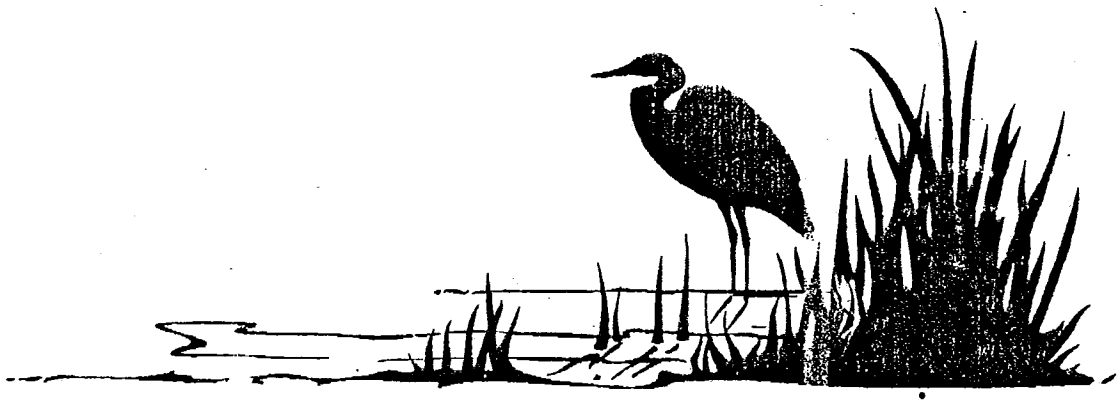
Survey of Bird Population in Narayani River Basin Lowland, Nepal



Narayan Pd. Dhakal

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INTRODUCTION

In Nepal, a vast net work of mountain streams come together to form the Narayani river basins. The Kali Gandaki, Trisuli and Marsyangdi, all being glacier fed, are the main tributaries. The Narayani river system is the third largest river systems of Nepal after Sapta Koshi in the east and Karnali in the west. Eventually converging with Ganges river in India and emptying in the Bay of Bengal the Narayani river meets the Gangetic plain below the gorge of Siwalik foot hills. The semi tropical Narayani basin fan out in alluvial braided channels that provide habitat for numerous local and resident bird species.

Lack of proper management systems, illegal capture and hunting, degradation and loss of forests for agricultural expansion, fuel wood, fodder and timber collection along the river banks for ever increasing population of the country are the main threats of bird conservation in Nepal. Water birds inhabiting the Narayani river basin are also threatened from the ffects of conversion of forest land into agricultural land along the river course.

About 60 km long stretch of Narayani river along the western boundary of the Royal Chitwan National Park provides a relatively secured refuge for water birds since it is well protected through park rules and regulations as clearly stated in the National Park Act 1973. Despite the strict protection measures the bird populations in this section are affected by local communities inhabiting along the western bank. A comprehensive management system, regular monitoring of the bird population, use of local particepatory approach in conservation and conservation awareness among local residents are needed to ensure long term survival of the water birds in the Narayani river basin. This study should be an important contribution to better understanding of water birds of Narayani river and also provides basic information necessary for conservation of avifauna of this area.

OBJECTIVES

The main objectives of the present study were to:

1. prepare a check list of bird species in the 58.9 km long stretch of Narayani river that forms the western boundary of the RCNP.
2. determine frequency, density and diversity of water birds in the study area

STUDY AREA

General

Location

The Royal Chitwan National Park (84o 20' E and 27o 30' N) is Nepal's first national park gazetted in 1973. The park is located in the subtropical lowland, Terai, in the Chitwan District, roughly 60 miles from Kathmandu (Fig. 1). The park lies between Rapti River, which demarcates the northern boundary from an intensively cultivated farm lands, and Indo-Nepal border in the south. Narayani river delineates the western boundary while in the east the park is bounded by forests and cultivated lands.

Climate

The climate is subtropical with a summer monsoon from mid June to late September and a relatively dry winter season. The mean temperature reaches a maximum of about 37o in May. Rainfall pattern is unimodal. The mean annual rainfall is about 2500 mm, 95% of which fall between May and September (Mishra 1982).

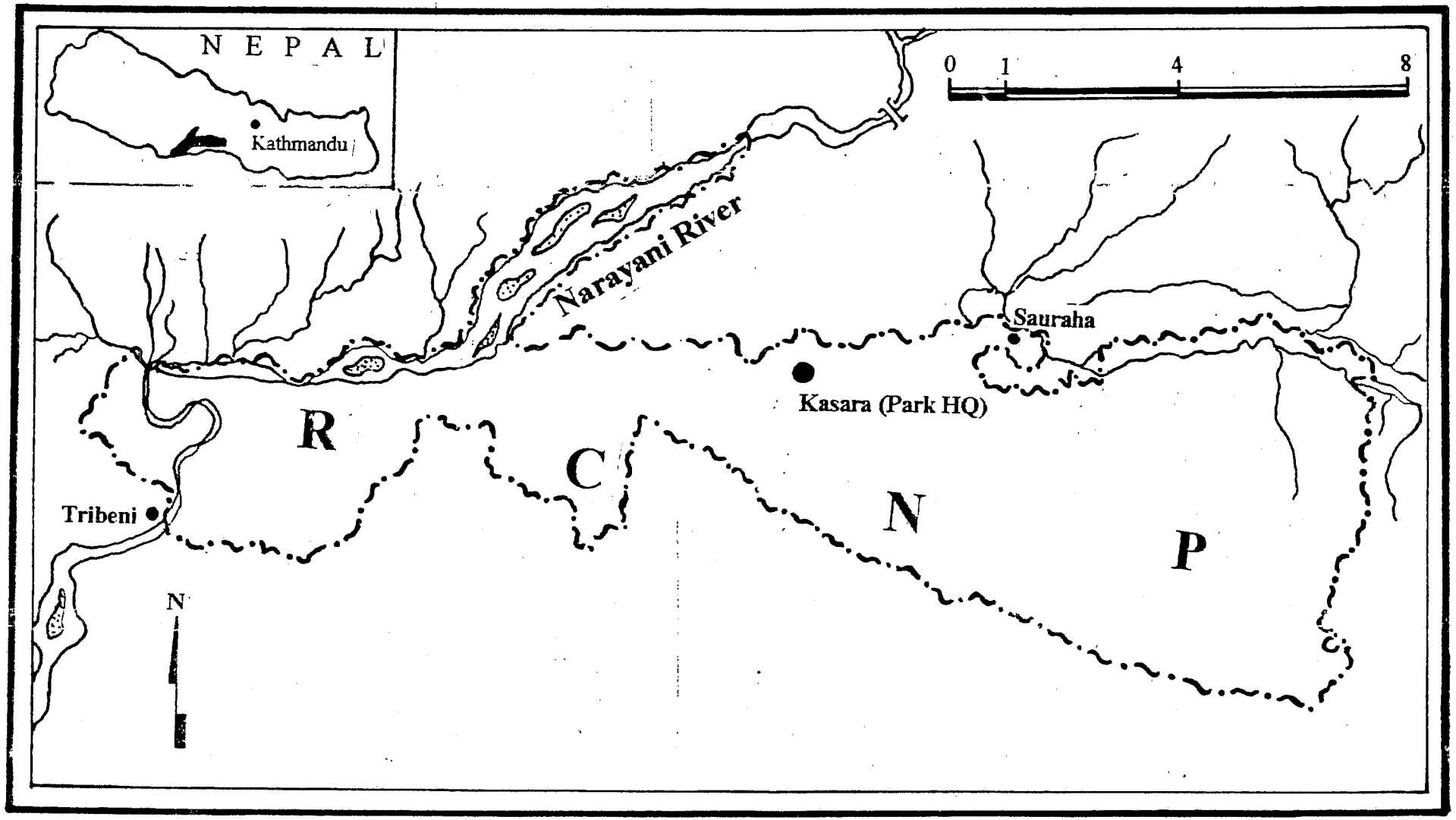

Figure 1. Map of the RCNP showing the location of the Narayani River.

Drainage and Hydrology

The park consists of three main river systems: Rapti in the north, Reu in the middle and Narayani in the west. The Churia hills bisect the park with its northern face draining into the Rapti, the southern aspect form the catchment of the Reu river. The Someswor ridge and the Daunne hill forms the southern catchment and both drain into the Narayani. Both the Rapti and Rew flow westwards and converge at Khoria Mohan near Tiger Tops from where they drain into the Narayani. The Narayani then meanders southwards through a narrow gorge between the Someswor and the Daunne hills for about 25 km until it reaches to Nepal-India border where it is dammed near Tribenighat. Narayani originates in the high Himalaya and finally drains into the Bay of Bengal after joining the Ganges in India. The flood plain along the northern sector of the park in the Rapti valley are interspersed with a few oxbow lakes and swamps which contain water even during the dry season.

Vegetation

Three major vegetation types have been studied in Chitwan (Lauric 1978). They include sal and riverine forest, and grassland. Sal forest consists of monotypic stand of sal (*Shorea robusta*) and covers about 70% of the park area. The homogenous sal forest is occasionally associated with a few other tree species including *Terminalia tomentosa, Dalbergia latifolia* and *Bahunia spp. Themeda arundinesia* is the important grass species found in the sal forest.

Riverine forest occupies an area of about 7% along the water courses and islands in both Rapti and Narayani rivers. *Bombax ceiba, Trewia nudiflora, Mallotus philippinensis, Butea monosperma, Bahunia spp.* and *Careya arborea* are the most common tree species. Associated under story shrubs (*Murraya koinigii, Callicarpa macrophylla, Clerodendron viscosum, Colebrookea oppositifolia*) and various types of climbers (*Acacia conicinna,*

Bridelia stipularia, Stipharia joponica and Tinospora sinensis) are also common in the riverine forest. Grasses are sparse except in clearings and at the forest edges.

Grasslands extend along the water courses, mainly on both new and old floodplains. The important grass species include *Saccharum spontaneum, S. bengalensis, S. arundinaceum, Narenga porphyroconia, Themeda spp., Phragmitis karka and Imperata cylindrica.*

Fauna

Royal Chitwan National Park contains such endangered species as *Rhinoceros unicornis, Penthara tigris, Plananista gangeticus.* Among others, *Panthera pardus, Melursus ursinus, Bos gaurus, Axis axis, A. porcinus, Cervus unicolor, Muntiacus muntjak, Gavialis gangaticus and Crocodilus palustris* are also important fauna found in the park. Besides, above 450 species of both terrestrial and aquatic avifauna are recorded in the park. Bengal florican, giant hornbill, lesser florican, black stork and white stork are among the endangered bird species recorded in the park. Other common avifauna include peafowl, redjungle fowl, different species of egrets, herons, kingfishers, flycatchers, woodpeckers, mynas, drongos, wagtails, geese, ducks, cormorants, wabblers and babblers.

Intensive Study Area

The intensive study was carried out in a 58.9 km long stretch of the Narayani river that forms the western boundary of the Royal Chitwan National Park (Fig. 2). The 58.9 km long study area was divided into 5 sections and extends from Kujandi in the north to the Tribeni barrage in the south to encompass a total area of ca 98 sq. km. The river forks and diverges to form a mass of channels and islands, majority of which are densely vegetation.

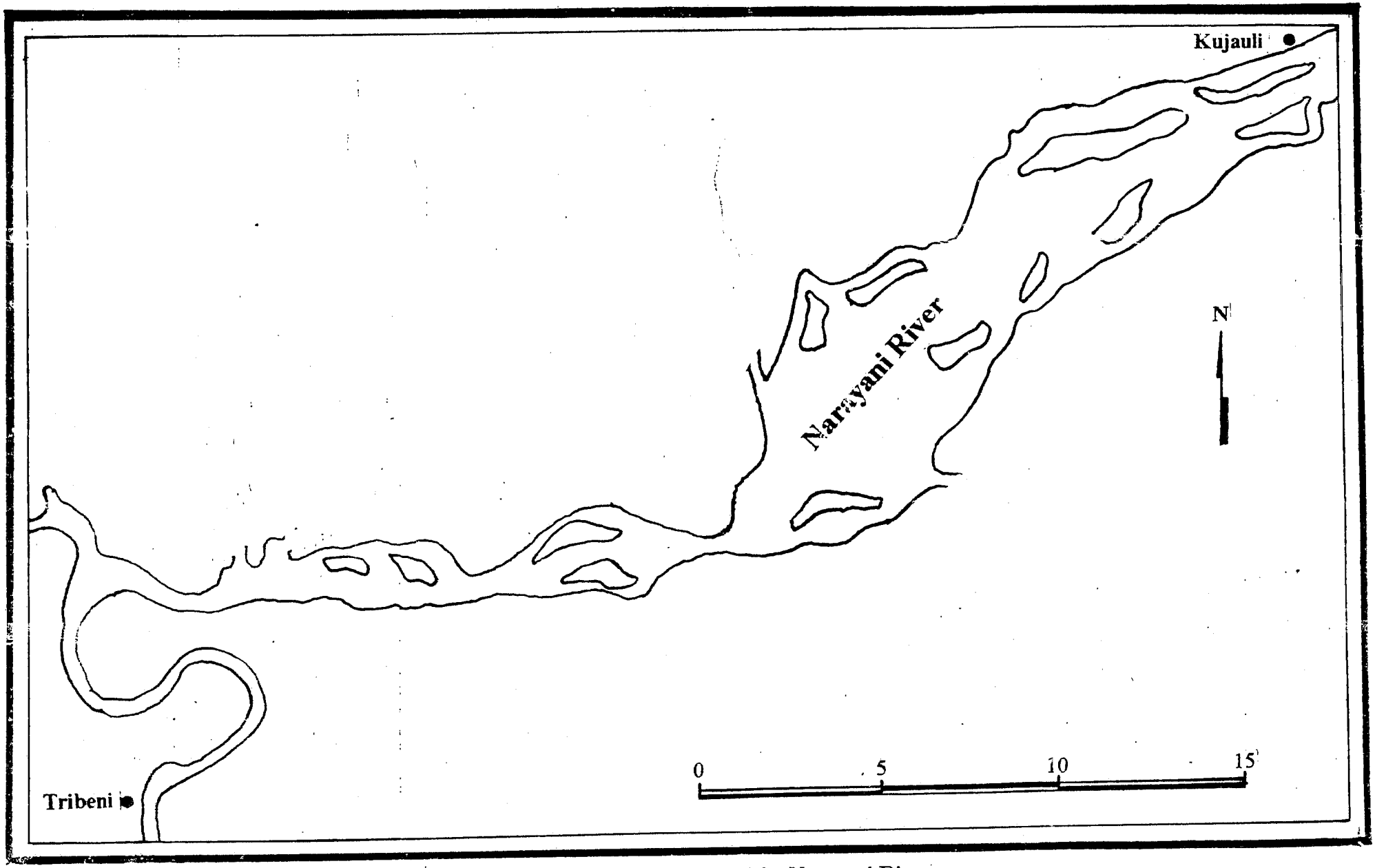

Figure 2. Map of 58.9 km long main study area in the Narayani River.

In general, the vegetation in the Islands consists of khair-sissoo forest and floodplain grasslands. The khair-sissoo forest is dominated by *Acacia catechu* and *Dalbergia sissoo.* and floodplain grassland by tall grass species, mainly *Saccharum spontaneum.*

Important fauna in this section of the Narayani include a large number of water birds, endangered species of crocodiles, Gengetic dolphin, Indian otter, and above 25 species of fishes.

Description of Sections

Section I

Section I of the survey area extends from Kujauli to Laukhani check post and measures a total length of ca 10 km. Near Bhendabari (little north of Kujauli where Tuborg Beer Factory is located), Narayani bifurcates into two main channels forming a large island and joins few hundred meters down stream. The island is densely vegetated consisting of a dense khair-sissoo forest encircled by a narrow strip of tall grassland along the edges. Khair *Acacia catechu* and sissoo *Dalbergia sissoo* are the dominant tree species found in the island forest. *Bombax ceiba, Ehretia laevis* and *Sigizium cuminii* are among the associated tree species commonly found in the island. Similarly, *Murraya koenigii, Callicarpa macrophylla* and *Colebrookia oppositifolia* are among the common under story shrub species. *Saccharum spontaneum* and *Imperata cylindrica* are the two important grass species found in the grassland.

Of the two channels, the southern channel with minimum human interference provides a secured resting and feeding ground for the water birds. The bird populations inhabiting the northern channel that flows through Pithauli village suffer from a number of human activities including laundry and illegal fishing. Besides, a number of village kids attempting to kill birds were also seen frequently in the northern bank. Furthermore, cattle grazing in a

narrow strip of degraded pasture near Laukhani also creates disturbances to both resident and migratory bird species.

Section II

This section of the study area extends between Laukhane Check Post and Gharial Camp and is ca 7.8 km in length. Near Laukhani the river splits into two channels and again joins near Lamichaur pasture land. Near Gharial Camp the river splits into numerous channels. The southern bank of this portion of the Narayani is absolutely undisturbed and provides the most suitable breeding ground for both resident and migratory birds.

Island vegetation consists of a mixture of grassland and riverbed forests. The floral composition is similar to that described in the Section I. On the northern bank, a small patch of degraded pasture land and a long narrow strip of protected forest strecthes from Laukhani Check Post to Lamichaur, and Lamichaur to Amaltari Ghat, respectively. The disturbance by the local communities was remarkably high. Cattle grazing, fuel wood collection, fishing and bird killing with Guleli (shilling shot) were among the notable disturbances observed in this section. Besides, picnic celebrations were also commonly observed.

Section III

With a total length of ca 12.5 km, the third section extends from Gharial Camp to Finda Ghat. Near Gharial camp three channels merge to form a wide confluence. Gundari Khola joins Narayani near Amaltari Ghat. About 200 m south of this confluence Narayani again splits into numerous channels.

Compare to others the southern bank of this section is much disturbed. Tourism (mainly from Tiger Tops and Temple Tiger, both located inside the park) is the main source of

disturbances. Besides, cattle grazing and fuelwood collection in a small patch of mixed forest stretched from Lamichaur to Brahmathan, and fishing activities in the northern bank of this section have posed a serious negative effect on the bird population. Despite of these disturbances, few feeding and resting sites of the resident birds were recorded from the southern bank of this section.

Section IV

Stretched from Finda Ghat to Binai confluence, the fourth section is about 10 km long. About 200 m down from the Finda Ghat, the river splits into four small channels and later join to form a single course near Tamaspur. The island vegetation consists of grassland and riverbed forest as described in above mentioned sections. Unlike in other sections a continuous patch of sal *Shorea robusta* forest occurs near Sukraj Island.

The nearby areas of the northern bank of this section is intensively cultivated, the crop fields being extended right up to the eroded river bank. Among five sections, Section IV is the most influenced (human interference) portion in the study area. Above 1000 cattle are brought everyday from the nearby villages and released into the park for grazing. Besides, more than 50 fisher men and women were seen between Finda Ghat to Binai confluecne during the survey period. Trapping water birds by using locally made nylon thread snares was another serious problem recorded in the northern bank of this section. However, Sukraj island was found less disturbed probably be due to difficult access.

Section V

About 17.7 km long, the fifth section of the study area extends from Binai confluence, where Binai Khola joins Narayani near Bhagban Post, to Triveni Barrage. Narayani forms single course after Binai confluence and flows between Someswor (in the east) and Daunne hill (in the west) forming a deep gorge. Narrow, rapid water and large boulders

on the river banks are the characteristics of this section. The vegetation on the steep slopes of both sides consists of hill sal forest. Mainly due to difficult access this section of the study area is least influenced by human activities. However, bird hunting by Indians was reported from the southern portion of the barrage (Ram Saran Kushbaha , Pers. Comm).

METHODS

A three days preliminary survey was conducted during mid November, 1995. This included a quick trip from Laukhani to Tribeni with the help of dug-out canoe and discussion with the local communities inhabiting adjacent to the western bank of the river. Relevant literature, aerial photos of the study area and equipment (binocular, camping gears etc.) were collected before the actual field work was initiated in early December, 1995. An intensive survey was conducted for 3 months between December, 1995 and February, 1996. The limits of the survey and length of each section is given in Table 1.

Table 1. Limits and length of five sections of the Narayani River in the survey area.

Sections	Limits of sections	Length of sections
I	Kujauli to Laukhani Check Post	10.9
II	Laukhani to Gharial Camp	7.8
III	Gharial Camp to Finda Ghat	12.5
IV	Finda Ghat to Binai Confluence	10.0
V	Binai Confluence to Tribeni Barrage	17.7
Total		58.9

During the three months intensive survey period the total 58.9 km long stretch was completely surveyed on three occasions and the survey area was limited to the river channels, islands and river banks and species directly associated with the river were

recorded. Birds observed in the forests and grasslands adjacent to the river were neglected during the survey. Details of the visits and duration of survey are given in Table 2 :

Table 2. Details of visits and duration of survey.

Observation	Section	Started	Completed	Total days
First (V1)	I - V	29 Dec 1995	4 Jan 1996	6
Second (V2)	I - V	6 Jan 1996	12 Jan 1996	7
Third (V3)	I - V	19 Feb 1996	25 Feb 1996	7

Observations and counts of the water birds were basically carried out on foot. However, in areas where intricate system of channels and islands did not permit full coverage each channels and islands were treated separately in each section and survey was done from both river banks, particularly in sections I, II and III. Dug-out canoes were also used to obtain maximum possible count in such circumstances. However, birds of small body size, such as small waders (stints, plovers, wagtails and sandpipers) were occasionally difficult to observe. This might have under estimated the populations of such small body sized bird species. Data obtained from the survey were analyzed by using the formula as described by Halliday (1992). All sightings of each species were summed for each section and a density was calculated by using the Formula (I) given below:

$$D = \frac{S}{V} \times \frac{1}{L} \quad \text{.....(i)}$$

Where, D = density; S = total sightings; V = no of visits; L = length of the section

Similarly, diversity (d) of the species in each section was calculated by using Formula (ii) given below:

$$d = \frac{s}{v} \times \frac{1}{l} \quad \text{.....(ii)}$$

Where, d = diversity; s = total number of species; v = total number of visits; l = length of the section

RESULTS AND DISCUSSION

Check List

The check list of bird species recorded in the 58.9 km long stretch of the Narayani river is presented in Table 3.

Table 3. Check list of bird species recorded in the study area.

Scientific Name	English Name
ACCIPITRIDAE	
Icthyophaga icthyaetus	Grey - headed Fishing Eagle
Pandion haliaetus	Osprey
ALCEDINIDAE	
Alcedo atthis	Eurasian Kingfisher
Ceryle rudis	Small Pied Kingfihser
Halcyon pileata	Black-caped Kingfisher
Halcyon smyrnensis	White-breasted Kingfisher
Pelargopsis capensis	Stork-billed Kingfisher
ANATIDAE	
Anas acuta	Pintail
Anas clypeata	Shoveler
Anas crecca	Common Teal
Anas penelope	Eurasian Wigeon
Anas platyrhynchos	Mallard
Anas strepera	Gadwall
Anser indicus	Bar - headed Goose
Aythya ferina	Common Pochard
Aythya fuligula	Tufted Pochard
Aythya nyroca	White-eyed Pochard
Mergus merganser	Merganser
Netta rufina	Red-crested Pochard
Tadorna ferruginea	Ruddy Shellduck
ARDEIDAE	
Ardea cinerea	Gray Heron
Ardeola grayii	Pond Heron
Butorides striatus	Little Green Heron
Egretta alba	Large Egret

Egretta garzetta	Little Egret
Egretta intermedia	Intermediate Egret
CHARADRIIDAE	
Calidris minutus	Little Stint
Calidris subminutus	Long-toed Stint
Calidris temminckii	Temminck's Stint
Capella stenura	Pintail Snipe
Charadrius alexandrinus	Kentish Plover
Charadrius dubius	Little Ring Plover
Tringa hypoleucos	Common Sandpiper
Tringa nebularia	Greenshank
Tringa ochropus	Green Sandpiper
Tringa totanus	Common Redshank
Vanellus indicus	Red-wattled Lapwing
Vanellus spinosus	Spur-winged Lapwing
CICONIIDAE	
Anastomus oscitans	Open-billed Stork
Ciconia episcopus	White-necked Stork
Ciconia nigra	Black Stork
Leptoptilos javanicus	Lesser Adjutant Stork
GLAREOLIDAE	
Glareola lactea	Small Pratincole
LARIDAE	
Larus ichthyaetus	Great Black-headed Gull
Larus ridibundus	Black-headed Gull
Sterna acuticauda	Black bellied tern
MOTACILLIDAE	
Motacilla alba	Pied Wagtail BBF
Motacilla alba	Pied Wagtail GBF
Motacilla caspica	Gray Wagtail
Motacilla citreola	Yellow-headed Wagtail
Motacilla flava	Yellow Wagtail
Motacilla maderaspatensis	Large Pied Wagtail
PHALACROCORACIDAE	
Anhinga rufa	Darter
Phalacrocorax carbo	Large Cormorant
PODICIPEDIDAE	
Podiceps cristatus	Great crested grebe

Podiceps caspicus	Black necked grebe
SITTIDAE	
Tichodroma muraria	Wall Creeper
THRESKIORNITHIDAE	
Pseudibis papillosa	Black ibis
TURDIDAE	
Chaimarrornis leucocephalus	White - capped River Chat
Enicurus immaculatus	Black - backed Forktail
Monticola solitarius	Blue Rock Thrush
Rhyacornis fuliginosus	Plumbeous Redstart

A total of 62 species of water birds representing 14 different families were recorded from the study area. Of the 14 families, Anatidae included the highest number (13) of species belonging to Anas, Anser, Aythya, Mergus, Netta and Tadorna genera.

The total number of bird species recorded in the present study was slightly higher than in the previous study of the same area (Halliday 1992). This was probably due to large number of persennel involved during the present study. In the present survey 3 highly trained bird watchers were involved through out the survey period, where as in the previous study Halliday done surveyed the area.

Density and Frequency

The density and frequency of the water bird species in the study area were calculated seperately for different sections. The density and frequency distribution of each species recorded in Section I is shown in Table 4. In this section the highest density was calculted for Ruddy Shellduck and Bar - headed Goose at 12.81 and 10.15, respectively. Similarly, the lowest density was calculated for Plembeous Redstart, Gray Wagtail and Black Stork - D = 0.03 for all.

In Section II the highest density was calculated for Ruddy Shelduck (D = 19.19) and Large Cormorant (D = 16.97) and the lowest for Gray Wagtail, Green Sandpiper, Black Stork, Kentish Plover and Pond Heron - D = 0.04 for all (Table 5).

As in I and II sections the highest density in Section III (Table 6) and IV (Table 7) was estimated at D = 20.29 and D = 34.50, respectively, for Rudy Shelduck.

The density of all bird species in Section V was very low compare to other four sections with a highest density estimated for Small Pratincole, D = 2.82 (Table 8).

Table 4. Number, frequency and density of the bird species recorded in Section I

Species	Visits			Frequency	Density
	V1	V2	V3	%	
Bar-headed Goose	151	180	1	100	10.15
Black Ibis	18	30	-	66.7	1.47
Black Stork	-	-	1	33.3	0.03
Common Redshank	13	-	-	33.3	0.40
Common Sand Piper	5	5	-	66.7	0.31
Common Teal	15	-	-	33.3	0.46
Darter	2	-	-	33.3	0.06
Eurasian kingfisher	2	-	-	33.3	0.06
Godwall	15	-	6	66.7	0.64
Greenshank	52	-	3	66.7	1.68
Grey Wagtail	1	-	-	33.3	0.03
Intermediate Egret	20	2	5	100	0.83
Large Cormoant	13	-	1	66.7	0.43
Large Egret	2	-	1	66.7	0.09
Large Pied Wagtail	5	-	-	33.3	0.15
Little Egret	11	12	4	100	0.83
Little Ring Plover	8	4	8	100	0.61
Little Stint	4	1	-	66.7	0.15
Long-toed Stint	1	2	-	66.7	0.09
Merganser	27	2	9	100	1.16
Open Billed Stork	14	-	1	66.7	0.46
Osprey	1	1	-	66.7	0.06
Pied Wagtail BBF	1	1	3	100	0.15
Pied Wagtail GBF	3	2	4	100	0.28
Pintail	15	22	20	100	1.74
Pintail Snipe	101	-	-	33.3	3.09
Plembeous Redstart	1	-	-	33.3	0.03
Pond Heron	-	-	5	33.3	0.15
Ruddy Shellduck	190	145	84	100	12.81
Small Pied Kingfisher	6	2	-	66.7	0.24
Spur-winged Lapwing	2	-	-	33.3	0.06
Stork Billed Kingfisher	1	-	2	66.7	0.09
Temminck's Stint	4	11	2	100	0.52
White Breasted Kingfisher	4	-	1	66.7	0.15
Yellow-headed Wagtail	1	-	-	33.3	0.03

Table 5. Number, frequency and density of the bird species recorded in Section II

Species	Visits			Frequency	Density
	V1	V2	V3	%	
Black Headed Gull	2	2	2	100	0.26
Black Ibis	-	32	6	66.7	1.62
Black Stork	1	-	-	33.3	0.04
Common Sand Piper	2	2	6	100	1.43
Common Teal	-	17	-	33.3	0.73
Darter	-	4	-	33.3	0.17
Eurasian Kingfisher	1	-	1	66.7	0.09
Godwall	-	30	11	66.7	1.75
Gray Wagtail	1	-	-	33.3	0.04
Green Sandpiper	5	-	4	66.7	0.38
Greenshank	3	38	2	100	1.84
Grey Heron	5	-	-	33.3	0.21
Grey-headed Fishing Eagle	-	1	-	33.3	0.04
Intermediate Egret	5	11	11	100	1.15
Kentish Plover	-	3	-	33.3	0.13
Large Cormorant	60	322	15	100	16.97
Large Egret	-	1	2	66.7	0.13
Large Pied Wagtail	7	2	4	100	0.50
Little Egret	-	39	4	66.7	1.84
Little Green Heron	1	-	-	33.3	0.04
Little Ring Plover	2	8	12	100	0.94
Mallard	-	-	76	33.3	3.25
Merganser	18	22	41	100	3.46
Open Billed Stork	-	2	-	33.3	0.09
Osprey	1	1	1	100	0.13
Pied Wagtail BBF	2	5	9	100	0.68
Pied Wagtail GBF	3	46	11	100	2.56
Pintail	-	62	-	33.3	2.65
Pintail Snipe	-	-	50	33.3	2.14
Plembeous Redstart	-	1	1	66.7	0.09
Pond Heron	-	-	1	33.3	0.04
Red-wattled Lapwing	-	-	5	33.3	0.21
Ruddy Shellduck	146	200	103	100	19.19
Small Pied Kingfisher	2	6	11	100	0.81
Small Pratincole	-	-	7	33.3	0.30
Spur-winged Lapwing	2	-	-	33.3	0.09
Temminck's Stint	1	9	12	100	0.94
White Breasted Kingfisher	1	6	5	100	0.51
Yellow-headed Wagtail	-	-	4	33.3	0.17

Table 6. Number, frequency and density of the bird species recorded in Section III

Species	Visits			Frequency	Density
	V1	V2	V3	%	
Black Headed Gull	1	-	1	66.7	0.05
Black Ibis	5	50	15	100	1.87
Black Stork	-	1	1	66.7	0.05
Common Sandpiper	4	5	2	100	0.29
Common Teal	-	3	-	33.3	0.08
Eurasian Kingfisher	4	1	3	100	0.21
Godwall	152	-	45	66.7	5.25
Great Black-headed Gull	-	-	1	33.3	0.03
Green Sandpiper	9	3	-	66.7	0.32
Greenshank	28	3	19	100	1.33
Gray Heron	4	12	6	100	0.59
Gray Wagtail	-	1	-	33.3	0.03
Grey-headed Fishing Eagle	-	1	-	33.3	0.03
Intermediate Egret	54	61	13	100	3.41
Kentish Plover	3	1	-	66.7	0.11
Large Cormorant	5	170	16	100	5.09
Large Egret	-	-	2	33.3	0.05
Large Pied Wagtail	12	6	6	100	0.64
Lesser Adjutant Stork	-	-	1	33.3	0.03
Little Egret	49	3	5	100	1.52
Little Ring Plover	13	17	8	100	1.01
Long-toed Stint	18	-	-	33.3	0.48
Mallard	-	-	13	33.3	0.35
Mergenser	39	22	62	100	3.28
Open Billed Stork	-	3	-	33.3	0.08
Osprey	1	1	1	100	0.08
Pied Wagtail BBF	4	17	5	100	0.69
Pied Wagtail GBF	10	14	8	100	0.85
Pintail	-	-	4	33.3	0.11
Pintail Snipe	3	-	-	33.3	0.08
Plembeous Redstart	2	-	-	33.3	0.05
Pond Heron	5	1	5	100	0.29
Red-wattled Lapwing	2	-	-	33.3	0.05
Ruddy Shellduck	234	280	247	100	20.29
Small Pied Kingfisher	4	11	3	100	0.48
Small Pratincole	40	-	162	66.7	5.39
Temminck's Stint	19	12	7	100	1.01
Wall Creeper	-	1	-	33.3	0.03
White Breasted Kingfisher	3	1	-	66.7	0.11
White-necked Stork	2	-	-	33.3	0.05
Yellow-headed Wagtail	-	-	1	33.3	0.03

Table 7. Number, frequency and density of the bird species recorded in Section IV

Species	Visits			Frequency	Density
	V1	V2	V3	%	
Black Bellied Turn	-	-	1	33.3	0.03
Black Headed Gull	1	-	-	33.3	0.03
Black Ibis	-	13	2	66.7	0.50
Black Stork	-	25	33	66.7	1.93
Black-backed Forktail	1	-	-	33.3	0.03
Blue Rock Thrust	3	2	-	66.7	0.17
Common Sandpiper	2	5	5	100	0.40
Darter	-	-	1	33.3	0.03
Eurasian Kingfisher	2	3	3	100	0.27
Godwall	-	68	253	66.7	10.70
Green Sandpiper	-	4	8	66.7	0.40
Greenshank	1	-	25	66.7	0.87
Gray Wagtail	2	5	-	66.7	0.23
Gray-headed Fishing Eagle	5	1	-	66.7	0.20
Intermediate Egret	1	7	30	100	1.27
Kentish Plover	-	-	7	33.3	0.23
Large Cormorant	3	4	14	100	0.70
Large Egret	2	3	3	100	0.27
Large Pied Wagtail	-	18	5	66.7	0.77
Lesser Adjutant Stork	-	2	-	33.3	0.07
Little Egret	3	9	4	100	0.53
Little Ring Plover	12	15	8	100	1.17
Little Stint	-	1	-	33.3	0.03
Long-toed Stint	5	3	1	100	0.30
Mallard	-	-	72	33.3	2.40
Merganser	29	52	49	100	4.33
Osprey	-	-	1	33.3	0.03
Pied Wagtail BBF	15	29	6	100	1.67
Pied Wagtail GBF	49	30	5	100	2.80
Pintail	-	-	20	33.3	0.67
Plembeous Redstart	2	2	2	100	0.20
Red-wattled Lapwing	-	2	4	66.7	0.20
Ruddy Shellduck	128	484	423	100	34.50
Small Pied Kingfisher	5	11	7	100	0.77
Small Pratincole	-	-	130	33.3	4.33
Temminck's Stint	34	21	13	100	2.27
Wall Creeper	1	6	-	66.7	0.23
White Breasted Kingfisher	2	1	1	100	0.13
White-capped River Chat	1	2	-	66.7	0.10
White-necked Stork	19	-	6	66.7	0.83
Yellow Wagtail	1	-	-	33.3	0.03
Yellow-headed Wagtail	-	2	1	66.7	0.10

Table 8. Number, frequency and density of the bird species recorded in Section V.

Species	Visits			Frequency	Density
	V1	V2	V3	%	
Black Stork	-	-	2	33.33	0.04
Black-caped Kingfisher	-	-	1	33.33	0.02
Black-necked Grebe	-	1	-	33.33	0.02
Blue Rock Thrust	3	1	-	66.67	0.08
Common Pochard	10	10	6	100	0.49
Common Sandpiper	1	1	2	100	0.08
Darter	1	1	-	66.67	0.04
Eurasian Kingfisher	-	-	3	33.33	0.06
Eurasian Wigeon	10	12	33	100	1.04
Godwall	-	100	47	66.67	2.77
Great-creasted Grebe	-	-	5	33.33	0.09
Greenshank	-	-	2	33.33	0.04
Intermediate Egret	-	-	1	33.33	0.07
Large Cormorant	-	11	4	66.67	0.28
Large Egret	-	-	2	33.33	0.04
Large Pied Wagtail	5	2	3	100	0.19
Little Egret	-	2	60	66.67	1.77
Little Green Heron	1	1	2	100	0.08
Little Ring Plover	-	2	-	33.33	0.04
Mallard	-	50	40	66.67	1.69
Mergenser	-	11	-	33.33	0.21
Osprey	1	-	-	33.33	0.02
Pied Wagtail BBF	2	1	1	100	0.08
Pied Wagtail GBF	3	7	-	66.67	0.19
Pintail	-	-	30	33.33	0.56
Plembeous Redstart	-	-	1	33.33	0.02
Pond Heron	-	2	2	66.67	0.08
Red-creasted Pochard	-	4	20	66.67	0.45
Ruddy Shellduck	-	-	1	33.33	0.02
Shoveler	6	4	-	66.67	0.19
Small Pratincole	-	-	150	33.33	2.82
Spur-winged Lapwing	2	3	7	100	0.23
Tufted Pochard	-	6	5	66.67	0.21
Wall Creeper	-	2	1	66.67	0.06
White Breasted Kingfisher	-	2	5	66.67	0.13
White-eyed Pochard	-	8	-	33.33	0.15
White-necked Stork	-	-	1	33.33	0.02

Density (D) and Diversity (d) of the Total Population

The density and diversity of the bird species in five different sections of the study area is shown in Table 9. Among 5 sections, the highest density (D = 76.6) was calculated in Section IV (Table 9, Fig. 3) where as the highest diversity (d = 3.25) was estimated for Section III (Table 9).

The lowest density and diversity among five sections were estimated for Section V. This was probably due to habitat quality of this section. In this section Narayani flows rapidly through the narrow gorge between Someswar in the east and Daunney hill in the west which might not be suitable for those species that prefer shallow water. Besides, gregareous bird species, such as Ruddy Sheldducks and Cormorants, in the study area are mostly observed in the shallaw water. Furthermore, narrow river banks with large sized boulders may not provide diverse habitat types to refuge different bird species.

Table 9. Densities and diversity of total population of the water birds in the study area.

Sections	Visits	Sightings	Density	Species	Diversity
	V1	709		33	
I	V2	422	39.54	16	2.08
	V3	162		19	
	V1	271		22	
II	V2	869	66.54	26	3.25
	V3	417		28	
	V1	729		29	
III	V2	701	55.79	27	2.24
	V3	662		28	
	V1	329		26	
IV	V2	830	76.67	30	2.87
	V3	1141		30	
	V1	45		12	
V	V2	244	13.67	24	1.21
	V3	437		28	

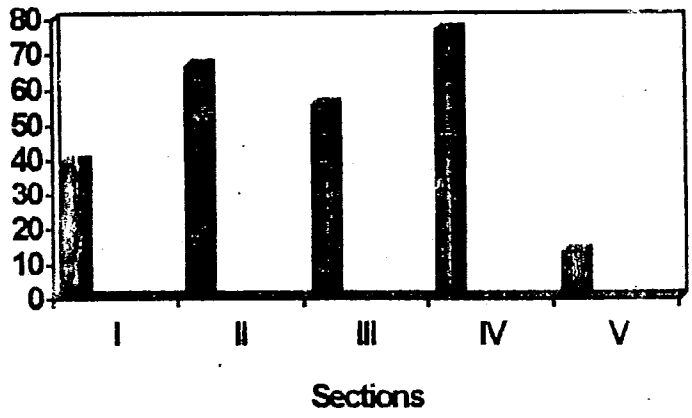

Figure 3. Density of bird species in the study area.

CONCLUSION AND RECOMMENDATIONS

The Narayani river is of outstanding importance for diverse migratory and resident water bird species. The habitat diversity along the Narayani provides a suitable habitats for water birds. A total of 62 water birds of 14 different families were recorded in the 58.9 km long stretch of the Narayani river. Among the five sections, the highest density of water birds was recorded in Section IV and the highest diversity in Section II. However, increasing human activities along the western fringes have thretened the population of the bird species. Besides, the water quality of the Narayani has also been degraded due to various human activites including disposal of industrial affluents from Vrikuti Paper Mill located near Narayanghat. A massive conservation awareness among the local inhabitants residing along the river banks should be launched to ensure long term viability of both resident and migratory bird species. Illegal bird hunting near Tribeni barrage seriousely affect the viability of the migratory bird population. Park authorities in close coordination with concerned Indian authorities should take lead to stop such illegal activities. Finally, the entire 58.9 km section of the Narayani river should be declared as a special orienthologically significant area to provide special attention for its better management.

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