CHAPTER 1: INTRODUCTION

1.1 Background

Storks are large wading birds with long and powerful bills, broad wings, short tails and long necks. Sexes are similar but males are usually larger than females (Ferenc, 2000). Usually storks are found in open shallow water or wetland areas, but some species prefer drier or forest regions (Ali and Ripley 1983).

The stork family (Ciconiidae) includes 19 species, (Hillaljyoti. et al. 2002), and are widely distributed, mainly in old world tropics. Being large, conspicuous and easily observed, storks are well known birds throughout their range (Faye, 2007). Several populations are threatened or endangered. The family Ciconiidae has three distinct subdivision or tribes. The woodstork/openbills group contains six medium-sized members that have generalized courtship but specialized feeding behavior (Hancock. et.al. 1992). The five to seven species of “typical” storks are all somewhat similar with mainly black and white plumage and straight bills (Kahl, 1987). The “giant” storks comprise six species with impressive stature and massive bills.

Storks are not swimmers, just waders (Anderson 1838). Feeding is solitarily or in small groups on invertebrates and small vertebrates. Storks are highly carnivorous birds feeding on a range of animals from small mammals and birds to reptiles, amphibians, fish and invertebrates (Kahl, 1971). Not all species feed on all these foods, however some species are generalists taking whatever is available, while others have very specialist diets.

Nests of the Openbills are built in trees, though some species nest on cliffs and the White Stork has come to nest primarily human buildings, now-a-days these often include specially constructed platforms form them to nest on. Nests of most species are relatively large being built out of various plant material brought to the site by the male who offers the materials to the female (Hancock. et.al. 1992).

Among 19 species of storks, 8 species of storks occur in Nepal. Among 8 species of storks 2 species are endangered, 2 species are threatened and 4 species are under the vulnerable category according to the IUCN category (BCN, 2004).

Table 1: Species of Storks found in Nepal

S. N	*Scientific name*	*local name*	*Distribution in Nepal*	*Status* (IUCN)
1.	*Mycteria leucocephala*	Painted stork	Bardia	Vulnerable
2.	*Anastomus oscitans*	Asian openbills stork	Chitwan, Suklaphanta Koshi barrage, Koshi tappu Kapilbastu	Vulnerable
3.	*Ciconia ciconia*	European white stork	Chitwan, Bardia	Vulnerable
4.	*Ciconia episcopus*	White necked stork	Chitwan, Bardia, Fewa Lake	Near-threatened
5.	*Ciconia nigra*	Black stork	Makalu Barun National park, Koshi, Chitwan, Fewa Lake	Vulnerable
6.	*Liptoptilos dubius*	Greater adjutant stork	Koshi	Endangered
7.	*Leptoptilos javanicus*	Lesser adjutant stork	Koshi, Rara Lake	Endangered
8.	*Ephippiorhynchus asiaticus*	Black necked stork	Koshi, Bardia	Threatened

(B. C. N., 2004, Baral 1999)

1.2 Biology of Openbills

The Openbills are characterized by large bills, the mandibles of which do not meet except at the tip (Sibylle, 2006). Being large, conspicuous birds they can be easily seen in their habitat sites. The openbills storks consist of two species of stork (family Ciconiidae) in the genus Anastomus. The two species of openbills storks are:

Asian Openbills Stork (*A. oscitans*), a resident breeder in tropical southern Asia from India and SriLanka to Southeast Asia (Ferenc, 2000).

African Openbills Stork (*A. lamelligerus*), a resident breeder in Africa and Madagascar (Ferenc, 2000).

Asian openbills stork is a broad-winged soaring bird which relies on moving between thermals of hot air for sustained flight (Faye, 2006). The Asian openbills is white or grayish white in colors and edges of the wings are black. This feature develops only in the adults. During flight this black portion of the wings makes it easy to identify the bird (Singh, 2005). In Nepal Asian openbills is recognized by local name called “Ghungifor” (Baral. et.al. 2003).

Breeding adults are all white except for black wing flight feather, red legs and dull yellow bill. Non breeding adults have the white of the plumage replaced by off-white. Young birds have brown tinge to plumage (Faye 2006). Openbills storks are mostly visual hunters catching prey on sight.

1.3 Ecology of Asian Openbills

1.3.1External Morphology

Hancock et.al. (1992) describes the morphology of Asian Openbill as, Adult Openbills are characterized by the black colored feature at the base of wings and at the posterior part of its short tail. The color of bill is dull yellow. Legs are large and red in color.

The newly hatched chicks are almost naked. In short period of time, covering of fluffy down feathers are developed in its body. Chicks are altrical so parents spend a lot of time for caring their chicks. Both male and female contribute equally for the feeding purpose to their chicks. After about 3-4 weeks, the chicks shows the characteristic flap by their stubby wings. After few months, the body of chicks develops the flight feathers which helps them to fly. As the chicks becomes able to fly for short distance, but they do not search for food. Instead, they remain still dependent on their parents for food.

Asian openbill storks are large wading bird with long and slender legs. These long and slender legs helps to take large strides through deep water and tall grasses to find food. By the help of its long neck, they lean down to catch their food with their feet.

Asian Openbill do not flap their wings continuously during their flight. Rather they fly by soaring in the air. They flap their long wings occasionally. During the flight, Asian Openbill stretches their necks and legs behind their bodies and due to the presence of black color in the lower part of feather, they can be easily recognized.

1.3.2Distribution

The Asian openbills is native to Asia and breeds in Bangladesh, India, Bhutan, Cambodia, Thailand, Vietnam, Laos, Myanmar, Nepal, Pakistan and Sri Lanka (Sharma, 2007). It is resident breeder in tropical southern Asia, from India and Srilanka, east to Southeast Asia.

Asian openbills is a fairly common and resident species found in the wetland areas (Baral and Upadhyay, 1998) found altitude between 75m-250m. In Nepal it is found in Koshi barrage, Koshi Tappu, Kapilvastu, Chitwan, Suklaphanta (Baral and Upadhyay, 1998).

1.3.3 Habitat

The Asian Openbills prefer to feed on open patches, marshy lands, paddy fields etc. (Ali and Ripley, 1968). Water closeness is found to be very important factor for their survival and abundance of storks (Pokharel, 1998). It was never recorded far from water i.e. water played a vital role in the distribution of birds. Mostly they prefer tall trees near the wetland for their nesting where there is availability of their foods near by their nests (Dhakal, 2006).

1.3.4 Food

Asian Openbills feeds mainly on apple snails, but it also consumes frogs and insects and other small aquatic animals living in rice fields and swamps (Kahl, 1971). Prey is located by touch and sight. While feeding they are seen to pick up the snails, insects, frogs from the marshy land areas (Dhakal, 2006). Asian Openbills walks slowly in shallow water searching for prey. The gap in the bill allows good grasp of the snail's shell. Asian openbills extracts snail from the shell with pointed lower mandible (Ali and Ripley, 1968). One interesting thing is that the openbills do not break the shell while eating their prey (Dhakal, 2006).

1.3.5 Behaviour

Asian Openbills populations are resident in their range. Some groups may move after breeding season, but most of them are sedentary (Hancock. et.al. 1992). Asian Openbills are social birds. They nests in colonies with numerous nests in the same tree up to 40 and more (Birdlife International, 2004). In threat displays, Asian Openbills has open wings and neck outstretched (Faye, 2006). Usually rivals threaten each other but rarely fight.

1.3.6 Voice and Calls

Asian Openbills are very noisy while flying in flocks. We can hear a continual hubbub sound, as the gabbling of hundreds of ducks. Call is sorrowful "hoo-hoo" (Khadka,

2006). The breeding call of asian openbills sounds like khaek…. khaeek…. khyeek….. thyeek….thyeek (Khadka, 2006).

1.3.7 Breeding

Season: The breeding season is principally from June to October (Khadka, 2006). Long courtship displays occur at the beginning of breeding season. Mostly nest building period is July and some nest building activity is also seen in June and August (Khadka, 2006). In August mostly eggs are hatched and upto September eggs are found to be hatching. October is the peak month for production of fledglings. Some of the fledgings are produced earlier in September (Khadka, 2006).

Nest: Nest of Asian Openbills stork are relatively large being built out of various plant materials brought to the site by the male who offers the materials to the female (Hancock.et.al 1992). Female does the most of the construction work. Nest of Asian Openbills is found to be flat made with dry sticks (Faye, 2007) and plant twigs of Simal *(Bombax ceiba),* and Sal (*Shorea robusta)* on the ground floor. Large colony of nests can be seen upto 75 nests in a single tree and nests are built 10-30m up at or near the top of large Simal *(Bombax ceiba),* Palas (*Butea monosperma* (Khadka, 2006). Saj (*Terminalia tomentosa*), karam (*Adina cordifolia*) or similar tree growing near the marshy area or wetlands (Khadka, 2006).

1.4 Objectives

The general objective of this study was to collect the basic ecological information of Asian Openbills in the Lami Tal and Tikauli Tal, of Chitwan. The specific objectives were:

- to determine population size,
- to assess habitat use of openbills and
- to study the breeding activities.

1.5 Justification

Asian Openbills is fairly common species found in wetland area (Baral and Upadhay 1998). Ecological information on openbills is still lacking and only little information is available in Nepal. As no any detailed study is done in this species, the further study on this species was felt necessary to gain broad knowledge. Since, mainly they feed on snails and also feed on fishes, frogs, crabs, large insects but chemical effluents in water makes the snails, fishes, crabs etc. contaminated which directly affect birds health and breeding habits which has not yet been studied. So it was felt necessary to monitor population and their response to the change in habitat, habitat use, nesting ecology and breeding success. This study generated current information on the population, habitat use and conservation threats of Asian Openbills.

1.6 Research Hypothesis

There is variation in the flock size of Asian Openbills storks between nesting and post nesting phases.

1.7 Important Aspect to Humans

These birds prevent to the diseases caused by helminthes, because these birds mostly feed on snails which is the vector or intermediate host of Trematodes (Mishra, 2008).

1.8 Limitation of the Study

i. All the feeding grounds of the Asian Openbill might have not been recorded.

ii. As all the feeding grounds were not surveyed in a single day so the no. of Asian Openbills might have been repeated in different feeding grounds.

CHAPTER 2: LITERATURE REVIEW

Nepal's wetlands are facing tremendous anthropogenic pressure (Sah, 1997) which can greatly influence the structure of bird community (Francle and schnell, 2002). Nearly half of the country's globally threatened birds (14) and 10 near threatened species regularly inhabit wetlands (Baral and Inskipp, 2005).

Total of 29 endangered species of wetland birds are at risk due to various anthropogenic pressures in Nepal (Baral and Inskipp, 2004). Wetland birds are especially at risk from hunting and trapping. Bird hunting, netting and egg collecting have been identified as serious threats in Chitwan's rivers (Roberts et al 2002, Tyabji. 2002).

Sharp decreases in wetland birds have also been recorded in the rivers, streams, lakes and ponds of Chitwan National Park, important area for wintering, breeding and passage migrant wetland birds (BCN, 2004). Figures available over a ten year period from 1989 to 1999 for three wetlands in Chitwan National Park revealed a decline in wetland dependent birds (Baral, 1999).Tyabji (2002) detailed the disappearance of bird species and steep drop in their numbers in Chitwan's rivers and streams over the past 15 years.

In India, there are 9 species of storks. Six of them are resident breeders and three winter migrants (Ali and Ripley, 1983). Of all residents, the Asian Openbills and Painted Storks have had the largest in number (Singh, 2005).

The storks (Ciconiidae) are the largest of the Ciconiiformes standing 55 to 150 cm tall. The smallest stork is African Openbills stork which stands 55 to 60 cm tall (Ali, 1969). Storks nests colonially, a habit which makes seeking extra-pair copulations easy, only the Black Stork nests solitarily (Khan, 1984). Some species such as the White Stork maintain and renew their pair bond every year, but for others, the pair bond only lasts for a single breeding season.

Singhal et.al; 2002 studied the nesting ecology of Greater adjutant stork in Assam, India. About 90% at nests were built on the top of canopy. Storks preferred to nest in compact colonies on large, widely branched trees with thin foliage cover and near by food sources (Kahl, 1971).

The globally threatened Milky Stork (*Mycteria cinerea*) faces extinction in the wild in Malaysia, according to the country's Birdlife Partner, the Malaysian Nature Society (MNS) (Hornbuckle, 2005). As few as ten milky storks are thought to survive in Malaysia. Yeap Chin Aik, MNS Scientific Officer (Ornithology), said human disturbance of nesting colonies, mangrove habitat loss and poaching had caused numbers to dwindle (Hornbuckle, 2005).

Storm's Stork (*Ciconia stormi*) is one of the rarest species of storks in the world and very little knowledge is known of its natural history (Luthin 1987, BirdLife International 2001, Wetlands International 2006). The species is classified as endangered due to its small (250-500 individual) and rapidly declining population caused primarily by the destruction of its preferred lowland evergreen forest habitat (BirdLife International 2001, Wetlands International 2006). The first sighting of this species was done in Thailand 18 years ago but recent range-wide assessments have suggested that the species is probably extinct in Thailand (BirdLife International 2001, Bird Conservation Society of Thailand 2004).

White Storks do not have a voice. To communicate with each other, they clatter their bills together and dance around, ruffling their feathers (Singh, 2005). Black Storks do have a rasping call, and rarely use the bill clattering technique that the White Storks use (Ali and Ripley, 1983). All storks fly with his or her necks and legs outstretched. Because of their size and weight, once the storks reach an acceptable altitude, they stop flapping their wings and glide (Anderson. H, 1938).

Sundar et al; (2007) described the records of Black-necked stork breeding pairs fledging four chicks. Among the large storks that nest singly, the maximum number of fledglings recorded was three with one exceptional record of a Jaibru (*Faibru mycteria)* nest with five chicks fledging (Thomas, 1981) and one record of four Black-necked stork chicks fledging in Australia, where the species has been well studied. There are no records of four Black-necked stork chicks fledging from a single nest in South-East Asia.

Openbills storks derive their generic and vernacular names from the peculiar shape of their bill in which the mandibles do not meet for part of their length (Kahl, 2005). The curious reddish black bill with arching mandibles leaving a narrow gap between them is diagnostic (Ali, 1969). The significance and function of the peculiar gap in the bill is doubtful. However it is an adaptation to facilitate extraction of the soft body and viscera of molluscs from the shell, particularly of the large *Pila globosa* snails on which the bird commonly feeds (Ali and Ripley, 1968).

Asian Openbill is resident, shifting locally with water conditions having the size of 68 cm while standing to top of head. It is found throughout the Indian Union, both Pakistan, Nepal (Terai) and Ceylon. Also found in Burma, Thailand, and east through the Indochinese sub region (Ali and Ripley, 1968).

Asian Openbill nests in colonies with numerous nests up to 40 and more on a single tree, in crowded association with darters, cormorants, and egrets with a tendency to segregation (Ali and Ripley, 1968). Nest is made up of sticks and interior is lined with green leaves.

Asian Openbills are very silent except for occasional deep moans and clattering of mandibles during greeting ceremony at nest. During copulation male clatters his bill against that of female (Kahl, 2005).

Asian Openbills reaches the sexual maturity at the age of 1 to 4 years. July and August are the peak months of nesting and hatching respectively (Dhakal, 2006). Generally, nest building starts after second week of June and nest type is platform (Khadka, 2006). Female usually lays 2 to 4 white eggs. Incubation lasts about 27 to 30 days and young fledge at 35 to 36 days after hatching (Sharma, 2007). The incubation duty is mostly performed by the female. Young birds are grayish with dark bill.

Breeding adults are all white except for the black wing flight feathers, red legs and dull yellow grey bill. Non-breeding adults have the white of the plumage replaced by off-white. Young birds have brown tinge to plumage (Faye, 2007). Young birds are fed by regurgitation by parent on to floor of nest, almost exclusively on soft bodies and viscera of large snails (Ali and Ripley, 1968).

The Asian Openbill is one of the six species of storks which have breed in Thailand. By 1995, Thailand had only one colony of Asian Openbill storks, at Wat Phai Lom (Phai Lom Temple) on the border of Bangkok (Williams, 1993) where they are protected by Buddhist Monks (Crosby, 1992).

Khadka, 2002 surveyed the nesting colony of Asian Openbills in CNP and recorded 504, 376, 435, and 2998 nests on 2002, 2003, 2004 and 2005 respectively and found decrease of nest number between the tears. Khadka, 2002 found 255 decreases in nest no. in 2003 in comparison with 2002 and 31% decrease in nest no. in 2005 in comparision with 2004. The decrease in nest no. is due to habitat destruction, natural disaster, unsuitable condition of environment etc.

Tim Inskipp and Carol Inskipp made a visit to Koshi, an internationally important wetland in lowland and noted the Asian Openbills daily. A maximum of 50 openbills were seen (Inskipp, T. and Inskipp, C. 2001).

In Koshi Tappu about fifty Asian Openbills were seen daily on bird watching trip made to Koshi Tappu and Koshi barrage by Mark Mallalieu. Single openbills near Biratnagar airport in flooded area is recorded (Mallalieu, 2006). A total of 10 Asian Openbills were seen flying over chitwan in trip in Chitwan by Barry Wright and Andrew Lawson.

In Thailand, the world's largest colony of the Asian Openbills stork is in the temple grounds at Wai Phai Lom, where they are protected by the Buddhist monks (Crosby, 1992).

In china, Asian Openbill was first of all noted by Yitian Wang in 2006 in the vicinity of Dali Xihu, the second largest lake in Yunnan. She saw the bird with the appearance of an oriental stork(*ciconia boyciana)*, but the bill was red and the lower mandible had a distinctive upward curve that left a gap in the distal half of the bill. Lateron, the bird was identified as Asian Openbills (Wang et.al 2007).

Dhakal (2006) studied the community perception towards Asian Openbills in Phailom and Ampuvararam temple wildlife non-hunting area, Thailand and concluded that the openbills was not perceived as an immediate threat to the community's well being.

The breeding colony of Asian Openbills of Kulik Bird Sanctuary is estimated among top heronries of India and now an important bird area of India. It could be that the Kulik Bird Sanctuary of North Dinajpur district, West Bengal, India is the highest Asian Openbills breeding Heronry not only in India but also in whole South Asia, which supports more or less than fifty percent of the global population (Sharma, 2007).

CHAPTER 3: RESEARCH METHODS

3.1 Study Area

This study has been done on Chitwan National Park (CNP). The specific study areas were Lamital area of CNP and Tikauli Tal area of Barandabhar corridor.

3.1.1 Location and Topography

CNP is located between 27^0 34' to 27^0 68' North latitude and 83^0 87' to 84^0 74' East longitude while the buffer zone extends further at 27^0 28' to 27^0 70' north latitude and 83^0 83' to 84^0 77' east longitude.

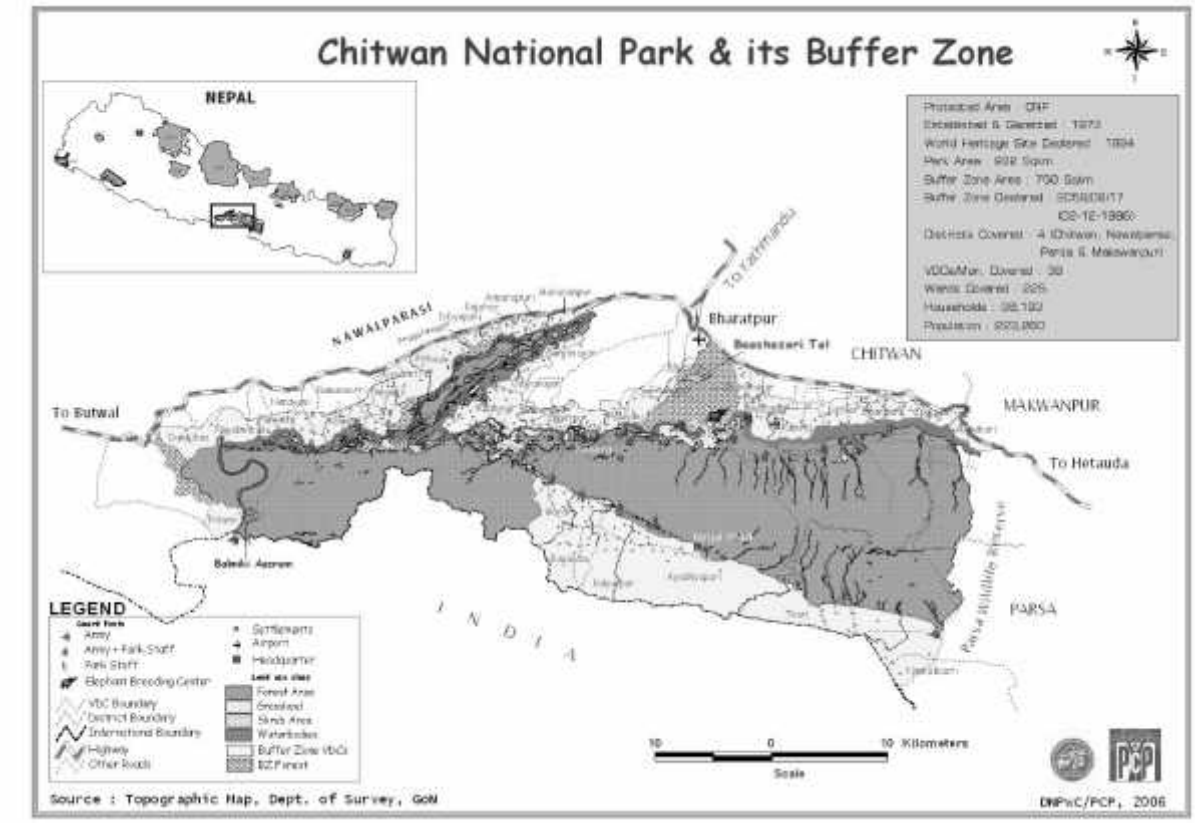


Fig.1 Map of the study area.

It lies in the south central part of the country in the sub-tropical lowlands of the Terai and spans across portions of four districts namely; Chitwan, Nawalparasi, Parsa and Makwanpur. Churia hills and flood plains of Rapti, Reu and Narayani rivers lie within the park (DNPWC, 2004). Rapti river demarcates the northern boundary from the

intensively cultivated area and Nepal –India border in the south.The western boundary is formed by Narayani river, while it touches Parsa Wildlife Reserve (PWR) in the east.

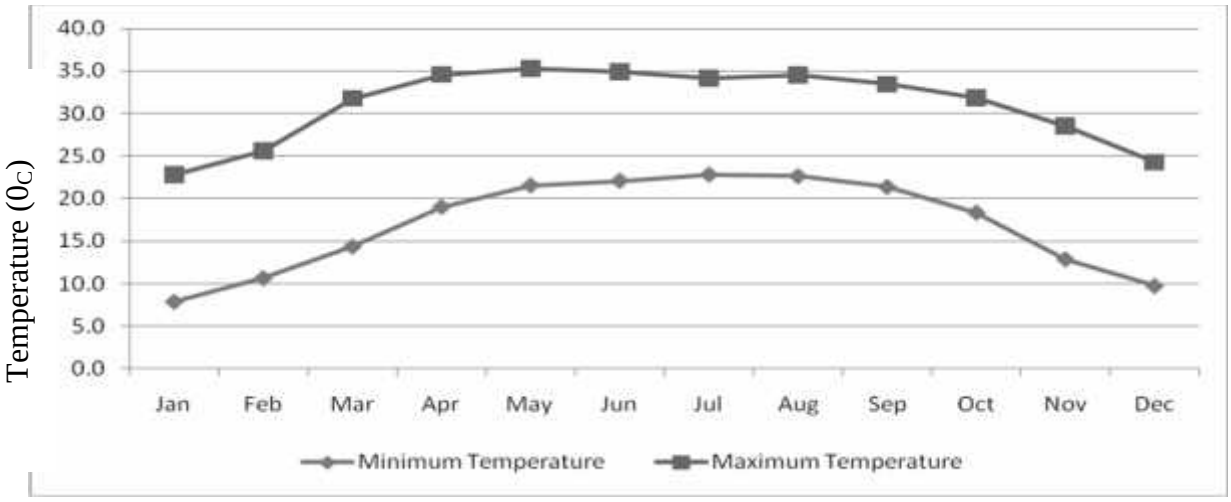
3.1.2 Geology and Soil

The Chitwan valley lies between Siwalik and Mahabharat range and is rich in thick deposit. Narayani, Rapti and Rew are the major river systems of this valley. The park soils are representatives of Chitwan dun valleys types (Gee, 1963). Most of the land inside park is loamy with fine sand. Hills soils are sandy loam and loamy rubble with stony surfaces less than 50cm from bed rock. Soil types found in the valley has been identified as sandstone, conglomerates, quartzites, shales, and micaceous sandstones during soil survey (HMG, 1968). Alluvial soils range from sand and coarse loams on new terraces to sandy and silty-clay loam on older terraces. Drainage is variable with the water table ranging seasonally from 0-2m. older soils on fans, aprons, ancient river terraces and Quatemary basin deposits are well-drained sandy loam to loam, with the water table seasonally ranging from 1-15 (Lehmkuhl, 1994).

3.1.3 Climate

Chitwan District has tropical monsoon climate with relatively high humidity with three distinct seasons; winter, spring and monsoon (DNPWC and Ministry of Forests and Soil Conservation, 2000). The summer days are quite hot. The rainfall average to about 2,400mm per year and about 90% of rainfall concentrates within four months of monsoon seasons (June-September). November to mid February is marked as winter season. Hot season is marked through mid February to May and mercury may rise up to 36˚C .

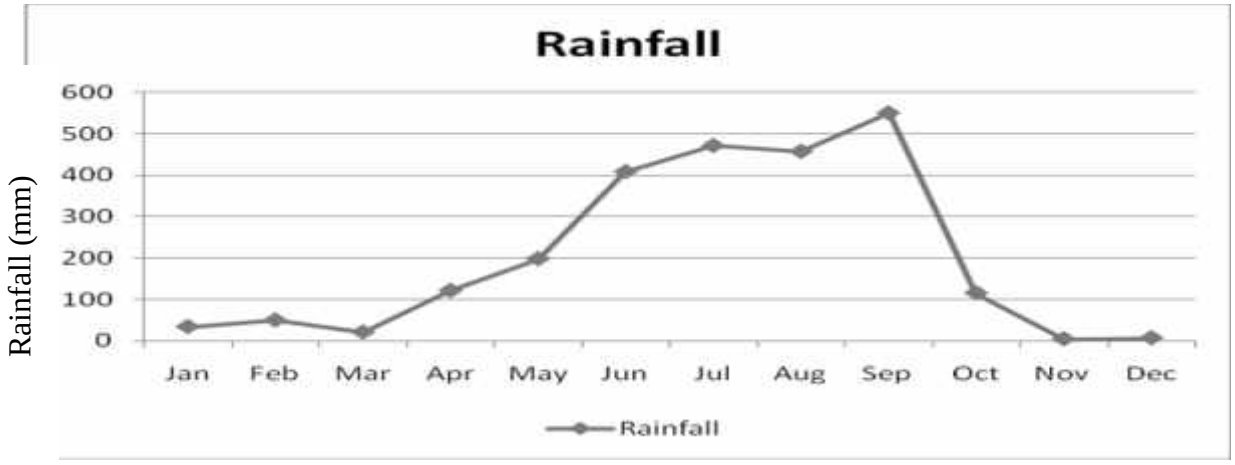
The mean monthly maximum temperature ranges from 22.8^0c to 35.3^0c and mean monthly minimum temperature from 7.86^0c to 22.8^0c. (Fig. 2, Annex 1 and 2)



(Department of Meteorology and Hydrology)

Fig. 2: Mean monthly temperature (^{0}c) recorded at Bharatpur Metrological station from 2001-2007.

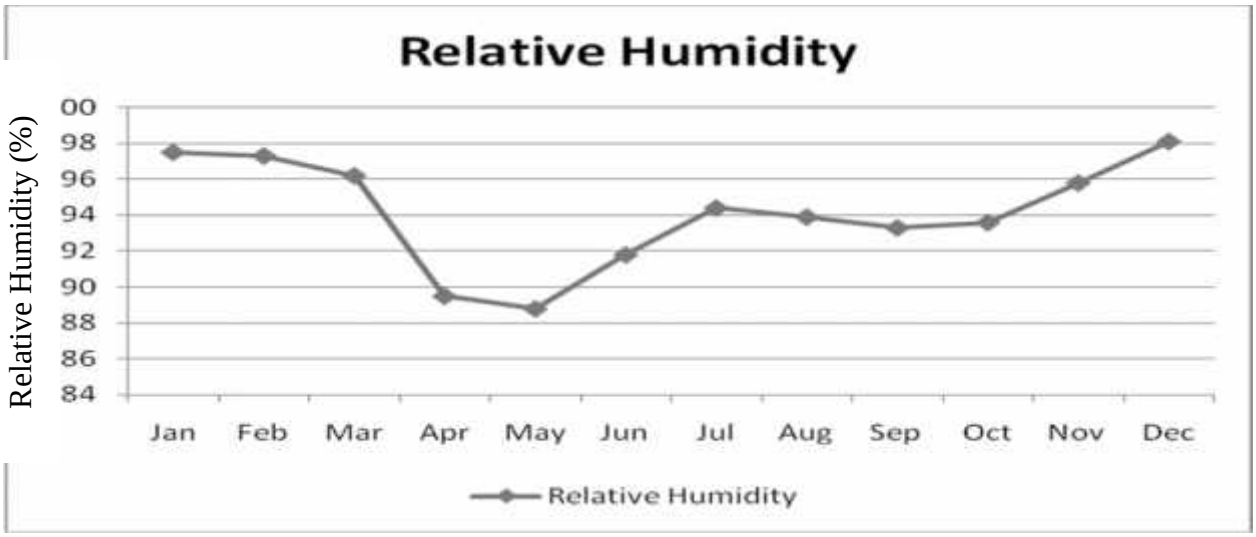
The summer monsoon starts from mid June and reaches peak in August and continues to late September. The average maximum rainfall was recorded to be 556 mm in September and the average minimum rainfall was recorded to be 0 mm in December. (Fig. 3, Annex 3)



(Department of Meteorology and Hydrology)

Fig.3: Mean monthly rainfall (in mm) recorded at Bharatpur Metrological station in 2004, 2005 and 2007.

The relative humidity varies from year to year. The mean maximum RH was recorded 98% in December while as the mean minimum RH was found to be 88.9%. (Fig.4, Annex 4).



(Department of Meteorology and Hydrology)

Fig.4: Mean monthly Relative Humidity (RH) recorded at Bharatpur Metrological Station from 2001-2007.

3.1.4 Biodiversity

3.1.4 i. Flora

More than 600 plant species have been recorded in the park (DNPWC2007). The major vegetation types of the park include Sal forest, Riverine forest, and Grassland.

Sal Forest:

Sal (*Shorea robusta*) forest covers 70% of the total park area. Sal (*Shorea robusta*), the dominant species attains a maximum height of 30m. It occurs in pure stands in association of other tree species like Harro (*Terminalia chebula*), Barro (*Terminalia belerica*), Kyamun (*Syzygium operculata*), Bhorla (*Bauhinia vahli*i), Jamun (*Syzygium cumini*), Amala (*Phyllanthus emblica*) (MOFSC and DNPWC 2000). The grass species found in the Sal forest is mainly Daddi (*Themeda arundinacea*), Ulla (*Themeda caudate*),

Khar (*Apluda mutica*), Thulo narkat (*Arundo donax*), Kure ghans (*Chrysopogan aciculatus*), Dubo (*Cyanodon dactylon*), Siru (*Imperata cylindrica*) (MOFSC and DNPWC 2000).

Riverine Forest:

Riverine forest occupied about seven percent of the park along water courses (Rapti, Reu, and Narayani), swamps and streams but the recent record suggests increase in area. The most common tree species found are Vellar (*Trewia nudiflora*), Simal (*Bombax ceiba*), Khair (*Acacia catechu*), Sisso (*Dalbergia sisso*), and Sindure (*Mallotus philipinensis*). Based on the stages of succession, the forests are found in double associations-the association of Khair (*Acacia catechu*) and Sissoo (*Dalbergia sissoo*) in the earlier stages and association of Simal (*Bombax ceiba*) and Vellar (*Trewia nudiflora*) in the later stage. Shrubs such as Mitho Neem (*Murraya koenigii*), Guyallo (*Callicarpia macrophyla*), Dudhe jhar (*Euphorbia hirta),* Bayer (*Zizyphus mauritiana*), Sisnu (*Urtica dioica*) are also found associated (MOFSC and DNPWC 2000). Tall grass species such as Kaans (*Vetiveria zizanioides*), Thulo narkat (*Arundo donax*) and shorter species such as Dubo (*Cyanodon dactylon*), Kure ghans (*Chrysopogan aciculatus*) occurs in the clearing and at forest edges (MOFSC and DNPWC 2000).

Grassland:

Grassland covers 20% of the park (DNPWC 2004). Grasslands are found in three major areas of the park-the moist places, old agricultural sites and alluvial flood plain.

Kaban bans (*Dendrocalamus strictus*), Babiyo (*Eulaliopsis binata*), Janao ghans (*Paspalum distichum*), Narkat (*Phragmites karka*), Daddi (*Themeda arundinacea*) are the tall grass species that grow in new alluvial plains. Short grasses like Siru (*Imperata cylindrica*) occur in old agricultural sites. Other short grasses such as Kagune jhar (*Seteris spp),* Kure ghans (*Chrysopogan aciculatus*), Dubo (*Cyanodon dactylon*) are found underneath the tall grass and in open fields. The common aquatic plants found in

the pools are: Pani unyo (*Hydrilla sps*.), Nilo jaluke (*Monochoria hastata*), and Jayanti jhar (*Lemna perpusilla*) etc (MOFSC and DNPWC 2000).

3.1.4 ii. Fauna

More than 55 mammals, 600 birds and 55 amphibians and reptiles have been recorded in the park (DNPWC 2007). The park holds a good population of endangered species.
Some important reptiles include Golden monitor lizard (*Varanus bengalensis*), Land tortoise (*Indotestudo elongate*), Common cobra (*Naja naja*), Indian python (*Python molurus*), Water snake (*Natrix piscator*) and Krait (*Bungarus*). Two species of crocodiles; gharial (*Gavialis gangaticus*) and marsh magar (*Crocodilus palustris*) are also found in the rivers and lakes of the park (MOFSC and DNPWC 2000).

CNP is called a paradise for bird watchers because it contains an exceptionally diverse avifauna. Avifauna such as Bengal florican (*Eupodotis bengalensis*), White stork (*Ciconia ciconia*), Sarus crane (*Grus antigone*), Lesser florican (*Sypheotides indica*), Koel (*Eudynamus scolopaceae*), Parakeet (*Psittacula krameri*), Swift (*Apus affinis*), Black drongo (*Dicrurus macrocerus*) etc. are found (Baral 1996).

The mammals found in the park include One-horned rhinoceros (*Rhinoceros unicornis*), Tiger (*Panthera tigris*), Elephant (*Elephus maximus*), Leopard (*Panthera pardus*), Sloth bear (*Melursus ursinus*), Gaur (*Bos gaurus*), Chital (*Axis axis*), Hog deer (*Axis porcinus*), Sambar (*Cervus unicolar*), Barking deer (*Muntiacus muntjak*), Wild boar (*Sus scrofa*) etc. (MOFSC and DNPWC, 2000).

3.1.5 Features

The park consists of a diversity of ecosystems, including the Churia hills, ox-bow lakes and the flood plains of the Rapti, Reu and Narayani rivers (DNPWC, 2004). The Churia hills rise slowly towards the east from 150m to more than 800m. The western portion of the park is comprised of the lower but more rugged Someshwor hill.

3.1.6 Indigenous Ethnic Group

Tharus, Bote-majhi and Mushar are indigenous inhabitants of Chitwan. These indigenous groups have been dominated mainly by hill migrants after the eradication of malaria (DNPWC, 2007). Tharus are the main indigenous ethnic groups in Chitwan. They are well known for their resistance to malaria. Traditionally they are farmers and practice their own unique tribal culture.

3.2 Materials and Methods

3.2.1. Preliminary Survey

Preliminary survey was carried out in the Lami Tal area of CNP and Tikauli Tal area of Barandabhar corridor to locate the nesting and roosting sites of openbills stork. During preliminary survey, questionnaire survey was done with the local people and park staff to get general information about openbills and their location in the national park.

3.2.2. Bird Survey

Bird survey was done in their nesting, feeding and roosting sites. The nesting and roosting sites were identified by thorough survey of the study area. All the roosting and nesting Asian Openbills were monitored in the morning hours (6.30 AM to 9.30 AM) and in the evening hours (4.00 AM to 6.00 PM). The nesting and roosting sites were also thoroughly searched for dead Asian Openbills and information was recorded. Binoculars were used to count the number of Asian Openbills, no. of nests and digital cameras were used to capture the photos of the Asian Openbills in different sites and nests wherever needed.

3.2.3Population Survey

3.2.3.1 Nest Survey

Nests of the Asian openbills were counted and nest occupancy was recorded by road transect method. The direct sensing was done by unaided eye while as binocular and

camera was used to observe them from the distance. According to Postupalsky (1974) an active nests is the one in which eggs had been laid.

3.2.3.2 Feeding Ground Survey

Feeding ground was surveyed at different places and the numbers of Asian Openbills were counted. Not only were that, the type of the feeding grounds were also recorded.

3.2.3.3 Roosts Survey

Roosting sites of the Asian openbills was surveyed in Tikauli Tal, Beeshazari Tal, Baruwa, Parasnagar, adjacent lakes of Beeshazari Tal and the tree species were also recorded.

3.2.4. Habitat Use

The vegetation composition of nesting site was carried out by quadrate sampling method. The quadrate size was 20×20 m^2. In area of Tikauli Tal, 9 quadrate was done and in area of Lamital 10 quadrate was done.

3.2.5. Breeding

Nest: In each nesting sites, all the nests (active, productive, non-productive) were counted. The name of the trees where nest was built was also noted. Nest observation was made twice a month to assess the nest status and breeding success. The diameter of the fallen nest was measured and by using the formula $C=2\pi r$, the circumference was obtained.

Egg: In the nesting site of Lami Tal, all the eggs were counted in the nests by the use of binocular from the machan. The clutch size was two, three and four. In Tikauli Tal some of the eggs were found fallen along with the nest.

3.2.6 Secondary Data

Various relevant literatures in journals, reports, books and internet were thoroughly reviewed to collect information on the status, breeding and nesting ecology of Asian Openbills.

3.2.7 Data Analysis

3.2.7.1 Population Size

The population size of Asian Openbills was determined using Jacknife technique (Cited in Rodgers, 1991). This method assumes that with repeated counts theoretically there is the probability of counting all the animals in the area at one time. This method requires at least five repeated absolute counts and uses the difference between the highest count 'n_{max}' and the second highest count 'n_{max-1}', to calculate population size (N).

The estimated total number,

$$N = 2n_{max} - n_{max-1}$$

(at no immigration or emigration)

3.2.7.2 Breeding Success

Breeding success of Asian Openbills was determined using following formula (Postupalsky, S. 1974)

$$\text{Breeding success} = \frac{\text{total nests with fledglings}}{\text{Total active nest}} \times 100\%$$

3.2.7.3 t-test

t-test was used to determine the difference in the flock size between nesting and post nesting stages.

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t_{n_1+n_2-2}$$

Where, $\bar{x} = \frac{\sum X}{n_1}$,

$$\bar{y} = \frac{\sum Y}{n_2},$$

And $S^2 = \frac{1}{n_1 + n_2 - 2}\left[\sum (x - \bar{x})^2 + (y - \bar{y})^2\right]$

CHAPTER 4: RESULTS

This study determines the population size, habitat use and breeding of Asian Openbills in Lami Tal and Tikauli Tal area of Chitwan.

4.1 Population Status:

4.1.1 Population count at nesting colony

The colonies of Asian Openbills were observed in Lamital of Ghatgain, and Tikauli Tal. The estimated population size of Asian Openbills in the Tikauli Tal area and the Lami Tal area were found to be118 and 151 respectively in 2007/2008.

Table 2: Population of Asian Openbills in Tikauli Tal

Date of Observation	Jul 15	Aug 1	Aug 15	Sept 1	Sept 15	Oct 1	Oct 15	Nov 1	Nov 15
Number of Individuals	41	34	72	96	51	36	21	19	18

The Asian Openbills population in Tikauli Tal ranged from 18 individuals in November to 96 in September (Table 2).

Table 3: Population of Asian Openbills in Lami Tal

Date of Observation	Jul 21	Aug 7	Aug 21	Sept 7	Sept 21	Oct 7	Oct 21	Nov 7	Nov 21
Number of Individuals	27	104	57	35	21	23	30	16	7

The number of Asian Openbills ranged from 7 individuals in November to 104 in August in Lami Tal (Table 3).

4.2 Habitat

As Asian Openbill is wetland bird, it prefers land with water .Water closeness is found to be very important factor for their survival and abundance. They prefer to feed on open patches, marshy lands, paddy fields etc. It was never recorded far from water i.e. water played a vital role in the distribution of birds. Mostly they prefer tall trees near the wetland for their nesting where there is availability of their foods near by their nests. They were found nesting in Palas (*Butea monosperma),* Saj (*Terminalia tomentosa*) and Simal (*Bombax ceiba*) at the vicinity of wetland. For roosting they were found preferring the Sal *(Shorea robusta)* and Simal *(Bombax ceiba)* tree near the wetland area.

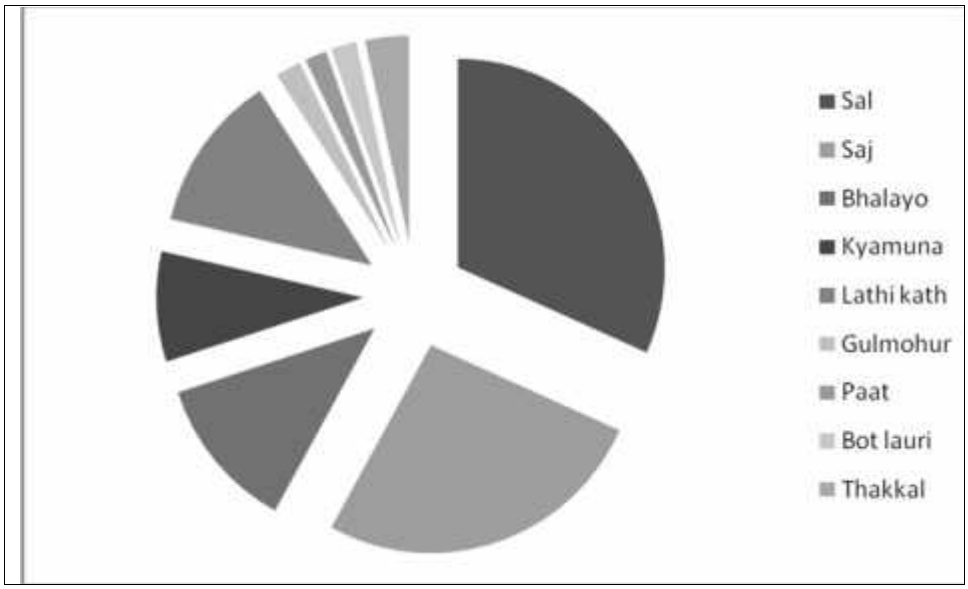


Fig 5. Vegetation composition in Tikauli Tal area.

The forest near the Tal was found to be Sal *(Shorea robusta)* and Saj (*Terminalia tomentosa*), dominant forest. Sal (*Shorea robusta*) was found to be highest in number in the nesting area of Asian Openbills in Tikauli Tal. Pat (*Helicteris irosal)* was found to be least in number in that area. The ground cover consists of Siru *(Imperata cylindrical),* Banmara (*Eupatorium odoratum),* Thulo dubo (*Cyanodon sps.),* Dubo (*Cyanodon dactylon*), Umriso *(Thysanolaena maxima),* Lahara *(Clematis gouriana),* Chari amilo *(Oxalis acetosella),* Tapre (*Cassia tora*), Ghol tapre *(Centella asiatica)* etc.

4.2.1 Nesting Habitat

Saj (*Terminalia tomentosa*), Simal (*Bombax ceiba*) and Palas (*Butea monoserma)* were found to be the nesting tree of Asian Openbills. 26 nests were found in Saj (*Terminalia tomentosa*), tree in September in Tikauli which reduced to 2 in December. The nesting tree of Asian Openbills was found to be in the edge of the Tikauli Tal. In Lami Tal of Ghatgain, 8 nests were recorded in the Palas (*Butea monoserma)* tree and a maximum of 17 nests were found in the Simal (*Bombax ceiba*) tree near the Lamital (Fig. 6).

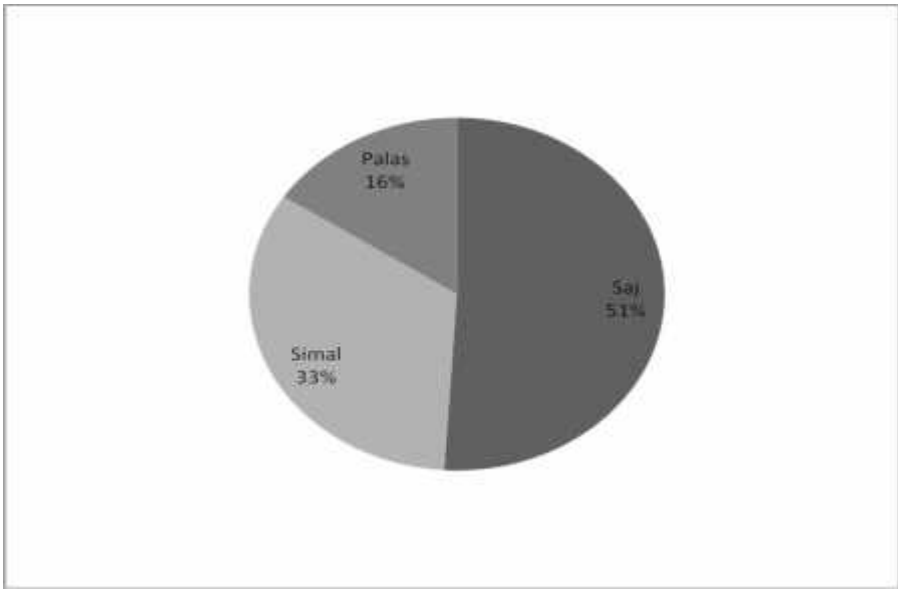


Fig. 6. Trees utilized for nesting purpose.

All nesting tree found are all at the vicinity of the wetlands. In Tikauli Tal, Saj (*Terminalia tomentosa*), was the nesting tree which was recorded only one in number while as in Lami Tal 1 Palash (*Butea monoserma)* and 3 Simal (*Bombax ceiba*) tree was recorded as a nesting tree.

4.2.2 Roosting Habitat

Five different roosting sites were recorded around the Beeshazari Lake area. A total of 24 Asian Openbills were recorded roosting in a dead Sal *(Shorea robusta)* and Simal *(Bombax ceiba*) tree of Parasnagar while a total of 16 Asian Openbills were recorded

resting in a dead Simal (*Bombax ceiba)* tree near Kingfisher Lake. In Beeshazari Tal 5 Asian Openbills were recorded roosting on a dead Simal *(Bombax ceiba)* tree and in Tikauli tal a total of 17 Asian Openbills were recorded (Table 4).

Table.4: Population of Asian Openbills at the Roosting sites

S.N	Location	Species of roost trees	Number of roost trees	Number of individuals
1.	Parasnagar	2 Simal and 1 Sal	3	24
2.	Kingfisher lake	Simal	1	16
3.	Baruwa	Sal	1	6
4.	Beeshazari tal	Sal	1	5
5.	Tikauli tal	Sal	2	17

4.2.3 Feeding Ground

Nine feeding grounds were recorded during the study time among which some of them were marshy land, some were rice fields and some were wetlands. The largest numbers of Asian Openbills were recorded in the rice field of Tikauli Tal area and the lowest numbers of Asian Openbills were recorded from the rice fields of Amarbasti (Table 5).

Table. 5: Feeding grounds of Asian Openbills.

S.No.	Place	Type of land	No. of Asian Openbills	Activity
1.	Bees hazari tal	Wetland	12	Feeding
2.	Devnagar	Marshy area/wetland	22	Feeding/wondering
3.	Parasnagar	Rice field	16	Feeding
4.	Amarbasti	Rice field	3	Feeding
5.	Baruwa	Marshy area and ricefield	36	Feeding/wondering
6.	Kesharbag	Rice field	14	Feeding
7.	Tikauli	Rice field and wetland	46	Feeding/wondering
8.	Jagatpur	Rice field	20	Feeding
9.	Kingfisher lake	wetland	13	Feeding/wondering

4.3 Breeding

4.3.1 Nesting

June to August was found nesting season of Asian Openbills while from July to September was found the egg hatching period of the species.

4.3.2 Nest Census

In Tikauli

A maximum of 26 nests (all active nests) were observed in September which reduced to 18 in October, last of October the number of nests reduced to 7. In November 4 nests were recorded among which 1 is active and 3 are inactive nests. In September 3 nests were added and reached upto 26 by 23 in August. No any new nests were built after September. In October 7 nests were destroyed by wind and heavy rainfall by dropping it

down in the ground. A total of 11 nests were destroyed upto the last of the October to become 7 nests.

Table 6: Distribution of active and inactive nest of Asian Openbills in Tikauli Tal

Nest type	2008				
	August	September	October	November	December
Active nests	23	26	18	1	0
Inactive nests	0	0	0	3	3

In August 25 (8 active and 17 inactive i.e. old one) nests of Asian Openbills were recorded in Lami Tal area. The number of nests reduced to 24 (7 active and 17 inactive i.e. old one) on September and October, In November, 19 (1 active and 18 inactive) on November and 14(all inactive) on December (Table 7).

Table 7. Distribution of active and inactive nest of Asian Openbills in Lami Tal

Type of nest	2008				
	August	September	October	November	December
Active nests	8	7	7	1	0
Inactive nests	17	17	17	18	14

Table 8. Comparison of nest numbers between years.

Average height of tree	Nest tree species	Number of nest year-wise					Remarks
		2002*	2003*	2004*	2005*	2008	
10m	*Butea monosperma*	45	54	47	0	8	All chicks killed as nesting tree fell into water in August 2004.
15m	*Butea monosperma*	53	0	66	0	0	
17m	*Bombax ceiba*	68	0	0	0	0	All eggs damaged due to nesting tree flooded in July 2002
20m	*Bombax ceiba*	195	209	0	0	10	All nests destroyed as nesting tree flooded in July 2003.
25m	*Bombax ceiba*	79	113	0	0	3	Tree died after hatching in 2003.
9m	*Butea monosperma*	13	0	0	0	0	All eggs destroyed due to nesting tree flooded in July 2002.
15m	*Bombax ceiba*	0	0	29	33	4	
16m	*Bombax ceiba*	0	0	58	44	0	
18m	*Butea monosperma*	0	0	70	7	0	
15m	*Butea monosperma*	0	0	64	0	0	
16m	*Butea monosperma*	0	0	48	0	0	
30m	*Bombax ceiba*	0	0	0	191	0	
17m	*Bombax ceiba*	0	0	0	23	0	
	Total	504	376	435	298	25	

(Khadka*. 2006.)

4.3.3 Nesting Materials

A total of 3 fallen nests were analyzed. The nest was built by collection of small sticks of Saj (*Terminalia tomentosa*), and other plants and their twigs, leaves of Sal (*Shorea robusta*) tree, leaves of Kyamuna (*Syzgium cerasoides*), Siru *(Imperata cylindrical)* and water hyacinth. The shape of the nest was almost round. The edge of the nest was built by the small sticks and mid/interior was lined by the leaves. The nest measures 22.5 inch in diameter and 67.5 inch in circumference.

4.3.3 Eggs

During the study 34 nests containing eggs were recorded. The clutch size was two, three and four in few. Some of the fallen eggs were collected and the size was found to be 3.3 inch in length and circumference was found to be 5.4 inch nearly as an egg of hen. The shape of the eggs was oval with grayish color. The eggs were collected from the base of the tree and were with very bad pungent smell. In Lami Tal the clutch size was found to be two, three and four (Table 9).

Table 9.Number of eggs in the nest of Lami Tal.

Nest number	Number of eggs
1	2
2	3
3	2
4	4
5	2
6	3
7	2
8	4

4.3.4 Breeding Success

In 2007/2008, breeding season, a total of 26 occupied nests of Asian Openbills in Tikauli and 24 nests in Lamital, Ghatgain were recorded (Table 10). In Tikauli Tal among 26 nests 19 nests were productive (fledged chicks) while all 26 nests were active nests. Based on active nests as primary unit the breeding success was 73%. A total of 7 nests failed. Out of 24 nests recorded on Lami Tal area, the breeding success was 87.5%.

Table 10. Nest status and Breeding success of Asian Openbills.

Colonies	Active nests	Productive nests	Unproductive nests	Total nests	Breeding success
Tikauli Tal	26	19	7	26	73%
Lami Tal	8	7	1	24	87.5%

Breeding success was calculated by using the formula,

$$\text{Breeding success} = \frac{\text{total nests with fledlings}}{\text{Total active nest}} \times 100\%$$

4.4 Flock Size

The flock size of Asian Openbills ranged from 7 in February to 104 in April in Lami Tal. The average flock size of Asian openbills was 51.8 individuals in nesting phase and 24.6 in post-nesting phase in Tikauli Tal (Table 11). Similarly the average flock size of Asian Openbills was 26 individuals in nesting phase and 16.8 in post-nesting phase in Tikauli Tal.

Table.11: Flock size of Asian Openbills in nesting and post-nesting phases in Tikauli Tal.

Sites	Phases	Months					Avg.
Tikauli Tal	Nesting	June	July	Aug.	Sept.	Oct.	
		32	41	83	61	42	51.8
	Post Nesting	Nov.	Dec.	Jan.	Feb	Mar.	
		34	26	32	11	20	24.6

There is significant difference in the flock size of Asian Openbills between nesting and post-nesting phases in Tikauli Tal area ($t_{(cal)}$ =2.71, at 5% level of significance).

Table 12. Flock size of Asian Openbills in nesting and post-nesting phases in Lami Tal

Sites	Phases	Months					Avg.
Lamital	Nesting	June	July	Aug.	Sept.	Oct.	
		26	23	23	34	24	26
	Post Nesting	Nov.	Dec.	Jan.	Feb	Mar.	
		26	19	21	7	11	16.8

There is no significance difference in the flock size of Asian Openbills between nesting and post-nesting phases in Lami Tal area ($t_{(cal)}$ =2.24, at 5% level of significance).

4.5 Dead Openbills

A total of 8 Asian Openbills were found dead during my study period and all of them were chicks. All 8 dead chicks were found in Tikauli tal. The cause of their death was heavy rainfall, storm and unbalanced nests.

4.6 Predators

During the study period crow was found trying to attack on the nest of the Asian Openbills containing the eggs. The crow did not succeed. The adult Asian Openbills spread its wings in such a way that it covered the whole nest area that it became impossible for the crow to snatch the eggs. The action was observed for sometime. After some minutes the crow was compelled to move away from the site and the adult Asian Openbills when felt safe, attain its normal posture and became successful to save their eggs.

CHAPTER 5: DISCUSSION

The maximum estimated population size of Asian Openbills in Lamital and Tikauli Tal were151 and 118 respectively. The minimum population size recorded by absolute count was 7 in January 2008 and maximum of 104 in Lamital. The size of Asian Openbill is very low in comparison with data of 2005 (Khadka, 2006) in Lamital, but in Tikauli Tal area it was the first time the Asian Openbills nested. The Asian openbills might have used the Tikauli Tal as nesting due to the suitable environment in that locality.

There was no any significant difference in the flock size of Asian Openbills between nesting and post-nesting phases (At 5% level of significance) in Lamital while as there was significant difference in the flock size of Asian Openbills between nesting and post-nesting phases (At 5% level of significance) in Tikauli Tal area. There was small number of Asian Openbills in the Lami Tal and the food availability may be sufficient to sustain the number of the Asian Openbills in that area. That is why the openbills from that area need not go anywhere in search of food. But in case of Tikauli Tal, the number of Asian Openbills was high. Due to their higher population, the food availability in that area may be not sufficient to feed all the population, so the Asian Openbills might have migrated to another location in search of sufficient food. As a result there was decrease in the number of Asian Openbill in post-nesting phase in Tikauli Tal.

A remarkable decline of Asian Openbills in Lami Tal was noticed since 2005. Up to 500 pairs have been noted during rainy season in the past (Khadka, 2006). There are now less than 10 pairs of Asian Openbills in the Lami Tal. The reason of decline may be due to lack of food, unsuitable environment for habitat and reduction in the number of nesting tree species because the land had been cleaned for the open land and some of the trees of the edge had been cleaned by flood.

If the area near the lake were not cleared and regular plantation of trees suitable for nesting to Asian Openbills would have done such reduction in population size of Asian

Openbills would not be possible. Over 6 years, there has been a gradual decline in Asian Openbills population in Lamital.

In Kulik Bird Sanctuary, up to the year 1992, there was a steady rise in the breeding population which was more than two times of the existing initial breeding population. In the very next year in 1993, the breeding population of Asian Openbills reduced to 50% because of the heavy rainfall, storm and flood in sanctuary. Due to the conservation efforts between the year 2000 and 2006, the population of Asian Openbills in the Kulik Bird Sanctuary rises and established between 40,000 and 50,000 (Sharma, 2007).

By conducting conservation efforts, as in KBS, CFUG, local people and other concerned institute, if worked together, there may be rise in the number of Asian Openbills in their natural habitat.

A total of 68 and 209 nests along with eggs were damaged due to the nesting tree flooded in Lami Tal in the year of 2002 and 2003 respectively. Due to this reason the number of Asian Openbill decreased in the corresponding year. Similarly in September 2008, about 1000 Asian Openbills stork died at a time due to the breakage of old Banyan tree where bird's nests were situated in India. A rescue team from the CWRC (Centre for Wildlife Rehabilitation and Conservation) had treated the injured birds (Agrawal, 2008).

The rapid decline in the number of Asian Openbills in Lami Tal may be due to the migration of the colonies of the Asian Openbills in other sites with suitable environment of habitat and in high food availability area. The Asian Openbills which was recorded in the Tikauli Tal using as nesting site for 1st time might have been migrated from the Lami Tal. They could have been migrated in Tikauli Tal as there is large rice field and 2 lake in the adjacent area i.e. Tikauli Tal and Chepang Tal. As Lami Tal was utilized as nesting site by the Asian Openbills since many years, the foods were regularly consumed by

them as a result food might have been scarced. Due to lack of nesting tree at the site they might be forced to migrate to another new nesting site for their survival and betterment.

According to Pokharel (1998), farmers in the field around Koshi Tappu Wildlife Reserve use highly toxic pesticides for the pest control in high amount as DDT, Dieldrin, B.H.C, Aldrin, Malathion, Butachlor etc. which is the major problem in the environment of storks which causes the egg shell breakage and child mortality. The use of such pesticides if can cause harm to other storks, it may be harmful to Asian Openbills and may cause the breakage of the egg shell. As the farmers of Jagatpur, Tikauli, parasnagar, Baruwa also uses such kind of pesticides, it may also be one reason for decreased number of Asian Openbill in Lami Tal.

Among the nine feeding grounds of Asian Openbills, six feeding grounds were the ricefield in different locations. As they primarily feed on the apple snail which are found widely in the rice fields so, the Asian Openbills might have choosen the ricefield as a feeding ground.

The roosting sites were surveyed near the feeding ground. The reason might be that the Asian Openbills after feeding for certain time fly over to the roosting sites near the feeding area so that they can return back to the feeding ground in short period of time. If the roosting sites were chosen far away from the feeding ground, long period of time would be utilized to return in the feeding ground.

According to Postupalsky (1974), an active nest is the one in which eggs had been laid, productive nest is the one in which fledglings are produced. In Tikauli Tal, among 26 nests all 26 nests were active nests and 19 were productive. In the same way among 8 nests in Lami Tal, all were active but 7 nests were productive. Using these data, breeding success was 73% in Tikauli Tal area and 87.5% in Lami Tal area.

The nesting material of Asian Openbill stork consists of twigs, branches and leaves of Sal (*Shorea robusta*), leaves of Kyamuna (*Syzgium cerasoides*), Siru *(Imperata cylindrical)* and water hyacinth. Asian Openbill might have used such materials for building nest because they were easily available in their nesting habitat. Water hyacinths were easily available in water of Tal adjacent to the nesting tree. As Sal (*Shorea robusta*) was the predominant species found in that area where nesting tree was situated so that the twigs and leaves of them can be easily collected. As Siru (*Imperata cylindrical*) was recorded to be the ground cover, so they were easily available for them.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

Asian Openbill is resident species found in the wetland areas. In Nepal it is found in Koshi Barrage, Koshi Tappu, Kapilvastu, Chitwan, Suklaphanta.

The estimated population size of Asian Openbill was recorded to be 151 and 118 in Lami Tal and Tikauli Tal area respectively. The population size of Asian Openbill in Lami Tal was low in comparision with the past years. The fluctuation in the population size may be due to change in habitat status, availability of food as well as environmental conditions. It was found that the Tikauli Tal is utilized as nesting site for first time in the year 2008.

The Asian Openbill was found to use the wetland areas. The wetlands provide water, food, nesting and shelter to the bird. They were analyzed to use the cultivated rice fields and other marshy lands/grasslands for their feeding purpose. Highly preferred nesting tree species of Asian Openbill was found to be Saj (51%), Simal (33%) and Palas (16%).

Asian Openbill built the almost round nest with the small sticks, twigs, leaves of Sal (*Shorea robusta*), leaves of Kyamuna (*Syzgium cerasoides*), Siru *(Imperata cylindrical)* and water hyacinth. The mean diameter and circumference of nests were 22.5 inch and 69 inch respectively. They usually built nest at the upper canopy of the tree. The breeding success of Asian Openbill was recorded to be 73% and 87.5% in Tikauli Tal and Lami Tal area respectively. In Lami Tal, no any significant difference in the flock size of Asian Openbill was found in between nesting and post-nesting phases while as the significant difference in the flock size of Asian Openbill was found in between nesting and post-nesting phases in Tikauli Tal area.

The decline in the number of Asian Openbills may be due to loss of their habitat. The reason for the habitat loss and alternation may be due to habitat destruction, disturbances, shortage of food, natural disaster, and unsuitable /unfavorable environment of habitat. So,

following action are necessary for helping the Asian openbills to resist in their survival environments.

a) The population size of Asian Openbill is very small, thus it is essential to monitor them regularly in order to have the population status.

b) Further research on the feeding ecology, breeding behavior, nesting habitat and their declining patterns to manage the Asian Openbills.

c) Tree suitable for nesting and roosting of Asian Openbills should be managed especially on the edge of Lami Tal and Tikauli Tal.

d) Raising awareness programs among the farmers and other local people in reduction of the environmental side effects of the fertilizers and pesticides. Not only that, to disseminate the value of birds and their habitat for maintaining natural balance, some program should be conducted at the school and college.

e) Farmers should be given knowledge that Asian Openbills has significant ecological role in controlling the Apple Snail (*Pomaceae Canaliculate*) and invasive mollusc that infect paddy fields.

APPENDICES

1. Table showing maximum temperature (^{o}C) pattern in Chitwan from 2001-2007

Year/Month	Maximum Temperature							Mean
	2001	2002	2003	2004	2005	2006	2007	
Jan	24.5	22.8	-	22.6	22.8	-	21.4	22.8
Feb	26.3	26.5	-	26.3	25.0	-	23.9	25.6
Mar	32.4	31.5	-	33.7	31.5	-	29.7	31.8
Apr	35.6	34.1	35.3	34.0	33.4	-	34.9	34.6
May	33.8	33.6	35.8	37.1	35.5	-	35.8	35.3
Jun	33.8	34.8	33.8	34.4	38.1	35.0	34.2	34.9
Jul	34.4	33.2	33.6	35.0	36.6	34.1	31.7	34.1
Aug	34.0	33.5	34.1	35.6	36.9	33.8	33.4	34.5
Sep	33.1	33.2	33.1	34.4	35.6	32.7	31.9	33.4
Oct	32.4	32.0	32.3	32.2	31.4	31.6	31.0	31.8
Nov	28.1	28.7	28.2	29.0	27.9	29.3	28.3	28.5
Dec	22.9	24.1	25.4	25.9	-	-	23.2	24.3

Source: Department of Meterology and Hydrology, Babarmahal, Kathmandu.

2. Table showing minimum temperature (^{o}C) pattern in Chitwan from 2001-2007

Year/Month	Minimum Temperature							Mean
	2001	2002	2003	2004	2005	2006	2007	
Jan	7.5	8.8	-	9.7	5.5	-	7.8	7.86
Feb	10.9	12.2	-	11.2	6.7	-	12.2	10.6
Mar	14.4	16.3	-	14.2	12.1	-	14.7	14.3
Apr	20.0	21.1	22.0	14.2	15.4	-	21.3	19.0
May	23.0	23.3	22.2	17.7	19.4	-	23.6	21.5
Jun	24.8	24.8	24.3	17.0	20.9	18.0	24.7	22.1
Jul	25.5	25.4	25.2	18.0	20.1	20.4	25.0	22.8
Aug	25.1	25.2	25.3	19.2	19.7	19.0	24.8	22.6
Sep	24.0	23.7	24.3	18.2	18.5	17.3	23.5	21.4
Oct	21.4	19.9	20.7	16.1	14.4	14.5	21.4	18.3
Nov	15.4	14.7	15.0	9.2	9.1	10.9	15.6	12.8
Dec	9.7	10.8	11.2	7.1	-	-	9.8	9.72

Source: Department of Meterology and Hydrology, Babarmahal, Kathmandu.

3. Table showing rainfall (in mm) pattern in Chitwan from 2004-2007.

Year/Month	Rainfall	Mean

	2004	2005	2006	2007	
Jan	58.8	41.7	-	0.0	33.5
Feb	0.0	6.0	-	141.5	49.2
Mar	9.0	24.1	-	27.5	20.2
Apr	184.4	24.0	-	155.5	121.0
May	145.8	218.9	-	228.4	198.0
Jun	603.7	215.6	-	408.4	409.0
Jul	336.3	479.0	436.5	635.0	472.0
Aug	293.4	532.0	429.0	576.4	458.0
Sep	443.9	115.5	643.7	1002.3	551.0
Oct	92.9	192.7	-	60.4	115.0
Nov	9.1	0.0	5.5	0.0	3.65
Dec	0.0	-	19.0	0.0	6.33

Source: Department of Meterology and Hydrology, Babarmahal, Kathmandu.

4. Table showing Relative Humidity (in%) in Chitwan from 2001-2007.

Year/Month	Relative Humidity							Mean
	2001	2002	2003	2004	2005	2006	2007	

Jan	97.2	100.0	-	98.9	97.7	-	93.9	97.5
Feb	99.8	98.8	-	97.8	97.7	-	92.5	97.3
Mar	100.0	99.8	-	96.0	97.9	-	87.2	96.2
Apr	100.0	87.4	90.6	94.3	91.5	-	73.4	89.5
May	100.0	81.0	85.8	95.1	93.0	-	77.8	88.8
Jun	100.0	87.4	90.0	97.8	88.3	95.8	83.4	91.8
Jul	99.7	95.6	93.1	97.1	89.2	96.3	89.6	94.4
Aug	100.0	92.3	93.9	95.5	89.0	96.4	90.4	93.9
Sep	100.0	91.5	95.6	91.3	89.6	94.1	90.8	93.3
Oct	100.0	92.8	96.7	88.0	93.7	95.6	88.4	93.6
Nov	100.0	97.6	96.0	96.0	97.7	96.8	86.3	95.8
Dec	99.9	98.6	99.4	99.4	-	-	93.3	98.1

Source: Department of Meterology and Hydrology, Babarmahal, Kathmandu.

5. Associate birds of Asian openbill

Asian openbill were with other wetland species of birds for feeding purpose in the field. Generally they shared their niche with Black ibis (*Pseudibis papillosa*), Pond heron (*Ardeola grayii*), Little egret (*Egretta garzeta*), Lesser adjutant (*Leptoptilos javanices*), Black stork (*Ciconia nigra*), Darter (*Anhinga melanogaster*), Wooly necked stork (*Ciconia episcopus*), White stork (*Ciconia ciconia*) etc. Their feeding niche overlaps with each other. Hence there was a competition for catching preys just like a game in a field. But there were slightly variable proportion of food items among their wetland species.

Among above pond heron little egret were found feeding in rice field with openbill in Kasara, Parasnagar and Baruwa. Wooly necked stork (*Ciconia episcopus*), Lesser adjutant (*Leptoptilos javanices*), was found feeding in marshy land near Beeshazari tal. Black ibis (*Pseudibis papillosa*), Darter (*Anhinga melanogaster*), and white throated kingfisher were found feeding in marshy land along with openbill in Ghatgain. Little egret and white throated kingfisher along with openbill were also seen feeding in rice field near Tikauli Tal and Chepang Tal.

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PHOTO PLATES

Plate 1: Asian Openbill in dead Sal tree

Plate 2: Openbills in roosting tree

Plate 3: Asian Openbills in Nesting Tree (Tikauli Tal)

Plate 4: Asian Openbills in Nesting Tree (Tikauli Tal)

Plate 5: Asian Openbills Feeding their Young ones

Plate 6: Asian Openbills in Roosting Tree (Beeshazari Tal)