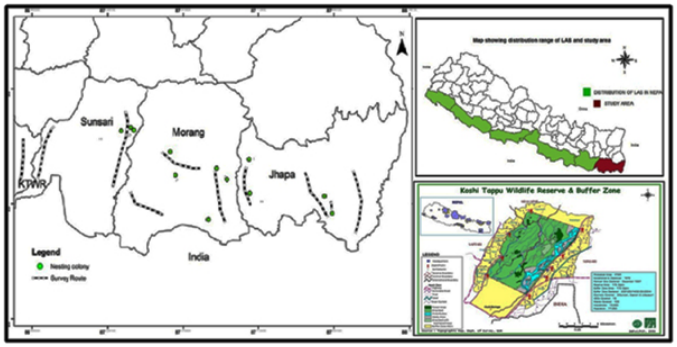

Figure 1: Map showing study area and line transects (dark dotted line).

Data collection and analysis

The entire study area was divided into four blocks (Jhapa, Sunsari, Morang districts and KTWR) for the LAS survey (**Figure 1**). The boundaries of the study sites were determined by using the political and administrative boundaries such as village development committees (VDCs), districts and protection status (e.g., KTWR, Urlabari Forest Groove). Nesting colonies were recorded during a reconnaissance survey and the location (GPS coordinates) of each colony was recoreded (**Figure 1**). Population status of the LAS was determined by two different methods: counting the total number of individuals and total number of nests. In each nesting colony, the total numbers of individuals including different age categories (chicks, juveniles and adults) of stork were counted directly in the early morning and at evening time when all birds were expected to be present at their nests. A nest was categorized as active or apparently occupied if young were seen in the nest or at least one adult was on the nest (Bibby et al.1992).

Table 1: Details of study sites and variables used in the analysis

Site	Location	Site	Location
Site A	Damak1	Site I	Bhaunne 1
Site B	Damak2	Site J	Bhaunne 2
Site C	Sarnamati	Site K	Sunbarsi
Site D	Tarahara 1	Site L	KTWR*
Site E	Tarahara 2	Site M	Kechana*
Site F	Barampur	Site N	Mahendr *
Site G	Urlabari Forest Groove 1	Site O	Rangeli*
Site H	Urlabari Forest Groove 2		

The nesting habitat selection and human disturbances were determined by collecting the information on habitat characteristics, number of individuals of storks in each habitat, species of the nesting trees and signs of human disturbance such as fishing, livestock grazing, cutting trees etc. To measure habitat characteristics around the nesting sites, 500 m line transects were laid in two directions from each nest site. A vegetation survey was conducted using 20×20 m plots within each nesting colony. Each nest tree was used as the center point of the survey plots. Habitat parameters measured within the survey plots included: tree species, tree density, diameter at breast height (DBH) of nest tree, height of nest tree, distance to the nearest water body, distance to the nearest human settlement and distance to the nearest cultivated land were measured in each plot. The ten largest trees from each plot were selected to measure DBH and their height was estimated using clinometers.

Questionnaire surveys made to local people near each nesting site were used to assess the threats to the lesser adjutant stork's ecology and survival. A total of 145 respondents were interviewed during the field surveys using random sampling. The threat was determined by analyzing different social and environmental factors that represents a threat to these birds. Social factors (e.g., people's economy, their perception, awareness level, conservation efforts, importance of the species) and environmental factors (e.g., rainfall pattern, wind, temperature, types of land, encroachment status and vegetation condition) were collected during the questionnaire survey in the study area.

Results

Population status and distribution

A total of 98 individuals and 49 nests of adult lesser adjutant storks were recorded in 10 trees (**Table 2**). Only two species of tree (*Bombax ceiba* and *Adina cordifolia*)were found to possess the nests of LAS. No nests of LAS were found in four of the study sites (site– L, M, N, and O). The population of LAS has decreased as compared to the previous studies in Urlabari Forest Groove (**Figure 2**). However, in the Dharan forest, the population of adults has increased even if the number of juveniles decreased (**Figure 3**). The population of lesser adjutant storks in eastern lowland has decreased compared to previous studies. Baral (2004) estimated 250 individuals (about 5% of global population) of this species from five colonies in this area. However, our study counted 240 individuals (3 % of global population i.e., 8000 individuals) from 11 different colonies. Of the 11 colonies, only few of these have been previously recorded (**Figure 3**).

Nesting habitat selection

There were a total 240 lesser adjutant storks including 94 juveniles and 146 adults recorded in 73 nests of 14 trees in post-breeding season (**Table 3**). We also found a significantly higher number of individuals of LAS in post-breeding season (240 individuals) as compared to pre-breeding season (98 individuals) (**Table 2, 3**). Lesser adjutant stork significantly preferred *Bombax ceiba* trees in comparison with other trees. In the study sites, there were 51 nests of LAS in ten trees of *Bombax ceiba* and 22 nests in four trees of *Adina cordifolia* (**Figure 4**).

Table 2: Population of lesser adjutant storks during pre-breeding season (July)

Site	Tree species	Number of nests	# chicks	Total individuals
A	*AC*	2	*	4
B	*BC*	2	*	4
C	*BC*	NS	NS	NS
D	*BC*	5	*	10
E	*BC*	7	*	14
F	*BC*	5	*	10
G	*AC*	9	*	18
H	*AC*	3	*	6
I	*AC*	3	*	6
J	*BC*	4	*	8
K	*BC*	9	*	18
L	*	*	*	*
M	*	*	*	*
N	*	*	*	*
O	*	*	*	*
Total		*49*	*0*	*98*

AC- *Adina cordifolia*, BC- *Bombax ceiba,* * No Nest , NS= Not studied, #- number of

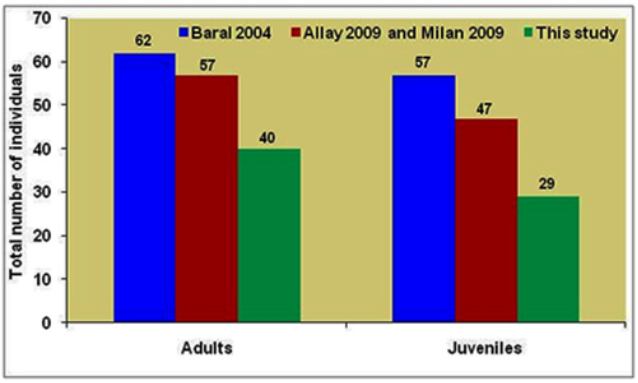

Figure 2: Population change trend of lesser adjutant storks in Urlabari Forest Grove (site G and H).

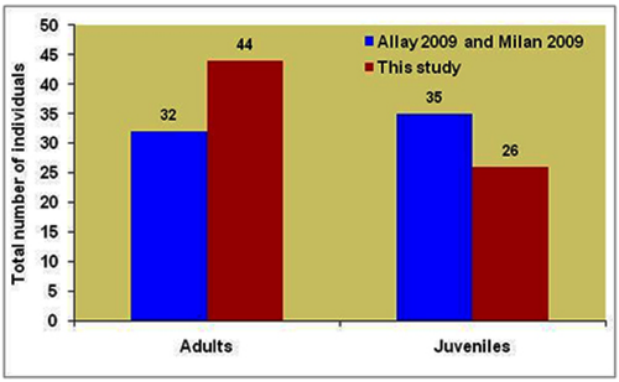

Figure 3: Population trend of lesser adjutant storks in Dharan Forest (Site D, E and F)

Table 3: Population of lesser adjutant storks during the post-breeding season (October)

Site	Tree species	# nests	# adults	# chicks	Total individuals
A	*AC*	2	4	0	4
B	*BC*	2	4	0	4
C	*BC*	16	32	22	54
D	*BC*	5	10	7	17
E	*BC*	7	14	11	25
F	*BC*	5	10	8	18
G	*AC*	15	30	22	52
H	*AC*	5	10	7	17
I	*AC*	3	6	0	6
J	*BC*	4	8	0	8
K	*BC*	9	18	17	35
L	*	*	*	*	*
M	*	*	*	*	*
N	*	*	*	*	*
O	*	*	*	*	*
Total		*73*	*146*	*94*	*240*

AC- *Adina cordifolia*, BC- *Bombax ceiba,* * No Nest , NS= Not studied, #- number of

A total 73 nests with 94 chicks were recorded during October. From these nests, 17 did not have any chicks, 20 nests had one chick, five nests had three chicks, and only one nest had four chicks (**Table 4**). The habitats of LAS in Morang district had the largest number of chicks and the average number of chicks per nest was1.29 chicks.

From a total of 11 nesting colonies recorded in the study area, six of them were located inside the community forest. Almost all nesting colonies were located close to human settlements, community forests, or public roads (**Table 6**).

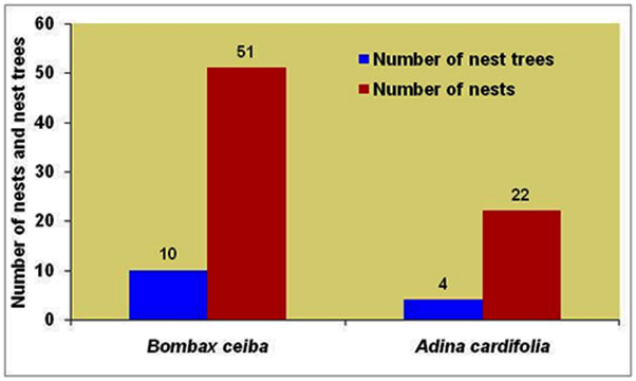

Figure 4: Distribution of nest trees and nests of lesser adjutant stork.

The nest sites were found near (D=0.111±0.08, n=11) human settlements, market areas and agriculture fields. Only two species of trees, *Bombax ceiba* and *Adina cordifolia*, were selected for nesting by the lesser adjutant storks (**Figure 3**). The heights of the trees with nests ranged from 30 to 60 m and were taller than other trees in the same sites (**Table 5**).

Table 4: Number of nests with total number of chicks in different nesting colonies

District	Location of nesting colonies	Number of nest with chicks					Total chicks	Total nests
		Total	1	2	3	4		
Jhapa	Damak Municipality	2	0	0	0	0	0	0
	Raniban Sarnamati VDC	6	6	7	1	0	22	20
Sunsari	Tarahara (Ith ari Municipality)	2	4	4	2	0	18	12
	Barampur (Hansposa VDC)	3	2	3	0	0	8	5
	Mangalbare, Urlabari VDC	4	5	9	2	0	29	20
Morang	Sunbarsi, Govindapur VDC	0	3	5	0	1	17	9
	Bhaunne, Dangihat VDC	0	0	0	0	0	0	7
Total		17	20	28	5	1	94	73

Six variables were selected to characterize the nest site environment of the lesser adjutant stork. Distance to water bodies was the most important factor to determine number of nests in a tree. Similarly, DBH, canopy height and canopy cover of the nest tree were also found as major factors to determine number of nests of storks on nesting trees (**Table 6**).The distance between water bodies and nesting tree was negatively correlated (r=-0.414) and was statistically significant (t=1.833, d.f.=9, p=0.05). Similarly, there was a negative correlation between the number of nest trees and cultivated land (r=-0.235), distance to water bodies, distance to human settlements and tree density. While, there was a positive correlation between number of nest tree and nest tree canopy cover, tree height and DBH of the nest tree (**Table 6**).

Table 5: Characteristics of nest tree species chosen by lesser adjutant storks

Tree Species	No. of Trees	No. of Nests	Height (mean ± SD)	Nest Height (mean ± SD)	DBH (m) (mean ± SD)	Canopy (m^2) (mean ± SD)
Bombax ceiba	10	51	43.5 ± 6.8	35.41 ± 4.3	2.63 ± 0.89	11.17 ± 2.35
Adina cordifolia	4	22	41 ± 5.6	33.371 ± 4.2	1.42 ± 0.13	8.60 ± 2.8

Table 6: Correlation between environmental variables and number of nests.

Variables	r	t-test value
DTWATER	-0.41458	1.36675
DTCULT	-0.0783	0.23561
DTSTMT	-0.2542	0.7885
TDENST	-0.1	0.31282
NTCNCOV	0.56904	2.076 *
NTRHT	0.49054	1.589
DBH	0.51339	1.795

DTWATER- Distance between nest tree and water bodies, DTCULT - Distance between nesting trees and cultivation land, DTSTM - Distance between NT and settlement. TDENST- Tree density, NTCNCOV- Nest tree canopy cover, NTRHT- Nest tree height, DBH - Diameter at breast height of nest tree.
R = Pearson Correlation coefficient ,
Significance test (*p < 0.05, df = 9)

Conservation threats

This study revealed that the anthropogenic threats especially hunting, habitat destruction and poisoning of wetlands were the most serious causes for the decline of lesser adjutant storks population. Some of the ethnic groups of people such as Muslim, Dhimal, Banjara frequently hunt LAS for their meat and bones (most importantly their beak). Some of the places where LAS was previously recorded did not have a single individual anymore. The VDCs such as Maheshpur and Rangeli, Bhaunne and Damak in the study area where LAS were recorded were considered as unsafe zones for storks because of their extensive hunting. Similarly, habitat degradation and human disturbances are also the major threats to storks in eastern Nepal.

Habitat loss

Nearly 83% of the respondents considered that the forest destruction was the major threat to LAS, while about 13% of the local people disagreed with this view (**Table 7**). The local people in the study area claimed that the cutting of the tall trees like Khair (*Acacia catechu*), Sisso (*Dalbergia sissoo*), Simal (*Bombax ceiba*), Sal (*Shorea robusta*), Karam (*Adina cordifolia*) and other similar species of trees cause habitat loss of stork. This has greatly affected the nesting and roosting habitat of storks.

Human disturbance

About 70% respondents reported that human disturbance was a major threat to lesser adjutant storks (**Table 7**). Local people informed that the rapid population growth caused increasing demand of forest resources. Major feeding habitat and nesting trees were in tremendous pressure. After the establishment of a Match Factory there was an increase of timber cutting especially of Simal (*Bombax ceiba*), a major nesting and roosting tree of lesser adjutant storks. Also the Vanner making industry (a butter product) uses *Bombax ceiba* tree in their processes. The excessive use of *Bombax ceiba* was seen by 43% of the respondents has a serious threat to lesser adjutant storks in the study areas.

Table 7: Respondents perception about the threats faced by lesser adjutant storks (n= 145).

Views	Responses (%)					
	Forest destruction	Human disturbance	Hunting	Pesticide use	Urbani - zation	Lack of awareness
Strongly agree	22.76	24.14	24.14	8.28	12.41	17.93
Agree	60.00	45.52	45.52	44.14	31.72	57.93
Don't know	4.14	7.59	7.59	31.03	35.17	2.76
Disagree	8.97	11.03	11.03	8.97	15.17	12.41
Strongly Disagree	4.14	11.72	11.72	7.59	5.52	8.97

Poaching

More than 73% of the people strongly believed that hunting was the major threat of lesser adjutant storks (**Table 7**). Some ethnic groups kill the storks for their flesh, while others trap and kill them to obtain their forehead which they call Jhaarmauro and that is used as a medicine for snake bites. They have a superstitious belief that there is a special organ named Jharmauro in the forehead of the males of lesser adjutant storks which acts as anti-venom.

Excessive use of pesticides

Farmers have been using large amounts of pesticides in agricultural fields which area major feeding site for storks. About 52% of the respondents accepted that the use of pesticides was another major threat for lesser adjutant storks, while 31% of the respondents did not know whether such pesticides affected lesser adjutant storks or not (**Table 7**).

Lack of conservation awareness

Lack of conservation awareness is marked as a major problem regarding conservation of birds including lesser adjutant storks. There was very low conservation awareness among ethnic groups such as Muslim, Dhimal and Rajbansi communities who used to hunt lesser adjutant storks for their meat and bones. So that the areas dominated by Muslims and indigenous people can be considered as unsafe zones for lesser adjutant storks. For example, in areas like Maheshpur and Rangeli, where previously lesser adjutant storks were recorded, now they were absent. More than 72% of the respondents reported that the lack of conservation awareness was another major problem regarding the decline of lesser adjutant stork populations in the eastern Nepal (**Table 7**).

Discussion

Population status and distribution

The colonies of lesser adjutant storks were mostly found near rivers and cultivated lands in the study area, because storks prefer to stay near wetlands for food sources such as fishes, snails etc. (Paudyal et al.2010, Pokharel 1998, Bhattarai 2012).This study revealed that the lesser adjutant stork were associated with the open wooded land (open canopy forest), transition zone between forest and grassland or cultivated land. In dense forest their distribution was limited, while close to cultivated land and wetland considerable numbers of nesting colonies were recorded. Such habitats are occupied by human settlements mostly wetland dependent communities (fishing is their major occupation) contributing to increase storks susceptibility to hunting pressure. Previous studies have showed that storks were distributed throughout the lowland Nepal– eastern Terai (Baral 2004), central Terai (Gyawali 2003) and western Terai (Baral 2004). However, its populations have been restricted in few areas and most of them are poorly represented in the protected area network. This study identified the largest breeding population with 73 nests as compared to previous studies that found 61 nests in four compared to previous studies that–found 61 nests in four colonies in eastern Nepal (Baral 2004) and 43 nests in central Nepal (Paudyal et al. 2010). Based on additional records and field observations of 15 probable sites, 11 sites were recorded with nesting colonies of the lesser adjutant storks. Seven out of 11 colonies were reported for the first time. From 15 selected sites for nest searching, four sites had good habitat conditions but were not chosen by storks for nesting. Local people informed us that these areas were previously occupied by the lesser adjutant storks but now they disappeared from these sites due to hunting and human disturbances. Despite of having appropriate habitats Koshi Tappu Wildlife Reserve (KTWR) only have feeding populations of lesser adjutant storks but not nesting populations. However in terms of conservation threats KTWR is not much different than other sites outside the protected area (Khatri et al. 2010).

In the study area, Morang district consist a large size of LAS population with large number of nest trees as compared to Jhapa and Sunsari districts. This relatively better population mainly associated with the availability of large number of feeding habitats (e.g., rice fields, lakes) near the nesting colonies. Koshi Tappu Wildlife Reserve supports a large number of globally threatened bird species (Bird Life International 2011, IUCN 2013). Even habitats within the reserve are subject to intense pressure from grazing by domestic livestock, cutting, burning, hunting, **fi**shing, and water management schemes (Kalsi et al. 2001) and all species are under pressure. The protection of habitats by community forestry (8 community forests)is also the main reason for the larger population of LAS. Among these community forests, two community forests namely Salghari and Mahalaxmi possess a good nesting habitat including a large number of nesting tree species such as Bombax ceiba, Adina cordifolia etc.

This study as compared to previous studies (Baral 2004, Gyawali 2003) has found wider occupancy of the lesser adjutant storks, but the population size has been decreasing. Not only the lesser adjutant storks, but other bird species have declined, bird population assessments in KTWR (Chhetry 2006, Khatri et al. 2010) have confirmed the decreasing trend in their populations. Habitat deterioration is one of the major causes of such decline of bird populations including lesser adjutant stork populations in Swamp Francolin (Dahal et al. 2009).

Nesting habitat selection

Similar to previous studies (Pokharel 1998), the nesting colonies of lesser adjutant storks were mostly found near the river and cultivated lands. During the breeding season after July there were a larger number of wetlands as compared to other seasons. At this time almost all the cultivated paddies were covered with water and lesser adjutant storks had enough food sources for their chicks (at the time of breeding storks need about 3 to 4 kg feeding material per day) (Pokharel 1998). The nesting activities of the lesser adjutant storks are also directly related to availability of several species of snails, fishes, frogs and reptiles because breeding

activities need a protein rich diet (Dierenfeld and Fidgett 2003). Pokharel (1998) reported that the number of stork nests was directly associated with availability of its prey species. From July to October the abundance of fish, frogs, snakes and snails were expected to be relatively higher in the study area due to greater area of rice fields. However suitable mate, nesting materials, temperature and rainfall may also determine the nesting season and nesting site selection of lesser adjutant storks (Tamang 2003).The significance test preformed between the nest tree and the cultivated land suggests that they are almost 5 to 6 meters apart from each other($r=0.0783$, $t = -0.235$, $n = 11$ and $p=0.05$). However there was a shift of LAS colonies towards lower altitude of southern regions due to the fact that the water level in higher elevations of northern side has decreased in the last few decades.

The nesting site selection, population structure and size of lesser adjutant storks are highly dependent on the habitat characteristics of the area they occupied. Among the habitat variables used in the analysis, three of them (nest tree canopy cover, nest tree height, DBH of nest tree)were positively correlated, while four variables (tree density, distance between nest tree and nearest water body, cultivated land, and settlement area)were negatively correlated with the number of nests in the study area. The high correlation between nest tree and cultivation land (e.g., rice fields) may be due to the altitude of study area (100 m), which is mostly (more than 6 months) covered with water. Such areas create temporary wetlands and provide a prime habitat for both predator (e.g., storks) and their prey species (e.g., snails, fish, snakes and frogs) as reported by previous studies (Pokharel 1998, Baral 2004).

Conservation threats

All the nesting colonies located in three districts of eastern Nepal lie outside the protected areas. Consequently, lesser adjutant storks in these areas are susceptible to the anthropogenic threats such as habitat destruction, disturbance, hunting, excessive use of pesticides, lack of conservation knowledge and rapid urbanization and industrialization. Previous studies also reported that the lesser adjutant storks in these areas were under heavy pressure due to habitat loss, disturbance and hunting (Pokharel 1998, Gyawali 2003, Bird Life International 2011). Most of the feeding habitat is being cleared for agriculture and settlements. Farmers have switched from traditional varieties of rice and wheat to more profitable crops such as vegetables and fruits in which they use a large amount of inorganic fertilizers and pesticides for higher yields. Since rice fields are apparently important feeding habitats for lesser adjutant storks, these changes may have serious consequences. The use of pesticides in agriculture fields have been increasing and agrochemicals pose a severe threat to lesser adjutant storks (Pokharel 1998, Gyawali 2003). The method of fishing by poisoning an entire water body was also found to be another major threat to wetland dependent birds (Dahal et al. 1999). Such practices severely damage the local ecosystems and have impact on all all species of the entire food chain, including lesser adjutant storks. For instance, due to the process of bioaccumulation, in which different pesticides can be stored inside animal body fat tissues. For example, Oaks et al. (2004) reported that diclofenac which is used as pain killer for livestock, was found to accumulate on the body tissues of vultures leading to fatal kidney failure. The active ingredients in pesticides can cause the egg shell breakage and may increase the chick mortality rate (Oaks et al. 2004). In our results, the use of pesticides might directly reduce the prey populations (e.g., fish, frogs, reptiles and snails) of water birds. Local people in the study area also believed that the increase in the trend of pesticide use has been playing a great role in population decline of lesser adjutant storks.

Similarly, habitat alteration is another major problem for storks, for example, small wetlands are getting dried and large areas of rice fields are being converted into human settlements. The rapid urbanization of the habitat areas has been the one of the major conservation threats faced by lesser adjutant storks. Nesting colonies are often close to human settlements, and many of them have been destroyed as villages and towns have expanded. It has also been noticed in previous studies (Baral 2004) that hunters from the ethnic groups like Dhimal, Rajbansi and Muslim kill these birds for their protein rich meat and forehead bones, as lesser adjutant storks are large and conspicuous, they are easy targets for hunters. Furthermore, bird parts, mainly the bills of storks and hornbills, are sold in shops in Kathmandu as a medicine (Sapkota 2002). Due to the lack of strict legal provision for such hunters, the illegal hunting activities have increased in recent decades. Conservation knowledge and awareness level is very low among the local people with low economic status and illiteracy because people give less value to biodiversity as compared to their daily needs.

Conclusions and Conservation Implications

Lesser Adjutant Storks were found in the wetlands of eastern lowland of Nepal, its distribution was observed on wetlands, forest openings and close to cultivated lands. The population census of 11 breeding colonies made in two consecutive seasons; pre- breeding and post breeding seasons showed 98 adults in July and 240 individuals (94 chicks and 146 adults) in October respectively. While comparing the population census in four blocks, Morang district had the highest number of lesser adjutant storks in comparison with Jhapa and Sunsari. The population trend of lesser adjutant storks has been markedly decreasing in last few decades. Bombax ceiba and Adina cordifolia were found to be the most preferred tree species by lesser adjutant storks. All the nests were found above 30m height with an average tree height of 42.5 ± 6.8 m an and average nest height of 34.4 ± 4.3 m. Nest-chick analysis showed that there was on average 1.29 chicks per nest. Lesser adjutant storks mostly preferred the nesting habitats that were dominated by cultivated land and swampy areas. The population of lesser adjutant storks was positively correlated with the distance between nesting tree height and the DBH of the nesting trees. Similarly, tree density, distance to the water bodies,

cultivated areas, and settlements were negatively correlated with the number of nests of lesser adjutant storks. All the nesting colonies in the three districts of eastern Nepal lie outside the protected areas, suggesting that lesser adjutant storks are more susceptible to anthropogenic threats. The major threats faced by storks were described by 145 respondents in which deforestation was reported as the most serious threat (83%) followed by human disturbance (79%), poaching (73%), lack of conservation awareness (72%), use of pesticides (52%), and urbanization and industrialization (43% of the respondents).

Our study reveals that the populations of lesser adjutant storks in eastern lowlands of Nepal are not protected in any way and therefore special conservation efforts are needed. The excessive extraction of *Bombax ceiba* trees for the industrial uses mainly Match Factory should be controlled to avoid the loss of nesting habitats of lesser adjutant storks. The study areas where dominated by rice fields and almost all farmers use inorganic fertilizers and pesticides for higher yields. Similarly, fishing is made by poisoning the whole water body. Therefore, for the long-term survival of the breeding populations of lesser adjutant storks in the eastern lowland Nepal excessive use of pesticides and fishing by poisoning should be banned or controlled. However, alternative livelihood options should be given to people who live closely associated with lesser adjutant storks and regularly harvest their eggs, chicks and adults for consumption and/or trade.

Acknowledgment

We would like to thank Grzegorz Mikusinski, Lars Edenius, Tomasz Wesolowski, Todd Engstrom and Prem Budha for their valuable suggestions, support and encouragement in this research. EMEM-Aves Award committee, Central Department of Zoology and Central Department of Environmental science of Tribhuvan University are well acknowledged.

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