WETLAND BIRD DIVERSITY OF RUPA LAKE

Red wattled lapwing *(Vanellus indicus)*

By

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A Dissertation Submitted in Partial fulfillment of the Requirement for the Degree of Master's of Science in Zoology (Ecology)

Institute of Science and Technoloty

Central Department of Zoology-Ecology Program

Tribhuvan University

Kathmandu, Nepal

2006

APPROVAL

This dissertation submitted by **Mr. Bhola Ram Subedi** entitled **"Wetland Bird Diversity of Rupa Lake"** has been accepted as a partial fulfillment of Master's Degree in Zoology Specializing in Ecology

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RECOMMENDATION

It is my pleasure to mention that **Mr. Bhola Ram Subedi** has carried out the Dissertation entitled **"Wetland Bird Diversity of Rupa Lake"** Under my supervision and guidance. This is the candidate's original work, which brings out important findings essential for biodiversity conservation in remote mountain region. To the best of my knowledge, this dissertation has not bee submitted for any other degree in any institution. I recommend that the dissertation be accepted for the partial fulfillment of the requirement for the Degree of Master's of Science in Zoology Specializing in Ecology.

_____

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Abstract

The survey was conducted during April 2005 to January 2006 in Rupa Lake which is situated in 28º8' N latitude and 84º6' E longitude covering 115 ha area, to determine the diversity seasonal variation, status and conservation of wetland birds, using five vantage points and two birding routes with direct observation. A total of 30 wetland birds' species including 4 associated bird species belonging to 16 families and 5 orders has been found. Just only one i.e. ferruginous pochard, which is valuable in status, is recorded during the study period. The highest number of bird species was recorded in winter (325 individuals of 25 species) and lowest in spring (96 individual of 14 species). Analysis of variance (ANOVA) showed the significant variation in bird diversity with seasonal variation. The diversity of the bird was measured by the Shannon's Weiner function where it was highest in winter (H =1.09) and lowest in spring (H = 0.95) and Jacob's Coefficient was highest in Autumn (J= 0.858) and lowest in winter (J = 0.78).

Among 30 species, 15 species were residential, 1 species summer visitor, 12 species winter visitor and 1 species vagrant. The major conservation threat to the bird diversity of bird in Rupa Lake are habitat distortion, over fishing and hunting, poisoning and aquatic plant harvesting for food trade and medicine, human encroachment and also livestock. Thus, this study recommends controlling human as well as livestock pressure for scientific management of the Rupa Lake wetland.

ACKNOWLEDGEMENTS

My hearty gratitude is to my supervisor Dr. Mukesh Kumar Chalise, Associate Professor, Central Department of Zoology, Tribhuvan University, Kirtipur for his noble guidance, keen supervision throughout my thesis work and inspiration towards research field and Mr. Abiskar Subedi the programme director of LI-BIRD helping and suggesting in my study as Co-supervisor.

I express my gratitude to Professor Dr. Tej Kumar Shrestha, Head, Central Department of Zoology for his continuous help throughout the study by providing administrative facilities and valuable suggestions. My sincere thanks to Mr. Indra Poudel Ms. Erika Udas and Hari K.C. (Bird Specialist) who assisted in all phase of field work.

I would like to thank to Mr. Mitra Pandey and Janak Khatiwada for continuous help and support. I am thankful to Mr. Rajiv Maharjan (Friend's Computer Service) who serve photocopy and Computer for preparing this dissertation.

Last, but not the least, I would like to remember all my friends who have supported, helped and encouraged me. I am also very much indebted to all my family members for their inspiration, continuous encouragement and specially to my dearest Saraswati for her endless spiritual support through my study period.

Bhola Ram Subedi

Exam Roll : 520

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1. INTRODUCTION

Nepal is land linked country occupying 1,47,181 sq km in area which is 0.1 percent of the total world land mass. It is situated in the transition zone between two bio-geographic realm Palearctic of the north and oriental (Indo-Malayan sub-region) to the south has resulted an extra and ordinary assemblage of flora and fauna (Shah 1996). Although it's being a small country it is the meeting point of highland as well as low land birds that is "cross road" for Trans - Himalayan species of birds. It harbors one tenth of bird species of the world (Giri, 1999).

Nepal contains 2.7 percent of flowering plant species of the world, 4.5 percent of mammalian species, and 2.2 percent of butterflies, 1 percent amphibians, 1.6 percent of reptile species, 2.2 percent of fresh water fish species and 9.3 percent of the bird. The bird species diversity shows that Nepal is one of the rich places of the world.

Birds are the creatures with feathers with wings which made them unique. Their brilliant colors, pleasing patterns of flight and melodious songs are aesthetically appealing the study of birds that provides an interesting and profitable activity to pass time. Birds live, love and die within natures aviaries. Every bird is unique and has their natural trail, blue prints of behaviors and life history. Birds made an important appearance in the earliest written records of human race and figured in the art and literature of early civilization. Biblical references to the birds are numerous. Sanskrit is full of references to Koel, Myna, Swan, Parrot, pigeon, peacock, etc. The Vahan or carrier of God Vishnu is Garuda and Swan is that of Goddess Saraswati. King Nala employed a swan as messenger to be sent the message to his queen Damayanti. A name of Jatayu has been mentioned in the great epic of Ramayana (Suwal 1992).

1.1 History of Ornithology

Masatomi (1986) has divided the historical process of ornithology and avian-fauna into three periods for Nepal. First, from 1820s to the end of the century, the birds were collected and sent to British museum by Hodgson, Scully and others. Second beginning of 19th century to the middle i.e. 1940s, plenty of classical books on the regional birds came out from adjacent countries during this period. Bailey was first to travel out of Katmandu valley in this period. The third is the prosperous one, after the world war-II.

The first detailed ornithological records were described by Hodgson in 1820-1843. His collection includes 665 species along with mammals, reptiles and fishes and amphibians representing 9,500 birds' skins. Mr. Raj Man Singh to become professional wildlife and birds artists (Inskip and Inskip 1991).

Proud's ornithological accounts between 1948 and 1961 of Gandak watershed and Katmandu valley summarized valuable and comprehensive records. Polunin was first scientist to describe the birds of western Himalayas during his botanical expedition with the British museum of Natural History during 1952 (Inskipp and Inskipp, 1991).

Biswas and Koelz collected 3,500 specimens representing about 350 species but their studies were restricted between Kathmandu valley and Raxaul in 1947. He summarized the ornithology of Nepal up to that date and published a number of Nepalese ornithological articles between 1960-1968 (Inskipp and Inskipp, 1991).

The first field guide to the birds of Nepal was published by Fleming along with Bangdel in 1976. Fleming traveled Nepal to study the

ornithology extensively. Their collections are held at Chicago Field Museum of Natural History. The publications on them were 35 papers and articles related to Nepalese ornithology (Inskipp and Inskipp 1991).

Hari Sharan Nepali 'Kazi'' a leading Nepalese ornithologist traveled extensively for ornithological expeditions and collected more than 650 species and several species were new to Nepal, his life time birds collection are now displayed in the Natural History Museum Nepal (Inskipp and Inskipp, 1991).

Now a day due to accessibility to several parts of Nepal, many amateur and professional ornithologist and bird watcher contributed to Nepalese ornithology. Beside this, wildlife resorts of Nepal contribute training to number of young bird watcher for their own tourism purpose that's why records are annually increasing. Various NGO's and INGO's are dedicated to birds and wildlife conservation in Nepal. Inskipp and Inskipp (1991) published a guide within which corporate observation of professional and amateur ornithologists. Grimmet *et. al.*, (1998) have described the Birds of the Indian subcontinent.

Avian fauna of Nepal reflects her as the paradise for some of the globally endangered species of birds. It is also the site for the spring, autumn, summer and winter migratory birds. Out of 844 species of Nepal Bird Conservation Nepal (BCN) has submitted it's country report compiling the information on 31 species of birds considered to be threatened, 11 species considered to be extinct, 2 species endemic, 22 species listed under IUCN threatened species category and 40 species in the CITES appendices (Inskipp and Inskipp 1991). Nepal has given legal protection status to 9 bird species (Table 1) according to the National Park Act, 1973 (BPP, 1995).

Table 1. Protected bird species of Nepal.

Scientific Name	**Common Name**
1. *Ciconia nigra*	Black stork
2. *Ciconia ciconia*	White stork
3. *Lophophrus impejanus*	Impeyan pheasants
4. *Tragopan styra*	Crimson - hormes pheasants
5. *Catreus wallichi*	Cheer pheasant
6. *Houbaropsis bangalensis*	Bengal florican
7. *Sypheotides indica*	Lesser florican
8. *Grus grus (antigone)*	Sarus crane
9. *Buserotides indica*	Giant hornbill

Many species of birds have become extinct during past few years, and today more than 100 species of birds are considered as near to extinct from the world. Some species of birds are vanished from the world as well as from Nepal. Pink - headed duck is globally extinct species. 226 species of birds are listed in National Red Data Book. Among them, some are considered as pest controller globally, regionally and nationally and bestowed economic contribution (Inskipp and Inskipp 1991). Among 226 species included in Red Data book 184 species (81%) are residential while rests are migrants. A total 88 species (68%) of the total threatened birds depend on forest habitat.

The endemic birds of Nepal are Nepal wren Babbler (*Pnoepyga immaculate*) found in central and eastern mid hills (BPP 1995). Spiny babbler (*Turdoides nepalensis*) is found in eastern to western border of Nepal. There are 841 species of birds (Inskipp and Baral 1996) recorded from Nepal, however recently it's number surpass 870 species (Shrestha 2000).

1.2 Bird Migration

Nepal is being transitionally lying between two realms; many birds' species visit Nepal seasonally from different parts of the world such as India, China, Russia, and Arabia. They also migrate from one place to another inside the country to escape from scorching heat and chilling cold. These birds again return back to their original habitat when the climate will be favorable. Most of the migrating birds are found to be wetland or water birds. There are 154 species of birds that migrates from the northern side in winter and 30-40 species of birds that migrates from the southern side in winter. The birds follow certain migrating routes using river system such as Koshi in the east, Bagmati and Narayani in the central part and Karnali in the western part of Nepal (Shah 2000). Bird migration has long been a subject of interest, though there is little information available about birds' migration in Nepal. These birds migrate not only from north to south but also from east to west. Some major migratory birds are Common teal (*Anas crecca*), Black kite (*Milvus migrans*), pied wagtail (*Motacilla madaraspatensis*), red–billed cough (*Prrhocorax graculus*) and hoopoe (*Upupa epops*) etc.

1.3 Wetlands of Nepal and Bio-diversity

Wetland is a land mass saturated with water due to high water table either through ground water or atmospheric precipitation or inundation. It may be natural or artificial, permanent or temporary, static flowing, or brackish (Bhandari *et al* 1994)

Wetlands are important in terms of their ecological, economical, cultural, sociological, recreational, religious and aesthetic values. Wetlands are transition and interposition between open water and terrestrial system, providing a major ecological benefit to the

environment in terms of bio-diversity, habitat for aquatic flora and fauna, hydrological regime, sustaining of local communities and storing large quantity of water recharge (Suwal 1992).

The wetland is among the most productive ecosystem in the world. Wetland is an important base for economic development of the country and plays vital role of subsistence population. The wetland occupy approximately 5 percentage of the total area of Nepal is in the form of rivers, streams, lakes, reservoirs, village ponds, paddy fields, marshes, and swamplands. It has been estimated that there are over 405 wetland sites in Nepal. Among them Koshi Tappu is the most outstanding wetland that has been designated internationally in 1987 as the First Ramsar Site of Nepal. Currently there are 3 Ramsar Sites in Nepal; Ghoda Ghodi Tal, Beesh Hazari Tal and Koshi Tappu. In Nepal about 230 bird species are known to depend on wetland (Shrestha 2000). The wild ducks, Geese and Swans are tangible resources in Nepal.

Wetlands are one of the most threatened habitats because of their vulnerability and attractiveness for development (Hollis *et al* 1989). The wetlands of Nepal have faced serious environmental problems such as loss of species (Birds and animals endemic to the region), soil erosion, deforestation, draining, etc. Consequently the population of waterfowl is in declining state every where, so, conservation and management of both wetlands and waterfowl in Nepal is essential.

2. LITERATURE REVIEW

Literature of birds are well discussed in Proud (1949-61), Fleming R.L. and Fleming R.L. Jr. (1976-1979), Scully (1979), Inskipp and Inskipp (1991), Baral (1996) and Shrestha (2000). This all are concerned about the ornithology of Nepal and about the bird species found in Nepal and the guide about the birds found in Nepal as well as the birds of Indian Subcontinents. There are some dissertations in birds for academic degrees too.

Some academic dissertation done in this field by Giri (1998) entitled "Study of abiotic and biotic Environment of Rupa Lake (Tectonic Lake) in Kaski district".

Suwal (1999) has done a dissertation work in Lumbini on the Sarus crane entitled "Study on the habitat preference, movements, nesting and population dynamics of Sarus crane in Lumbini". The main objective is to conserve the Sarus crane population from expiration. Since knowing its behaviors, it makes easy for the conservation program and helps to minimize it’s survival threatening cause. He selected three pairs of Sarus cranes and marked them and studied their roost, nest, behaviors, etc.

Shah (2000) did the dissertation work in Taudaha Lake entitled "Status and diversity of migrated birds in Taudaa Lake" The study was of one year duration and concerned to the migratory birds. However, winter migratory birds were noted more than summer one. The objective of that dissertation was to explore migratory bird species, to state historical background of that area and to explore the scope of tourism for Taudaha.

Basnet (2001) studied on the birds of the Siwalik forest of Morang entitled "Status and diversity of birds in Siwatik hills of Morang". Ojha

(2004) has done dissertation work in the community forest of the Bhaktapur, on the residential birds where he used the Mekinen's rule and recorded 85 species of birds.

“Environmental study of Nepal’s Begnas and Rupa Lake" has described the various features of those lakes. It includes aquatic vegetation, flora, fauna, location and diversity of the areas (Oli 1996). It provides total description of its physical condition, climate and geographical situation of the area (Inskipp and Baral 1996).

KMTNC Tiger/Rhino Conservation project (2005) has done research and monitoring on the topic "Status of the birds in Barandabar corridor Forest (BCF).

The bird check list (2001-2005) includes 307 species of birds. It includs various critically endangered species like Bristled grass birds *Chaetomis atriatus* and yellow vented flower pecker *Dicaeum chrysorrhacum* and 6 endangered species, 18 vulnerable species and 2 species of protected birds according to NPWC act 1973.

Danga (2006) has done dissertation on 'Study on diversity and conservation threats of birds of Mahakali watershed area near Darchula". He found 80 species of birds, out of them 63 are terrestrial and 17 wetland birds. The major conservation threats to the birds’ population were habitat destruction due to road construction, cattle ranching and public encroachment, etc. Over fishing, hunting of birds using catapult, poisoning of water, etc. provided additional threat of survival to bird. ANOVA and Cannons and Weirner diversity index was used as statistical tool.

Jha (2006) has done a dissertation on "Study of Bird diversity of Gokarna Sanitary land Fill site". He found 78 total species where 54 species of birds were winter visitor and 11 species of birds were summer visitor. Richness of species diversity was calculated by using Shannon Wiener function richness and result was higher in winter then in summer.

Chalise M.K. (1998) Recorded 79 sepceds of bords in GhodaGhodi Tal and 29 species of birds in Nakhoodi Tal on "Report of Wild Fauna of GhodaGhodi Tal" where most of them are wetland birds.

3. STUDY AREA

Pokhara is one of the most scenic places in the country. It lies in Kaski district of western development region and it is famous for its Phewa lake, Rupa lake, Begnas lake, Maidi lake, Khaste, lake, Gunda lake, Kamal pokhari and Dipang lake. Among them only the first three are, important for economic potential and biodiversity.

Despite of the deep river gorge, dark caves and spectacular Himalayan views of Annapurna, Machhapurchre, Dhaulagari, Himchuli and Lamjung, Pokhara valley is one of the most attractive tourist destination in Nepal. The natural setting of the valley is considers as divine gift for tourism development. The Rupa watershed area is 16 km east of the Pokhara city.

3.1 Rupa Lake

3.1.1 Physical Description

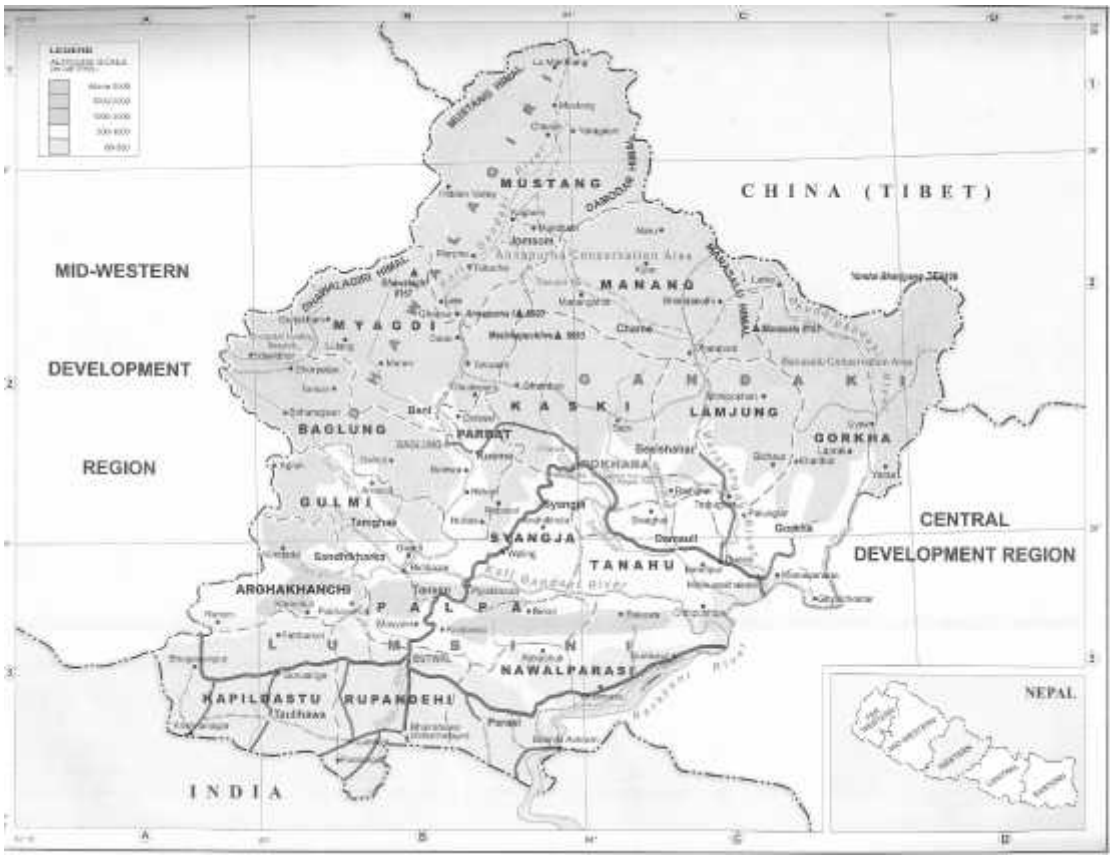
The panoramic Rupa Lake is situated of an elevation of 600-637m asl and lies between 28^0 8' N latitude to 84^0 6' E longitude, surrounded by the Pachbhaiya Danda in west, Rupakot Danda to the East, Talbesi in the North and Sisuwa in the South. It is situated in ward number 10, 11 and 14 of Lekhnath Municipality in one side and the remaining the eastern and north-eastern sides of lake touch the boundary of Rupakot VDC. Rupa Lake is still under relatively wilderness pristine and attractive. Its area is 115ha and an average depth of 3-4m. It is advancing eutrophic lake with marshes and rice field along its shore. Its major inlet stream is Dovan Khola and its outlet is Tal Khola.

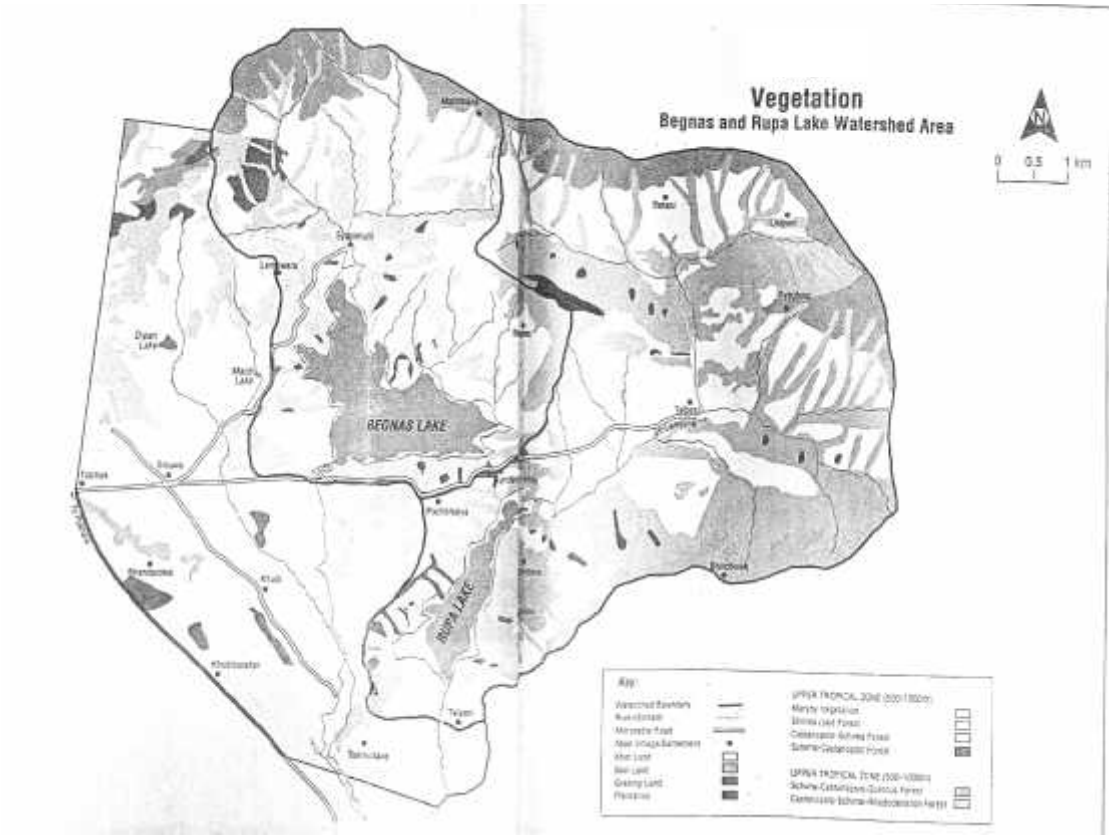
The lake received its name due to its very mysterious phenomenon of changing the color of water many times in a single day. The usual image of the lake has greatly contributed to its name 'Rup' in Nepali which means the external ’appearance’ or ’face’. Due to fairly unrevised and beautiful appearance the lake was named Rupa. The lake area is famous for migratory and residential birds which add to the natural beauty of this area. Hence due to such composition of natural component the whole lake area could be considered as real wetland. The local people around Rupa Lake are utilizing the lake resource mainly for fish culture and irrigation. Fish culture practices applied in this lake are cage and open fish culture, enclosure fish culture and open water stocking.

From time immemorial, Rupa is not under any institution and committee. The local people around Rupa Lake have established a community in December, 2041 named "Lake Rupa Conservation and Fishery Community”. The community is now registered by District Development Committee, Kaski Under local self government act, 2055 BS which has 450 stake holders. The technical, equipmental and other necessary supports are provided by Fisheries Research Center (FRC), Pokhara, Nepal Agriculture Research Council (NARC) and LI- BIRD, the local NGO. Few local stakeholders with six expert fishermen are employed by the community itself. Both of this committee is claiming for the authority of this lake.

The Area of Rupa Lake has been decreasing due to dense population of macrophytes to pelagic area. Beside this the lake water receives silt and organic debris from near by catchments area which has caused source reduction in its size and depth considerably. According to local people about 30 hectare area of the lake has been depleted and changed to land from 2030 to 2060 BS. Hence the clay, sediments, and

human encroachment are the main causes for the degradation of lake. Small and shallow lakes are fragile environments prone to rapid eutrophication than larger water bodies. Studies have shown that Rupa has achieved hyper-eutrophic condition due to heavy siltation for catchments areas and organic load from decaying aquatic weeds from the lake itself. If this condition remains constant or siltation and load of decaying organic matter's rate continues the lake will disappear within twenty year (IUCN, 1996).




Vegetation
Begnas and Rupa Lake Watershed Area
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BEGNAS LAKE
RUPA LAKE
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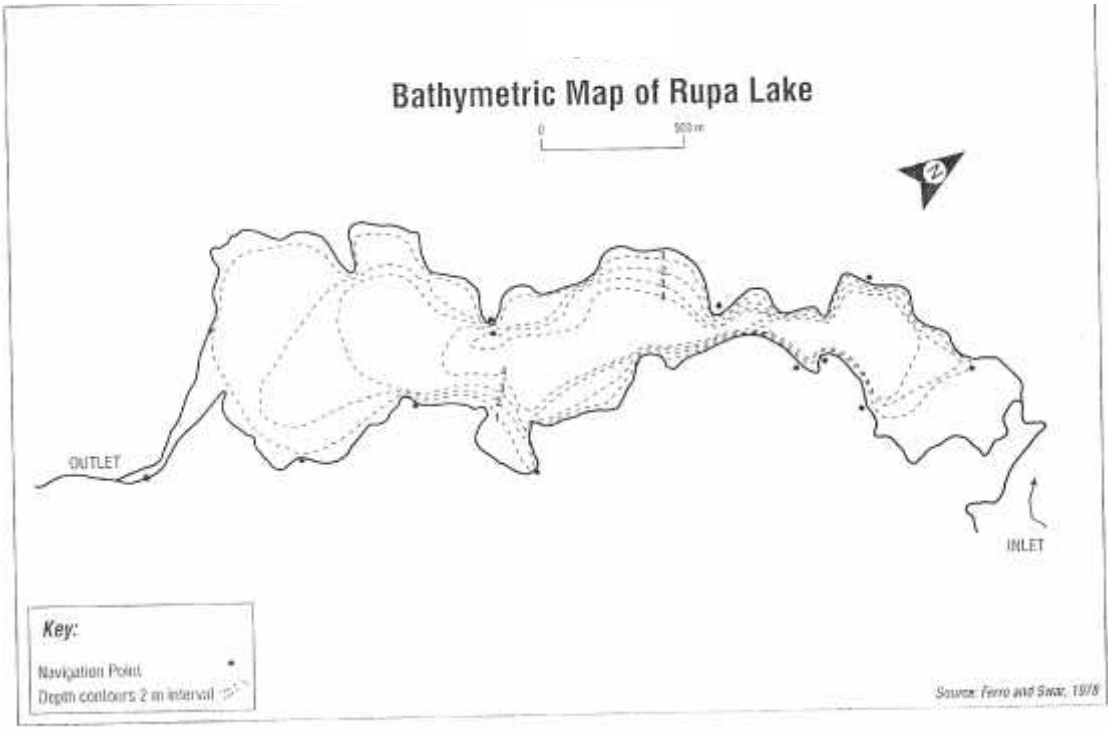
Bathymetric Map of Rupa Lake
0 500 m
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OUTLET
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Key:
Navigation Point
Depth contours 2 m interval
Source: Ferro and Swar, 1978

3.1.2 Vegetation

Natural vegetation in Begnas-Rupa Lake ranges from upper tropical in the lower elevations (500-1000m) to lower sub-tropical in the higher elevation along the crystalline ridge (1000-1500m). There are five vegetation type in the upper tropical zone, including marshy vegetation and two vegetation types in the lower subtropical zone (Oli 1996).

In concern with aquatic vegetation, it consists of emergent vegetation of reeds around the shoreline and floating macrophytes like *Nymphaea* and *Trapa* species (Appendix-I)

3.1.3 Fauna

Fish

There are ten native and seven exotic fish species estimated in the Rupa lake (Oli 1996). But thirteen species of fish in three fish families were recorded during that study. Among them most fishes belong to the family cyprinidae are *Garra gotyla, Barillius barana, Labeo angara, Labeo rohita, Chagunio chagunio, Catha catta Cirnina mrigala, Xenontedon cancila and Macroognathus aulentus, Aristichythy* nobilic. (Oli 1996).

Amphibians

Two toads and 4 frogs from Bufonidae and Ranidae families were recorded. They are *Bufo melanasticutus, Bufo endersoni, Rana swami, Rana limnochoris, Rana pipen and Rana tigrina* (Oli 1996) (Appendix-II).

Reptiles

Rupa lake watershed consists of 14 species of reptiles of five reptile families. *Mabuya Carniata, lygosoma indicum, Agna tuberculta, Calotes versicolar, Elphae hodsoni, Amphisesma phatydeps, Amphisesma stolata, Pytas Mucosus, Trichis chum tenuiceps, Psendo Xenodon macropus,* etc (Oli 1996) (Appendix-III)

Birds

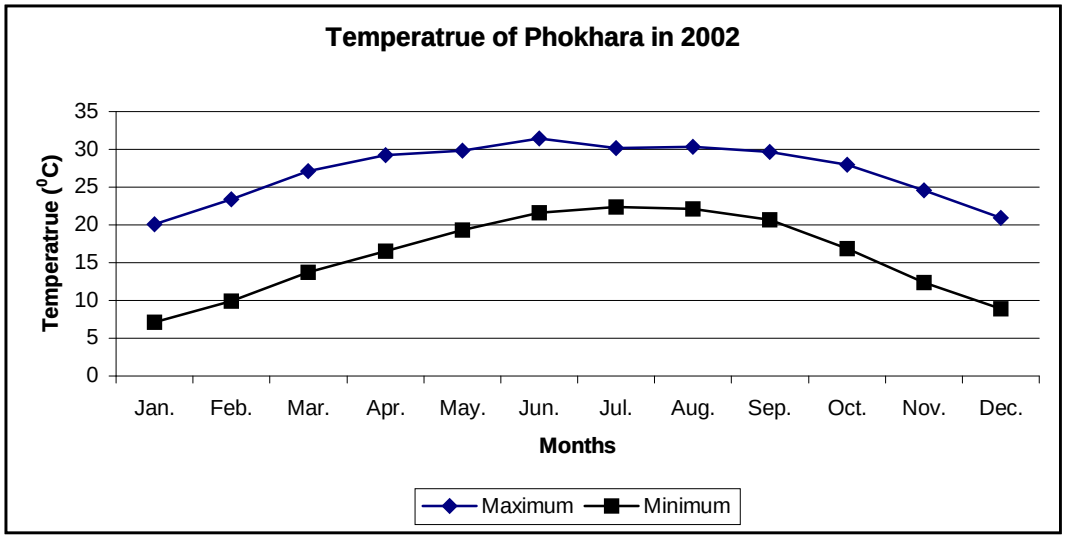
There are many birds found in this area including migratory and residential birds. Altogether there are 104 species of birds including the terrestrial and wetland birds in this area (Appendix-IV)

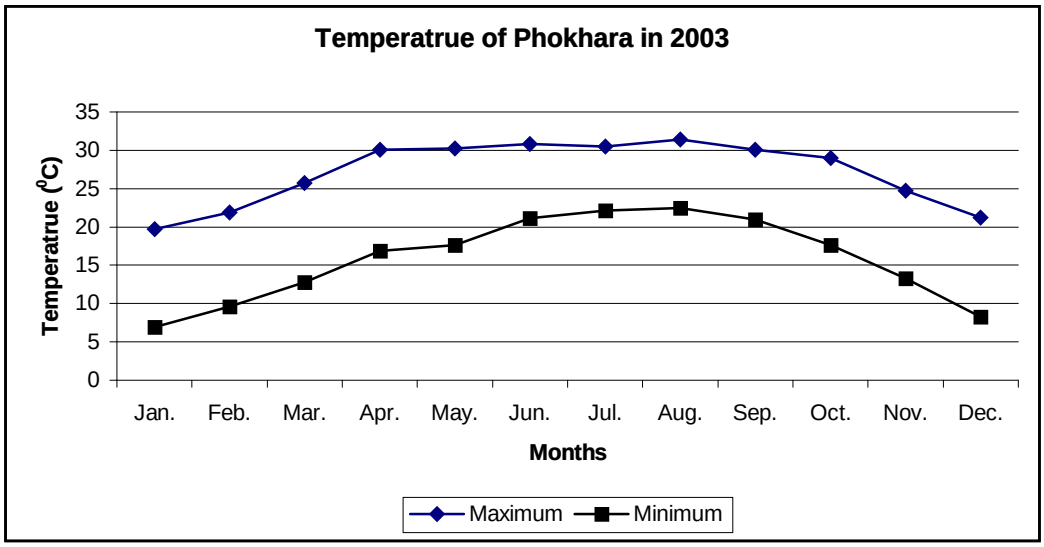
Mammals

Thirty four species of mammals of 17 families were noted which are *Macaca mulatta, Panthera pradus, Hystrix indica, Herpestes edwards, Muntiacus muntjak, Lutra lutra, Selenarctes tibetanous Manis crassicaudata, Cynoptenus spninx* are common. Besides these there are several other mammals found in the area (Appendix-V).

3.2 Climate

The climates of Rupa Lake watershed can be divided into humid upper - tropical and lower sub-tropical zones, with a monsoonal rainfall pattern. Micro climates vary with orientation, slope and location. The area is characterized by moderate temperatures between 13.2^0C and 25.5^0C. Winters are mild and summers are tolerably warm. The seasonal cycle is cool - warm to not warm. The peak mean temperature in July August in 25.5^0C and falls to 13.2^0C in January, the mean temperature is 19.3^0C. The annual rainfall is 3,710 mm. Rainfall in the area within distinct seasons differ such as during the pre-monsoon (March to May) 215 mm (6%), in the summer monsoon (June to September and peak rain fall is in July) 2,965 mm (80%), in the post monsoon (October) 886 mm and lowest in November and December is 13 mm (Appendix-IX)





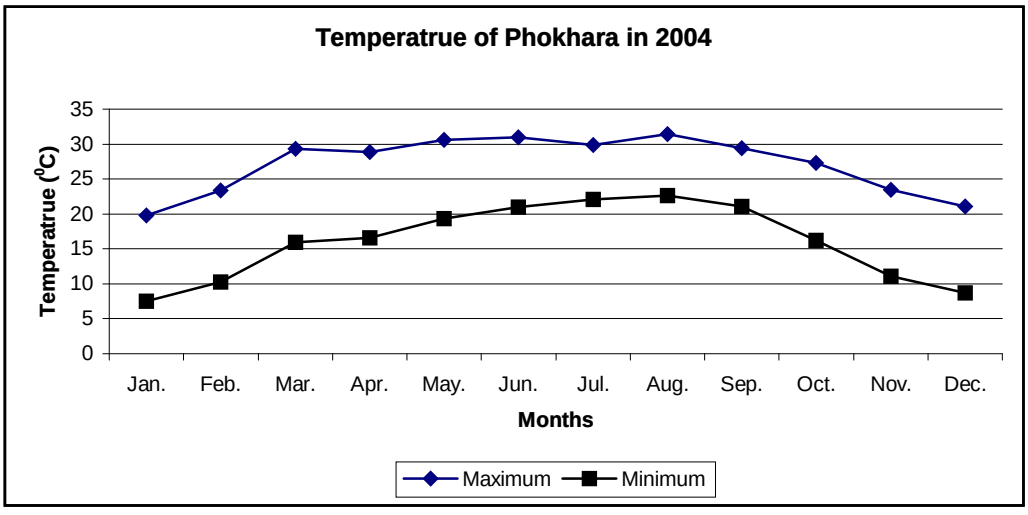
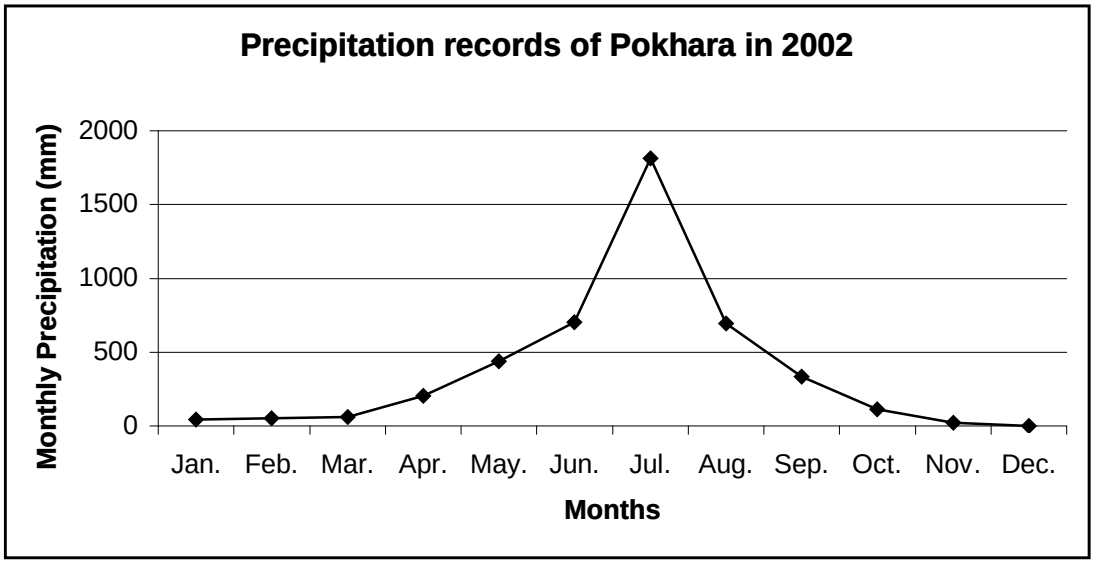
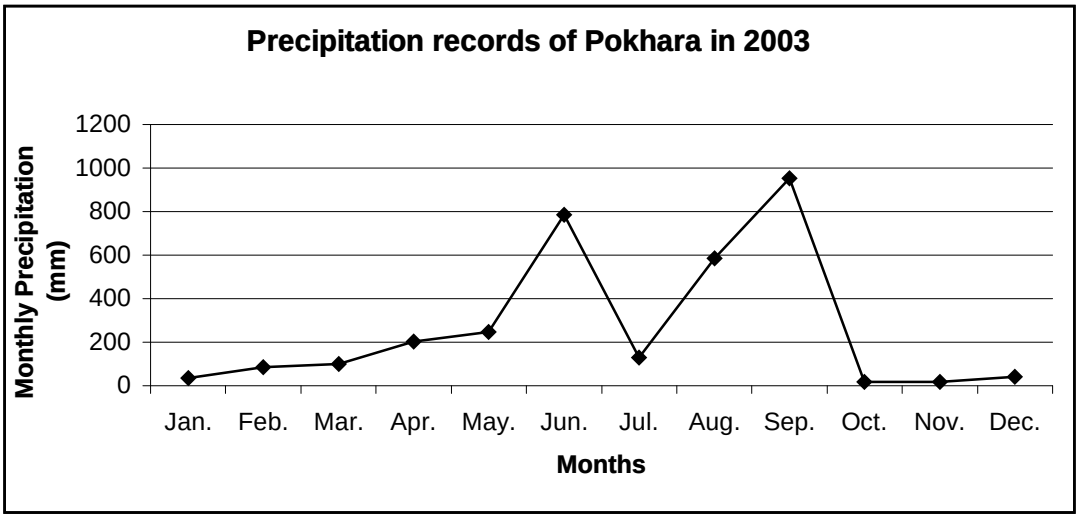


Figure: 1 Monthly Maximum and Minimum temperature (2002-2004) recorded at Pokhara.





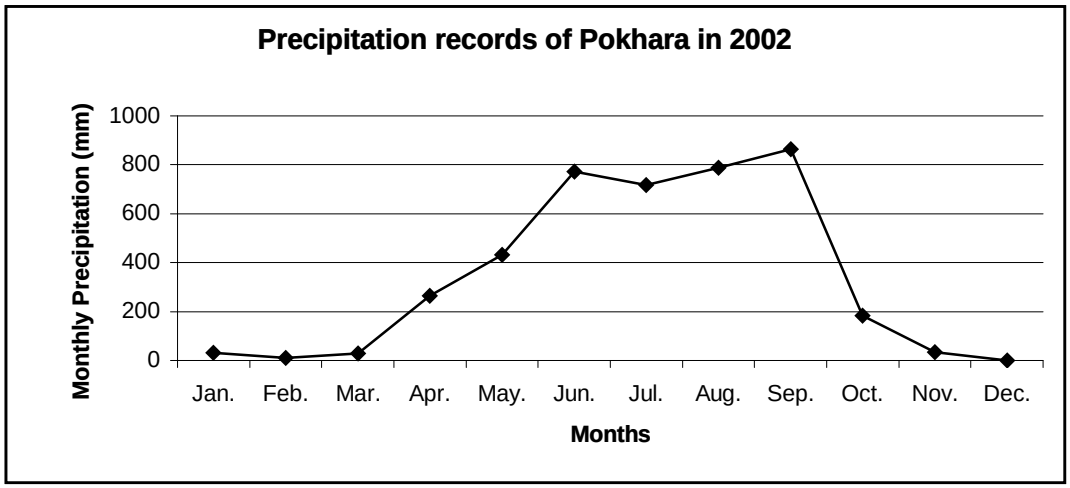


Figure 2: Monthly Precipitation Recorded at Pokhara, (2002-2004)

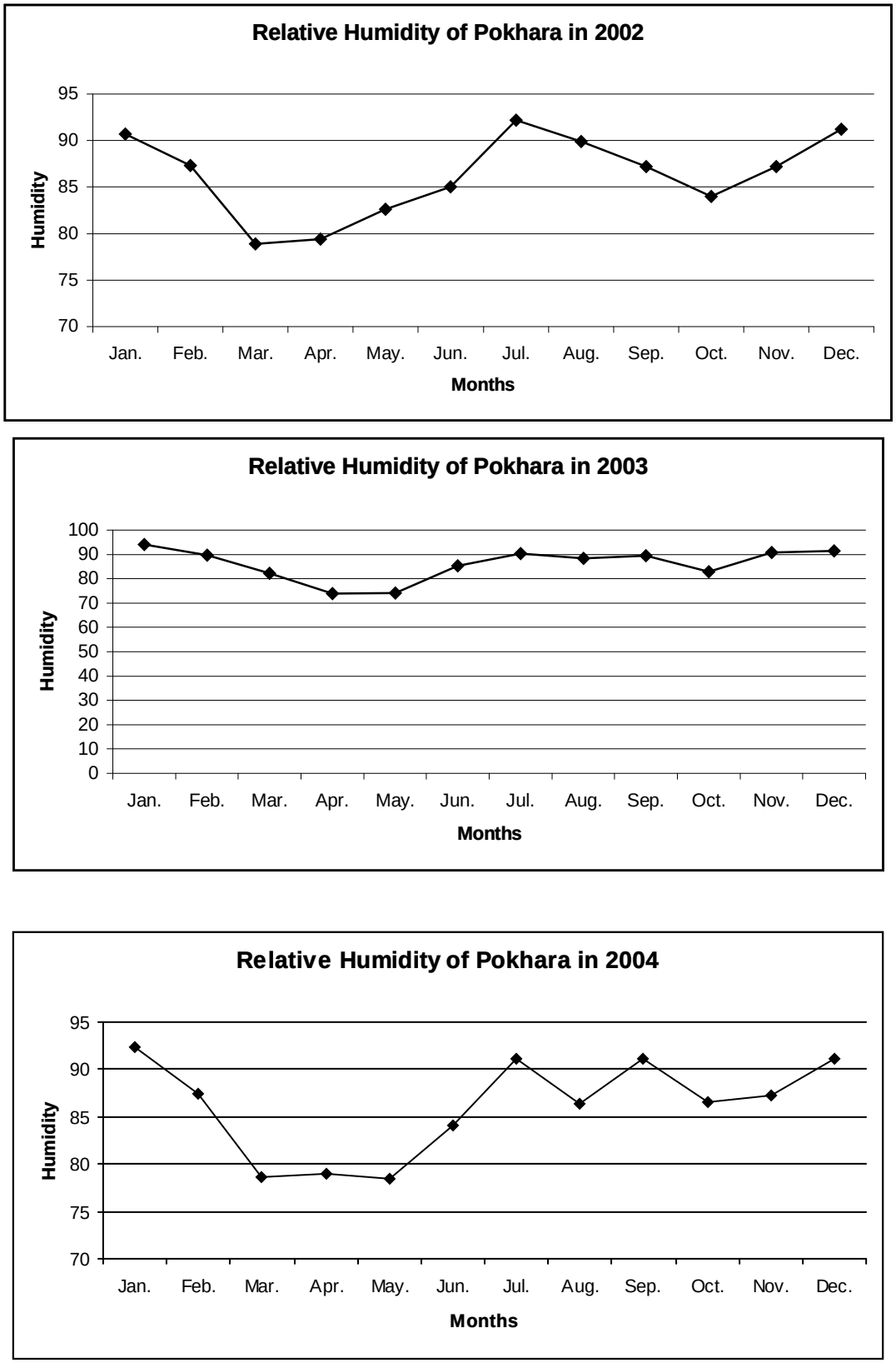


Figure 3: Monthly Relative Humidity (2002-2004)

3.3 Justification of the Study

Like Rupa is endowed with immense social, scientific, cultural values. It is rich in bio-diversity including a large number indigenous fish species and other aquatic flora and fauna. This lake area is inhabited by many residential as well as migratory birds adding more importance for the research works.

The processes of sedimentation, eutrophication, use of chemical fertilizers and human encroachment are responsible for the change in physiochemical parameters of lakes which makes adverse habitat for the living species like fish, water birds, flora and fauna. So, this study helps for better management of Lake Rupa and explores problems of changing environment. Ultimately helps to conserve bio-diversity of Rupa Lake as a whole.

3.4 Objectives

The main aim of the study is to assess status and species diversity of wet land birds of Rupa Lake. Some specifying is:

1. To explore wetland bird species diversity in Rupa Lake.
2. To identify the seasonal variation of bird species.
3. To aware the local people for conservation of birds.

3.5 Limitations

As our dissertation schedule is for less than a year, so sometime migratory and seasonal birds listing may lack. The present study is mainly based on the direct observation. So, it may not cover all the species scientifically within limited time.

4. METHODOLOGY

The method for the direct observation was supported by various instruments like Binoculars, telescope, camera, GPS, Measuring tape, field data sheet and questionnaire sheets.

4.1 Preliminary Survey

The preliminary survey of the study area was performed in the April 2005 for two times. Observation of area and interaction with the local people was major activity of these events direct observation using the vantage point and birding routes were the method used for bird counting.

4.2 Direct Count

Total five permanent vantage points were selected at different corner of the lake for direct observation.

i. Vantage Point: 1 N 28^0 8' 32" E 84^0 0' 57" Elevation = 637m
ii. Vantage Point: 2 N 28^0 8' 30" E 084^0 6' 39" Elevation = 621 m
iii. Vantage Point: 3 N 28^0 8' 36" E 084^0 6' 36" Elevation = 620 m
iv. Vantage Point: 4 N 28^0 8' 54.9" E 084^0 6' 44" Elevation = 612 m
v. Vantage Point: 5 N 28^0 8' 54" E 084^0 6' 24.9" Elevation = 619 m

4.3 Transects Use

The remaining part of the lake where vantage point could not establish alternative method i.e. two line transects (birding routes) are established. For this reason, boat was used as the means of transport from

one point to another in the birding routes (650m - 830m long) across the lake.

During the survey, the individuals' numbers, activities, habitat type, weather and time were noted on appropriate field data Sheet (Appendix-VI). To know the seasonal variation and movement of birds, the surveys were made on 4 season's viz. winter, spring, summer and autumn. Monitoring were few days in every months. It always begins at early in the morning and ends at late evening but resting at daytime. It is done so because the birds are very active in the morning and evening but take rest during the daytime. The species diversity of birds in different seasons is recorded simply by direct counting methods and are analyzed by using Shannon - Wiener function as

$$H = \frac{n \log n - \Sigma fi \log fi}{n}$$

Where

H = index of species diversity

n = Total number of individual

f = frequency of individual species

From relative density of species Jacob's coefficient 16 used as:

$$J = \frac{H}{H_{max}} \text{ (Since } H_{max} = \log k)$$

Where

J = relative density

H = Calculated species diversity

H_{max} = Proportion of maximum index possible diversity

K = Number of species present

4.4 Secondary Data Collection

i. Questionnaire

A structured Questionnaire (Appendix-X) was prepared basically focusing on the information about birds distribution, habitat utilization pattern, major threats, and public awareness about bird conservation in the study area. Questionnaires were targeted to local fisherman and bird number and other local residents.

ii. Literature Survey

The literature about the diversity and conservation threats on bird species was briefly surveyed. More information was collected from Tribhuvan University Central Library (TUCL). Library of Central Department of Zoology, Department of National Parks and Wildlife Conservation, International Union for Conservation of Nature and Natural resources (IUCN), International Center for Integrated Mountain Development (ICIMOD) and LI-BIRD (Local Initiative for Biodiversity Research and Development) were consulted for needy published and collected literatures.

4.5 Statistical Analysis

Analysis of Variance, (ANOVA) was applied to find out whether any significant variation in birds species according to season or not.

5. RESULT

Total 432 man-hours was spent in the field (i.e. 48 days and average 9 hours per day) for data collection on the birds in permanent vantage points and two birding routes. All together 30 species of wetland birds including 4 associated or partial wetland birds were recorded (Table 2).

Table 2 : Wetland Birds Recorded in Rupa Lake with Associated Birds

S.N.	English Name	Family	Scientific Name	S_1	S_2
1.	Nepal House martin	Hirundinidae	*Delichon nipalensis*	FC	R
2.	Black kite	Accipitridae	*Milvus migruns*	FC	W
3.	Black drongo	Ciconidae	*Decreums maro cerus*	C	R
4.	Bronze winged jacana	Jacanidae	*Metopidus indicus*	FC	R
5.	Cattle egret	Ardeidae	*Bubulcus ibis*	C	R
6.	Citrine wagtail	Passeridae	*Motacilla citreola*	FC	W
7.	Common coot	Rallidae	*Fulica atra*	FC	R
8.	Common kingfisher	Alcedinidae	*Alcedo atthis*	C	R
9.	Common moorhen	Rallidae	*Gallinula chloropus*	FC	W
10.	Common myna	Sturnidae	*Acridotheres tristis*	C	R
11.	Common pochard	Anatidae	*Aythya ferina*	C	W
12.	Ferruginous pochard	Anatidae	*Aythya nyroca*	R	W
13.	Gadwall	Anatidae	*Anas strepera*	FC	W
14.	Great cormorant	Phalacrocoracidae	*Phalacrocorax carbo*	C	W
15.	Indian pond heron	Ardeiae	*Ardeola grayii*	C	R
16.	Intermediate egret	Ardeidae	*Mesophoyx intermedia*	O	R
17.	Little egret	Ardeidae	*Eqretta yarzetta*	C	R
18.	Little grebe	Podicipedidae	*Tachybaptus ruficollis*	C	R
19.	Mallard	Anatidae	*Anas platyrhynchos*	FC	W
20.	Pheasant tailed jacana	Jacanidae	*Hydrophasianus chirurgus*	FC	S
21.	Pied kingfisher	Cerylidae	*Ceryle rudis*	FC	R
22.	Purple swamp hen	Rallidae	*Porphyrio porphyria*	O	W
23.	Red walted lapwing	Cararadriidae	*Venellus indicus*	C	R
24.	Rosy Pippet	Passeridae	*Anthus roseatus*	C	W

25.	Sand martin	Hirundinidae	*Rparia riparia*	O	V
26.	Timmincks Stint	Scolopacideae	*Calidris temminckii*	UNC	W
27.	White breasted water hen	Rallidae	*Amauronis phoenicurus*	C	W
28.	White browed wagtail	Passeridae	*Motacilla maderasspatensis*	FC	R
29.	White throated kingfisher	Dacelonidae	*Hakyon smymensis*	C	R
30.	Wooly necked stork	Ciconidace	*Ciconia episcopus*	FC	W

Status 1: C = Common; FC = Fairly common; O = Occasional; RA = Rare; UNC = Uncommon

Status 2: R = Residential; S = Summer visitor; W = Winter visitor; V = Vagrant

The birds found in Rupa wetland belong to 5 orders and 16 families. The highest number of species belonged to the order ciconiformes with seven family into 12 species of birds. The passeriformes contains 4 families with 7 species and Coracifomes contains 3 families with 3 bird species only. Anseriformes and Gruiformes (Appendix-VII) both contain only one family with 4 bird species each (Fig 4).

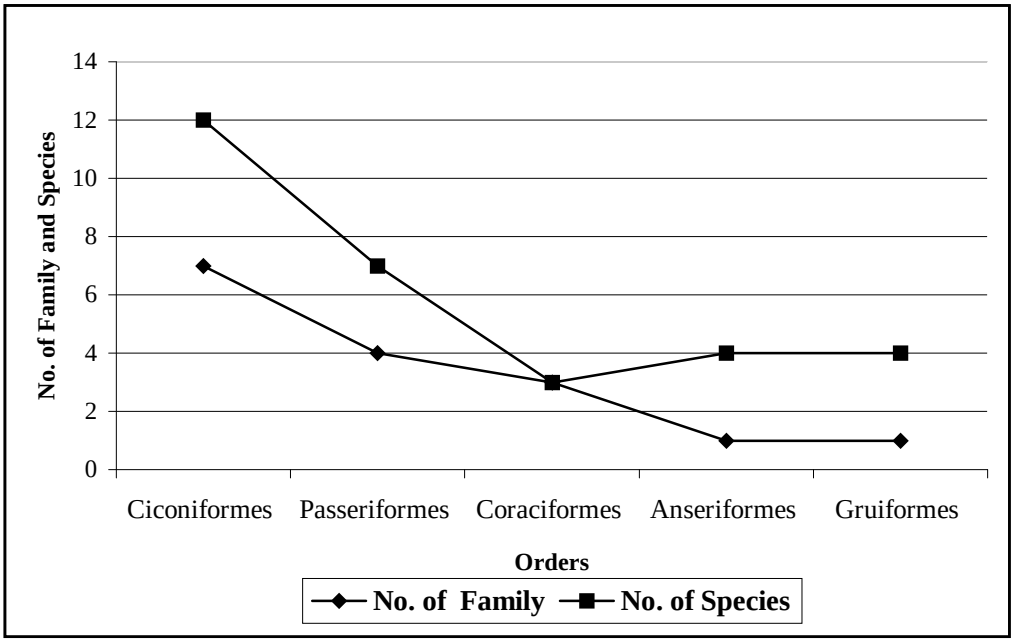


Figure 4 : Five Major orders and number of species distribution in Rupa lake, 2006.

5.1 Seasonal Variation of Birds

The bird data were collected in four different seasons (summer, autumn, winter and spring), to find out the seasonal variation in the birds species availability in the study area. There were more species in winter season (325 bird individuals) than other seasons. There was recorded of 123 bird individuals in summer, 115 bird individuals in autumn and 96 bird individuals in spring. The frequency of the bird species in the winter season was more due to the assemblage of winter migratory birds in study area (Fig 5).

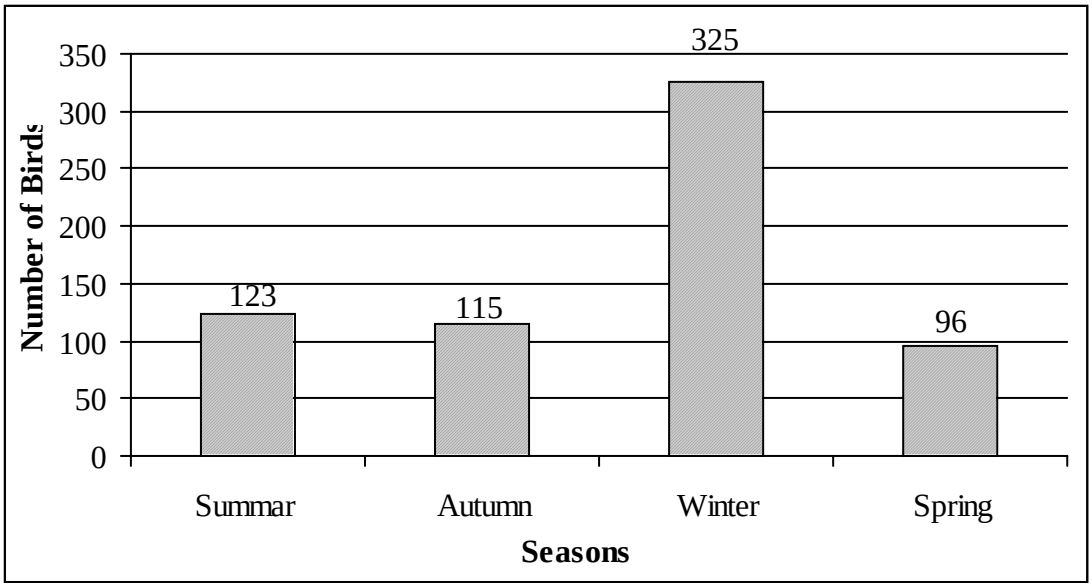


Figure 5. Number of Birds Individual recorded in Different seasons.

Birds were recorded in highest number in winter and least in spring. For the seasonal variation, F-Test (ANOVA) was used as statistical tool where hypothesis is set as.

Ho : There is significant variation in bird diversity with variation in season.

H1 : There is no significant variation in bird diversity with variation in Season.

Summer season also contains less number of birds species i.e. 14 but the number of birds individuals were high i.e. 123 individuals of birds (Figure 6)

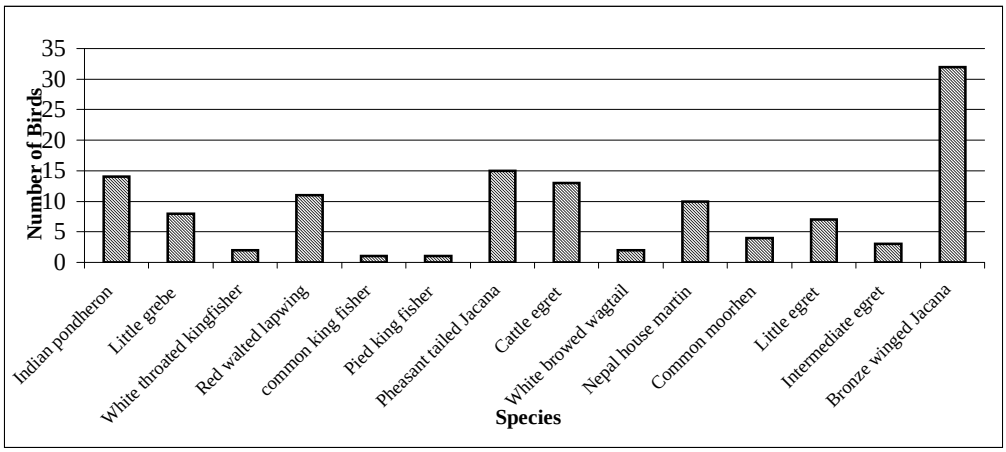


Figure 6. Bird species found in summer season in Rupa Lake, 2006.

The total number of birds individual recorded in Autumn season were 115 of 16 species of birds where birds species were high but bird individuals were less (Figure 7).

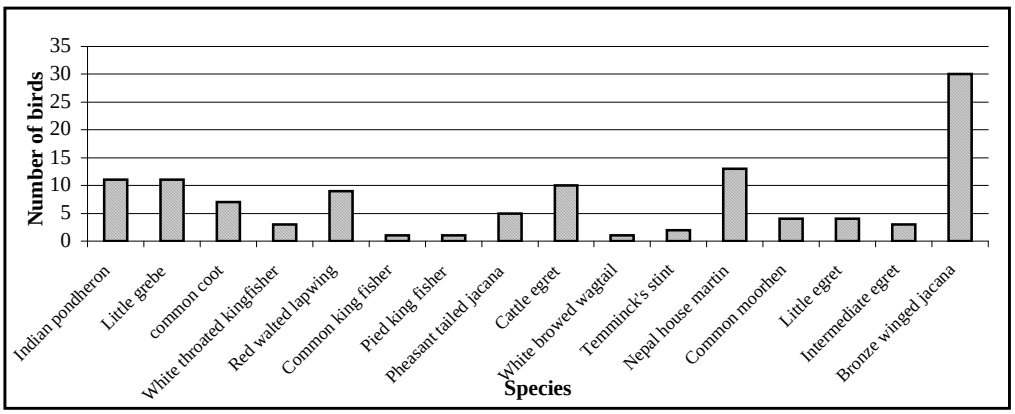


Figure 7: Bird species found in autumn season in Rupa Lake, 2006.

Altogether 25 species of birds and total 325 bird individuals were recorded in winter season which is highest in number of species and individuals both (Figure 8).

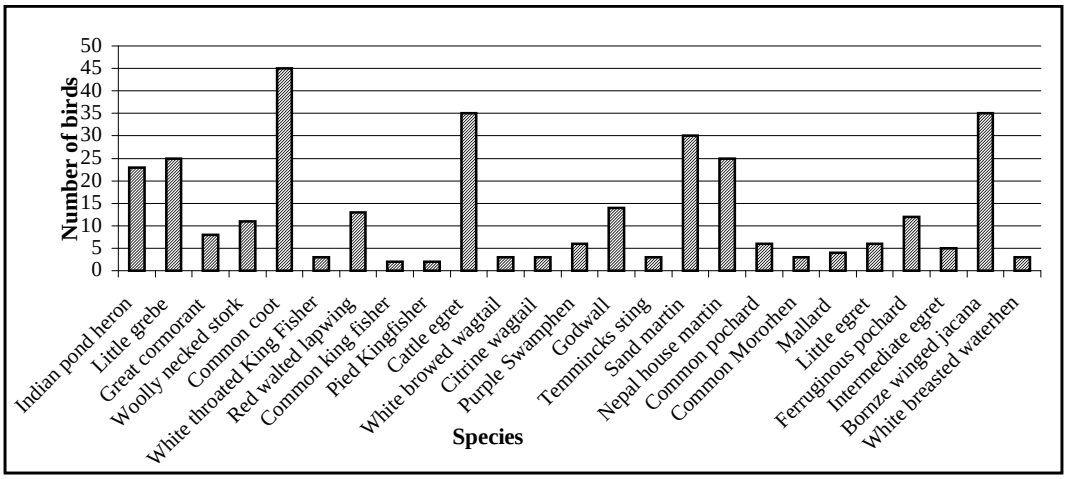


Figure 8: Bird species found in winter season in Rupa Lake, 2006.

Only 14, species of birds and total 96 individuals recorded which is the least number of species and individuals among four seasons (Figure 9) .

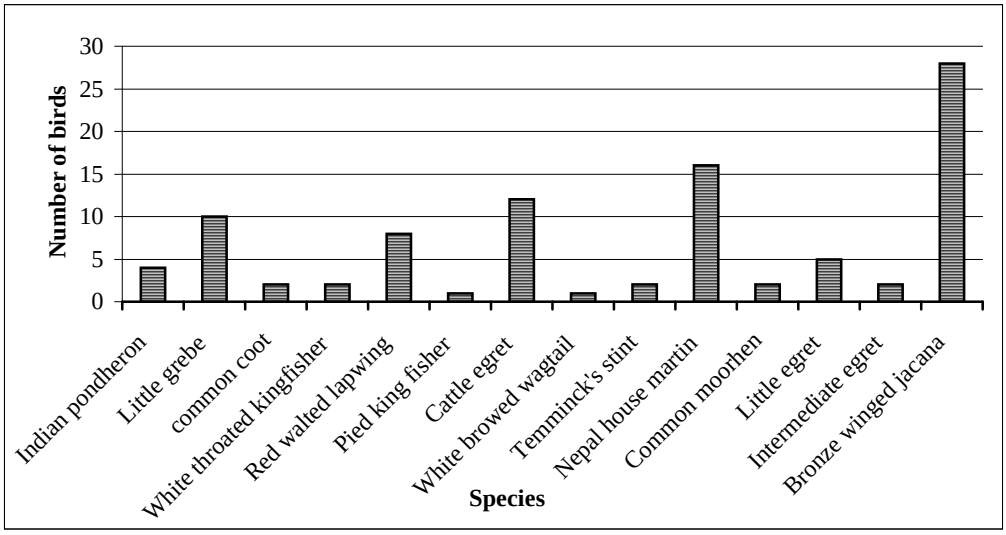


Figure 9: Bird species found in spring season in Rupa Lake, 2006

Table 3: List of bird species recorded except associated birds in Rupa Lake, 2006.

S.N.	Common Name	Summer	Autumn	Winter	Spring
1.	Nepal house martin	10	13	25	16
2.	Bronze winged jacana	32	30	35	28
3.	Cattle egret	13	10	35	12
4.	Citrine wagtail	-	-	3	-
5.	Common coot	-	7	45	2
6.	Common king fisher	1	1	2	-
7.	Common moorhen	4	4	3	2
8.	Common pochard		-	6	-
9.	Ferruginous pochard		-	12	-
10.	Godwall	-	-	14	-
11.	Great cormorant	-	-	8	-
12.	Indian pond heron	14	11	23	4
13.	Intermediate egret	3	3	5	2
14.	Little egret	7	4	6	5
15.	Little grebe	8	11	25	10
16.	Mallard		-	4	-
17.	Pheasant tailed Jacana	15	5	-	-
18.	Pied king fisher	1	1	2	1
19.	Purple swamp hen	-	-	6	-
20.	Red walted lapwing	11	9	13	8
21.	Sand martin	-	-	30	-
22.	Temmincks stint	-	2	3	2
23.	White breasted water hen	-	-	3	-
24.	White browed wagtail	2	1	3	1
25.	White throated kingfisher	2	3	3	2
26.	Wooly neck stork	-	-	11	-
	Total	123	115	325	96

Calculation; Grand Total (T) = 659
Correction factor (C.F) = 6294.
Total sum of square (TSS) = 6782
Sum of square between Samples (SSC) = 496
Sum of square within samples (SSW) = 6286

Table 4: Summary of ANOVA

Source of Variation	**d. f.**	**Sum of sq.**	**F-ratio**
Sum of S. Between Samples	4-1=3	$\frac{496}{3}$ =165.33	$\frac{165.33}{96.70}$ = 1.7(
Within Samples	65	$\frac{6286}{65}$ = 96.70	
TSS	(69-1) = 68		

The tabulated value of F in 3 and 65 d.f. in 0.05 level of significant is F (tab) = 3.07. Which is greater than that of calculated value F (cal) = 1.70.

Hence Ho is accepted so there is significance difference in bird diversity with seasonal variation in the study area.

5.3 Category of the Birds at Rupa Lake

Seasonal studies of birds help to identify the actual status of birds in any habitat. It helps to identify whether the birds are residential, summer visitor, winter visitor or vagrant. The result of the study within 4 seasons showed that 15 species (53%) were residential species, 1 species (3.33%) were summer migratory (pheasant tailed jacana), and 12 species (40%) winter visitor and 1 species (3.33) i.e. sand martin is vagrant (Fig 10).

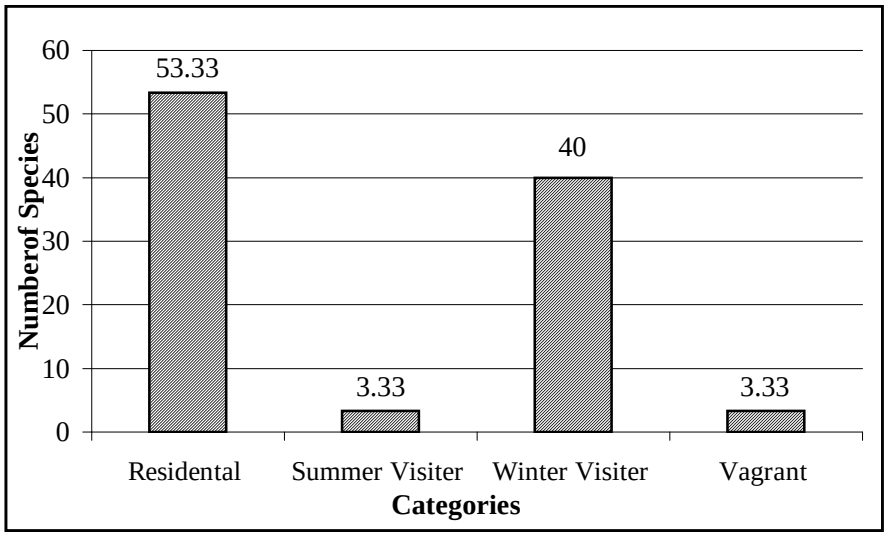


Figure 10: Bird categories according to their status in the study area.

5.2 Status of birds Species in Rupa Lake

This value is calculated by dividing the number of individuals of each species observed by number of hours in searching (Bibbly *et al* 2000) the field data showed that 13 species (43.33%) were common, 12 (40%) were fairly common, 3 species (10 %) were occasional, 1 species Rare (3.33) and 1 species uncommon (3.33%).

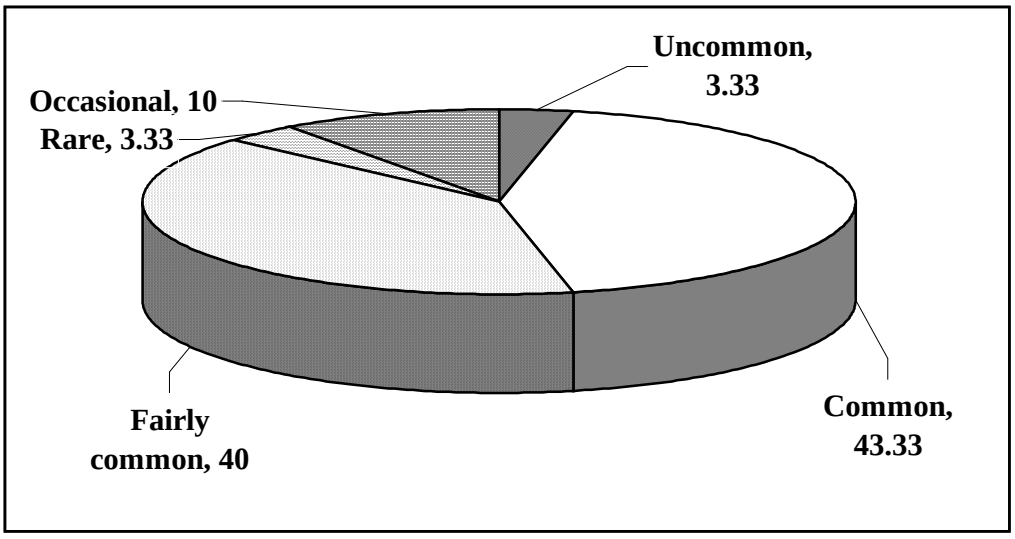


Figure 11: Local status of Birds in Rupa Lake in Percentage, 2006.

5.4 Species Diversity of Wetland Bird Rupa Lake

Species diversity (richness) during the study period was highest in winter season (1.09), followed by autumn (1.03), Summer (0.98) and spring (0.95). Similarly, the Jacob's coefficient (relative density) was highest in autumn (0.858), followed by summer (0.855) and spring (0.82), winter (0.78). The species diversity was high in winter season and low in spring. The Jacob's coefficient was high in autumn season and least in winter season (Appendix-VIII).

5.5 Description of Some bird Species of Rupa Lake Area

Description of the bird based on Guide to Birds of Nepal (Inskipp and Baral 2003) and Birds of Kanchenjungha Conservation Area (Thapa and Chaudhary 2005).

i. Common Pochard (*Aythya ferina*)

Order - Anseriformes

Family - Anatidae

Size - 42-49 cm

Identifying Characters

Passage migrant up to 4570m. Large with domed head pale grey flight features and prey forewings. Male has chestnut head, black breast and grey upper parts and flanks. Distributed in Lakes and large rivers.

ii. Fernginous Pochard (*Aythya nyroca)*

Order - Anseriformes

Family - Anatidae

Size - 38-42 cm

Local name - Malak hans

Identifying Characters

Passage migrant up to 4575m. Smallest among the sub-species, domed head, breast, lateral sides and head is brown. Females are some what lighter then male, while flying white abdomen is seen found in wetland.

iii. Mallard (*Anas Platyrhynechos*)

Order - Anseriformes

Family - Anatidae

Size - 50-65 cm

Local name: Hariotauke hans

Identifying Characters

Below 3050m to 2620m it broods, generally winter migratory and passage migrant head is lustrous greed with yellow billed in male. Tail tips are black. Abdomen is brown with orange color. Found in wetland.

iv. Gadwall (*Anas Strepera*)

Order - Anseriformes

Family - Anatidae

Sizes - 39-43cam

Local name - Khadkhade hans

Identifying Characters

Passage migrant up to 4750m. All the internal part features of sub-wing are white. Generally male are some what light colored and bill is dark black. Females one nearly comparable with female of mallard but the billed is yellow in the edges clear white abdomen. Found in wetland.

v. Common Kingfisher (*Alcedo atthis)*

Order - Coraciformes

Family - Alcedinidae

Size - 16 cm

Local name - Sano matikore

Identifying Characters

Below 1000m it is abundant and above 1800m it is rare and residential. Greenish - blue and head, scapula and wings are tortoise line down back. Fresh waters in open country.

vi. White throated King Fisher (*Halycon smyrnensis*)

Order - Coraciformes

Family - Alcedinidae

Size - 28cm

Local name; Seto Kanthe matikore

Identifying Characters

Residential, rarely above 1800m white in throated and centre of breast, brown headed and most of under parts. Found in Cultivation, forest edges, gardens and wetland.

vii. Pied King Fisher (*Ceryle rudis*)

Order - Coraciformes

Family - Cerylidae

Size - 31cm

Local name: Chhirbire matikore

Identifying Characters

Below 915m it is abundant, widely distributed, Residential. White supper cilium, white patches on wings and black bands across breast. Female has single breast band (double in male). Found in slow moving rivers, streams, lakes and polls in open country.

viii. Great cormorant (*Phalacrocorax carbo*)

Order - Coraciformes

Family - Phalocrocoracidae

Size - 80 - 100 cm

Local name: Jalewa

Identifying Characters

Winter visitors, Large with thick neck and stout billed. Adult breeding glossy black, with orange facial skin, white cheeks and throat, white head plumes and white thigh patch. Lakes and large rivers.

ix. White Browed Wagtail (*Motacilla maderasspatensis*)

Order - Passeriformes

Family - Passeridae

Size - 21cm

Local name: Khole Ticticke

Identifying Characters

Residential, wide spread nearly above 1700m. In high altitudes acts as summer migratory. The throat is black while the lower abdomen part is white. The brows are white as it is named as white browed wagtail. Head, back and breast grayish and white, found in the rivers, ponds, lakes.

x. Citrine Wagtail (*Motacilla citeola*)

Order - Passeriformes

Family - Passeridae

Size - 21cm

Local name: Besere ticticke

Identifying Characters

Passage migrant up to 5200m. Broad white wing - bars in all plumages. Breeding male has yellow head and upper parts, and black or grey mantle. Female breeding and adult non-breeding have broad yellow supercillium continuing around ear-coverts, grey upper parts, and mainly-yellow under parts. Marshes and Wet field.

xi. Cattle egret (Bubulusibis)

Order - Ciconiformes

Family - ardeidae

Size - 48-53 cm

Local name: Bastu bakulla

Identifying Characters

Residential below 1525m. Small stocky egret with short yellow bill and short legs. It has orange buff on head, neck and mantle in breeding plumage. wetlands and grassland, often associate with livestock.

xii. Little egret (*Eqretta garzdetta*)

Order - Ciconiformes

Family - Ardeidea

Size - 55-65 cm

Local name: Sano Seto bakulla

Identifying Characters

Abundant, widely spread, residential bird below 1525m. It has black bill, black legs and claws yellow. Curing breeding season puffy features present in neck breast and tail. Found in wet land.

xiii. Intermediate egret (*Mesophoyx intermedia*)

Order - Ciconiformes

Family - Ardeidae

Size - 65-72 cm

Local name: Majhaula seto bakulla

Identifying Characters

Residental, widely spread below 1370m. It is same as that of Great egret but smaller in size, feathery tail, during breeding period bill is black and out of breeding period bill is yellow. Found in wetland.

xiv. Woolly neeked stork (*Ciconia episcopus*)

Order - Ciconiformes

Family - Ciconiidae

Size - 75-92 cm

Local name: Lovi-papi Gadur

Identifying Characters

Summer visitor, occasionally up to 1800m. Stocky, largely brackish Stock with "Woolly white neck, black "Skullcap' and White vent and under tail Coverts. Found in flooded fields, marshes and lakes.

xv. Little grebe (*Tachybaptus ruficollis*)

Order - Ciconiformes

Family - Podicipedidae

Size - 25-29 cm

Local name: Dubulki chara

Identifying Characters

Below 3050 widely distributed Residential, some time it may also be winter migratory or passage migrant. The back part is some what broad. During the breeding period the cheek and neck side is grey and bottom of bill is yellow and out of breading period the abdominal sides and cheeks are browns dirt light color appears. Found in lakes, ponds etc.

xvi. Pheasant tailed Jacana (*Hydrophasianus* chirurgus)

Order - Ciconiformes

Family - Jacanidae

Size - 31 cm

Local name: Jalapsara

Identifying Characters

Passage migrant up to1512m but summer migratory in 3050 m. Mostly common in Koshi and western Tarai. The upper and lower part of wing is white, yellow patches on the nearside. During the breeding period the upper and lower part of wing will be brown and tail will be long and black stripe on neck and abdomen and out of breading period tail will be short, black strip of abdomen disappears. Wetland, hovers in floating vegetation, ponds, and lakes.

xvii. Bonze winged Jacana (*Metopidius indindicus*)

Order - Ciconiformes

Family - Jacanidae

Size - 28-31cm

Local name: Lama aunle

Identifying Characters

They are widely distributed, Residential. upper and lower wings are dark. Adult have white brow, upper part lustrous green and lower part black. Cheeks have orange patches in breast, white brown and yellow bill.

xviii. Red walted lapwing (*Vanellus indicus*)

Order - Ciconiformes

Family - Charodriidae

Size - 32-35cm

Local name: Huttityaun

Identifying Characters

Residential widely distributed below 1340m head breast black, black toped red bill, yellow legs. Sound like hittitau huttityaun.Its habitat is Open space near water.

xix. Teminck's Stint (*Culidris temminckii*)

Order - Ciconiformes

Family - Charadrildae

Size - 13-15cm

Local name: Jalranga

Identifying Characters

Passage migrant is 4710m and winter migratory below 1370m.During flight the side of the tail is white sound is like a cat with thrilling voice legs are yellow, back side is similar to all stints and seems to be 'v' shape. Its habitat usually in the wetland, near paddy field wetland.

xx. White breasted water hen (*Amauronis phoeniourus*)

Order - Gruiformes

Family - Rullidae

Size - 32 cm

Local name: Simkukhura

Identifying Characters

Residential below 3800m. Male's upper part some what light, white face, frontal week and breast lower part of the tail is brownish grey. In checks light colored, frontal neck and breast lower part of tail is greenish grey. Found in hear by bushes of lakes, point dither etc.

xxi. Purple swamp hen (*Porphyrio porphyrio*)

Order - Gruiformes

Family - Rulidae

Size - 45-50 cm

Local name: Kurma

Identifying Characters

It is winter migratory and passage migrant Body is purple blue the lower part of the tail is white. Big red billed. Chicks has dull with light red bill. It is found in Bush near wetland.

xxii Common moorhen (*Gallinual Chloropis*)

Breeds below 1370 m. mainly winter migratory or passage migrant. The lower part of the tail is white and white bands on the lateral side of abdomen. Adult are, yellow tipped red billed, and small red horn like sheet chicks are light green bill with gray color. It's habitat is Bushes near ponds lakes, pools.

xxiii. Common coot (*Fulica atra*)

Order - Gruiformes

Family - Rallidae

Size - 36-38cm

Local name: Marul

Identifying Characters

Winter migratory or passage migrant. The bird is black with whiter bill and white horn like sheet and found in the lakes, pool or ponds having fraises in the bank.

5.6 Conservation Threats

a. Habitat Distortion

The people near by lake have cleared the bushes and vegetation. local people has developed the bird habitat into paddy field which lost the bush hiding, bush nesting birds like purple swamp hen, moorhen, white breasted water hen etc. Due to lack of suitable habitat, they are unable to lay eggs safely and breeding is scare.

People harvest the aquatic plants for vegetable and medicinal purposes that also cause habitat loss. Birds are impacted due to this disturbance too.

b. Over fishing

The over fishing in the lake has caused decline in the fishes volume that directly effects the bird which relay on the fishing ducks, storks, king fishers etc. They are declining due to food shortage.

c. Hunting

Hunting of birds for food, trade and medicinal purposes are still prevailing in the lake area. It declines specially the population of game birds. Adult bird at the time of breeding if killed causes geometrical decline in population. So, hunting too is an important factor for bird declination.

d. Poisoning

Poisoning for fishing purpose indirectly effects (decline) the fishing bird population. It also impacts the diversity of bird by killing randomly to fishing bird. They are compelled to move away from that place as lacking of food. Some hard poisoning may be catastrophic to bird population by eating poisoned prey (fishes).

Similarly, the water drainage, silt and diversion practices of inlet water source for agriculture purpose also affects the wetland birds by the shrinkage of water level.

Plates

Group of Wolly necked stork (*Ciconia episcopus*)

Pied kingfisher (*Ceryle rudis*)

Gadwall (*Anas strepera*)

White browed wagtail (*Motacilla maderaspatensis*)

Great Cormorent (*Phalacrocorax carbo*)

Mallard (*Anas platyrhynchos*)

Purple swamp hen (*Porphyrio porphyrio*)

Bronze winged jacana (*Metopidius indicus*)

Intermediate egret (*Mesophoyx intermedia*)

Black Kite (*Milvus migrans*)

Common kingfisher (*Alcedo atthis*)

Common pochard (*Aythya ferina*)

Citrine wagtail (*Motacilla citreola*)

Indian pond heron (*Ardeola grayii*)

White breasted water hen (*Amauronis phoenicurcus*)

Nepal House Martin (*Delichon nipalensis*)

Group of Gadwall, Pochard and Common coot)

Rosy pippet (*Anthus roseatus*)

White throated Kingfisher (*Halcyon smyrnesis*)

Ferruginous pochard (*Aythya nyroca*)

Little grebe (*Tachybaptus ruficollis*)

Great cormorant (*Phalacrocorax carbo*)

Cattle egret (*Bubulcus ibis*)

Common coot (*Fulica atra*)

6. DISCUSSION

Among major lakes of Pokhara, Rupa is one of the important habitats of bird that is less explore for research. It is situated at 28^0 8' N latitude and 84^0 6' longitudes. Its elevation is 600m - 637m with an area of 115 ha. This research in Rupa Lake meant for its diversity of wetland avifauna where 30 species of wetland birds of 16 families were recorded, including 4 associated birds. Among them 16 species were residential, 12 species were winter migratory, 1 species was summer migratory and 1 species vagrant. The diversity was highest in winter (H=1.09) and lowest in spring (H=0.95) and there is seasonal variation in diversity of birds.

Suwal (1992) recorded a total of 850 bird species in Nepal of which 190 species were wetland dependent birds (i.e. 22%). Bhandari (1996) recorded a total of 187 species of birds dependent on Tarai wetlands of Nepal. Most of these were migratory (98) some resident (59) and some are vagrants. 180 species of water birds are reported from Koshi Tappu, barrage alone. In comparison, in my study the residential birds are higher in number than migratory. The bird migration variation with season is due to duration of sunlight, climatic changes, availability of food.

Shah (2000) studied the bird diversity in an around the Taudaha lake of Kathmandu and recorded 55 species of bird belonging to 23 families of which 23 species were water birds and 32 species were land birds. Among them winter migratory, summer migratory and residential were 22, 11 and 22 respectively. In my observation only wetland birds were observed. The status of migration does not resemble with the migration of Taudaha.

Basnet (2001) studied the status and diversity of avian fauna in Siwalik of Morang and recorded 114 bird species belonging to 13 order and 40 families. Among the total recorded bird species 86 (75.4%) were resident, 22 (19.3%) winter visitors, 3 (2.63) summer visitors, 2 (1.75%) local migratory and 1 species uncertain in status. This observation and migratory status is similar to my observation although it is of terrestrial birds.

Sharma (2004) has recorded 160 bird species in Barandabhar corridor forest (BCF) of Chitwan. Among them 12 were nationally threatened but in my field survey only one ferruginous pochard was listed as vulnerable species in status. The difference and dissimilarities in number of such status is due to habitat difference of study area.

Adhikari on behalf of KMTNC (2005) studied and surveyed in Barandabar corridor Forest (BCF) area. He recorded 370 bird species under 54 families of 15 orders. The winter migratory birds such as mallard (*Anas strpera*), Godwall, (*Anas strepera*), ferruginous pochard (*Aythya nyroca*), common coot (*Fulica atra*), woolly necked stork (*Ciconia ciconia*), etc., are common species in BCF wetlands and Rupa lake, resembles the similar habitat and climatic condition of both area. Since, the elevation of Rupa (600-637m) is also similar to that of Tarai; its ecological condition also shows similar affinity in vegetation. But summer migratory birds are less as Rupa provide limited habitat but Terai with large exclusive area and riverine flood plain of Narayani. The preference of the winter migratory birds than summer in Rupa Lake is due to its elevation characteristics.

Oli (1995) studied environmental study of Begnas and Rupa Lake. He recorded various species of birds (annex IV) where many birds that

are found in Rupa Lake were missed and the birds like common teal (*Anas crecca*), northern pintail (*Anas acuta*), cotton teal (*Natapus coromandelianus*), etc., were not recorded. In my research period, many bird species would not recorded due to research period limitation. The winter migratory bird only transformed every mid winter of the year to favorable climatic condition.

Due to habitat fragmentation, human encroachment, water poisoning over fishing the aquatic bird diversity is declining. News published in Kantipur daily (2062) on the headline" Dozen species of birds nearly extinct" inform the declining of important avifauna. During this study also, northern pintail (*Anas acuta*), Northern solver (*Anas clypeata*), Oriental darter (*Anhinga Melanogaster*), open-billed stork (*Anastromus oscitans*), lesser adjutant stork (*Leptoptilos javanicus*), Black Stork (*Ciconia nigrea*), blythis kingfisher (*Alcedo herculus*), Purple heron (*Adrea purpurea*), Great egret (*Casmerodins albus*) and Tufted duck (*Aythya Fuligua*) are scarcely noted.

Similarly, Annapurna Post (2062) wrote "Encroachment of Rupa lake still continuous". According to its report Rupa Lake is situated in Lekhnath Municipality at 11, 10 and 14 wards joining with Rupakot VDC which was 135 hectors according to local people but now it is limited up to 100 hectors. The human encroachment in Rupa Lake had affected biodiversity of animals as well as bird diversity. The over fishing, harvesting of aquatic plants, hunting caused directly decline of bird diversity number and species.

Chalise M.K. (1998) at Ghodaghodi Tal where 79 species of birds recorded, most of them are wetland birds and only winter migratory and residential birds were recorded since it was observed only in winter

season where common moorhen (*Gallinula chhoropus*) purple swamp hen (*Porphyrio porphyrio*) was recorded in highest number. The winter migratory brids like Godwall (*Anas strepera*), common coot (*Fulica atra*), commonteal (*Dendrolygna javania*) common pochard (*Aythya nyroca)* etc. were recorded and resident, similarly to Rupa Lake were recorded. The result were similar that of my observation.

7. CONCLUSION

Altogether 30 wetland birds including four associated birds are recorded in Rupa lake area during the study period. Among them the most abundant birds are Bronze jacana and little grebe. The diversity was highest in winter (H =1.09) followed by autumn (H = 1.03) summer (H = 0.98) and spring (H = 0.95). The numbers of bird individual were high in winter due to high number of winter migratory birds. The summer migratory birds were pheasant tailed jacana only. Habitat distraction, human encroachment, of wetland, water poisoning. Over fishing human by fisherman are the main cause of habitat loss and major threats prevalent in the study area for bird survival. Although the study area was found to be reach in bird diversity however, lack of proper conservation and management plan and practices, the bird diversity is threatened and number is declining. With conservation of wetland bird fauna a proper land use plan is required for prolong survival of existing bird species and to attract the winter and summer bird migration.

8. RECOMMENDATIONS

To improve to conserve the bio-diversity and the diversity of Avain fauna in Rupa Lake the following recommendations are suggested.

- Proper land use planning should be conducted.
- Over fishing should be controlled.
- The well management of the tourist should be done, who visits Rupa lake.
- Conservation of nest site and bird activity site should be done to protect eggs and chicks.
- The unlimited harvestment of aquatic flora should be limited.
- The detail survey of the bird species of the Rupa lake should be done for better conservation of bird diversity.

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Appendix I

Aquatic Plant Diversity in Rupa Lake.

1. List of aquatic plants found in various water conditions of Rupa Lake

S.N.	Parameter	Botanical name	Common name
1.	Free floating aquatic plants	*Azolla carliniana***	
		Azolla imbricata	Mosquito fern
		Eichornia crassipes	Water hyacinth
		Hygrorhyza aristata	
		*Lemna spp***	Duckweed
		Spieodela oligorhiza	
		Spirodela polyhizia	
		Spirodessa polyhizia	Water meal
		Wolfia spp	
2.	Submerged aquatic plants	*Blyxa aubertii*	
		Cerotophyllum demersum	Corn tail
		Egeroa spp	Water weed
		Hydrilla verticillata	
		Limnophilla sessilis	
		Myriophyllum spp	Milfoil
		Najas graminea	
		Nitella mucronata	
		Potamogeton conferoides	Pond weed
		Potamogeton crispus	Pond weed
		Potamogeton epihydrus	Pond weed
		Potamogeton octandrus	
		Potamogeton pectinatus	
		Urticularia australis	
		Urticularia gibba	
		Vallisneria spiralis	
3.	Rooted floating leaved species	*Caldesis parnassifolia*	
		Ludwigia adscendens	
		Nelumbo nucifera	White lotus

		Nymphoides indicum	
		Trapa bispinosa	Water chestnut
		Trapa quadrispinossa	Water chestnut
4.	Emergent rooted aquatic plants	*Hydrochloa spp**	
		Spaganium spp	
		sagittaria spp	Arrow head
5.	Emergent species	*Alisma plantago-aquatica*	
		Alternanthera sessilis	
		Butomposis latifolia	
		Ceratopteris thalictroides	
		Cryperus alternifolius	
		Cyperus esculentus	
		Elecoharis dulcis	
		Elecoharis congesta	
		Equisetum debile	
		Eriocaulon cinereum	
		Flscopa scandens	
		Hdrocotyl siebthorpoides	
		Isolepis setacea	
		Leeresia hexandra	
		Monochoria vaginalis	
		Oryza rufipogon	Wild rice
		Panicum repens	
		Persicaria barabata	
		persicaria hydropiper	
		Persicaria lanigerum	
		Persicaria lapathifolia	
		Rorippa nasturtium-aquaticum	
		Roatala rotundifolia	
		Schoenoplectus littoralis	
		Schoenoplectus mucronatus	

6	Plants growing in marginal lands of swamps	*Carex. spp* *	
		Cladium spp	
		Cyperus spp	
		*Ludwigia spp**	
		*Nymbaes spp**	
		*Nuphar macrophyllum**	Cow lily/mane
		*Polygonum spp**	Smart weed/pirre

Source; Fisheries research center, 1994 and Shrestha P. 1998 and Field Visit 2006.

* Toxic Microphytes ** Nutritious weeds

Appendix II

Amphibians Recorded in the Study Area.

Family	Scientific Name	Common Name	Local Name	Habitat
Bufonidae	*Bufo andersoni*	Toad	Bhyaguto	M Ri V
	Bufo melanostricutus	Toad	Bhyaguto	M Ri V
Ranidae	*Rana limnochoris*	Frog	Bhyaguto	M Ri V
	Rana pipens	Leopard frog	Bhyaguto	M Ri V
	Rana swami	Frog	Bhyaguto	M Ri V
	Rana tigrina	Bull frog	Bhyasguto	M Ri V

M = Migratory, Ri = Rice Field, V = Village

Appendix III

Reptiles Recorded in the Study Area.

Family	Scientific Name	Common Name	Local Name	Habitat
1. Agmidae	*Lgma tuberculata*	Agma	Cheparo	FS
	Calotes versicolar	Com. garden lizard	Cheparo	FS
	Lygosoma indicum	Common shink	Cheparo	FS
	Mabuya carniata	Hill shink	Vanemungro	FS
2. Colubridae	*Amphisesma platyceps*	Keel back	Thukre	Ri S V
	Amphisesma stolta	St. keel back	Thukre	Ri S V
	Pseudoxendodon macropus	St. keel back	Thukre	G Ri S F
	Pytas mucosus	Rat snake	Dhaman	G Ri S F
	Trichischum tenuiceps	Rat snake	Dhaman	G Ri S F
3. Elapidae	*Calliophis macclellandi*	Coral snake		VS
4. Elaphidae	*Elaphae hodsoni*	Karait	Karait	VS
5. Viperidae	*Trimerserus alborostris*	Green pit viper	Karait	F G S
	Trimerseru monticola	Mountain Pit viper		F G S
	Trimerserus Stejnegeri	mountain pit viper	Viper	F G S

F = Forest, G = Grassland, Ri = Rice Field, S = Shrub, V = Village

Appendix IV

Birds Recorded in the Study Area.

Family	Science Name	Common Name	MIG/ GES'	OCC2	Habitat
Accipitridae	*Accipter nisus*	Sparrow hawk	R	O	F
	Milvus Migrans	Dark kite	mi	C	Ri V
	Pandion haliaetus	Osprey	R	O	L
	Spilornis Cheela	Crested serpent eagle	Mi	C	F
Alcedimidae	*Alcedo atthis*	Eurasian kingfisher	R	C	M
	Ceryle rudis	Small pied kingfisher	R	C	M
	Halcyon smyrenensis	Wt.breasted kingfisher	R	C	M Ri
Anatidae	*Anas acuta*	pintail	Mi	C	L
	anas crecca	Common teal	Mi	C	L
	Nattapus Coromandelianus	Cotton teal	R	O	LM
Apodidae	*Apus affinis*	House swift	Mi	C	VG
	Collocalia breviostris	Edible nest swift	R	C	VG
	Apus affinis	House swift	Mi	C	VG
	Collocalia breviostris	Edible nest swift	R	C	VG
Ardidae	*Ardeola Grayii*	Pond heron	R	C	Ri M L
	Budulcus ibis	Cattle egret	R	C	Ri M L
	Butorides striatus	Little green heron	R	c	M L
	Gretta garzetta	Little egret	R	C	Ri M
	Egretta intermedia	Intermediate egret	R	O	Ri M L
Campephagidae	*Coracina melaschistos*	Dark cuckoo-shrike	R	C	F S
	Coracina novaehollandiae	Large cuckoo-shrike	R	C	F S
	Pericrocotus flammeus	Scarlet minivet	R	C	F
Capitonidae	*megalaima asiatica*	Blue-throated barbet	R	C	FS
	Megalaima haemacephala	Crimson-breasted barbet	R	C	F

	Megalaima virens	Great Himalayan barbet	R	C	F
Charadriidae	*Calidris temminckii*	Temminnck's stint	R	C	M
	Capella gallinago	Fantail snipe	R	C	M
Columbidae	*Streptopelia chinensis*	Spotted dove	R	C	FRiVS
	Streptopelia orientalis	Rufous turtle dove	Mi	C	F Ri S
	Treron phoenicoptera	Bengal green pigeon	R	C	V F S
Coraciidae	*Coracias benghalensis*	Indian roller	R	C	F
Corvidae	*Cissa chinensis*	Green magpie	R	C	FS
	Cissa erythrorhyncha	Red-billed blue magpie	R	C	F
	Corus macrorhynchos	Jungle crow	R	C	FSVRi
	Dendrocitta formosae	Himalayan tree pie	R	C	F S
	Dendrocitta vagabunda	Indian tree pie	R	C	F S
Cuculidae	*Clamator Coromandus*	Red winged crested cuckoo	R	O	F S
	Rhopodytes tristis	Lg.green billed malkoha	R	C	F
Dicaeidae	*Dicaeum agile*	Thick - billed floerpecker	R	O	F S
	Dicaeum concolor	Plain-coloured flowerpecker	R	C	F S
Dicruridae	*Dicrurus adsimillis*	Black drongo	R	C	G Fi S V
	Dicrurus aeneus	Little bronze drongo	R	C	F g
	Dicrurus hottentottus	Hair-crested dronogo	R	C	F
	Dicrurus leucophaeus	Ashy drongo	R	C	F
Frigilidae	*Lonchura punctulata*	Spotted munia	R	C	S G V Ri
	Lonchura striata	Sharp tailed munia	R	C	F S
Hirundinidae	*Delichon nepalensis*	Nepal house martin	Mi	C	GVL
	Hirundo smithii	Barn swallow	Mi	C	G G Ri
	Riparia paludicola	Sand martin	R	C	V G L
Irendiae	*Aegithina tiphia*	lora	R	C	F S

Laniidae	*Lanius schach*	Black - headed shrike	R	C	S G
Meropidae	*Nyctymis atherioni*	blue-bearded bee-eater	Mi	C	Fs
Motacillidae	*Anthus hodgsoni*	Hodgson's tree pipit	R	C	S G
	Anthus noaeseelandiae	Paddyfield pipit	R	C	S Ri
	Motacilla alba	Pied wagtail	Mi	C	M
	Motacilla caspica	Gray wagtail	R	O	F
	Motacilla citereola	Yellow headed wagtail	R	O	M Ri
	Motacilla maderaspatensis	Large pied wagtail	R	C	M Ri
Muscicapidae	*Culicicapa ceylonensis*	Gray-headed flycatcher	R	C	F
	Phipidura albicollis	Wt.l throated flycatcher	R	C	F
Nectariniidae	*Anthopyga siparaja*	Scarlet - breasted sunbird	R	C	S G
Oriolidae	*Oriouls traillii*	Maroon oriole	R	C	S F
Paridae	*Parus major*	Gray tit	R	C	S G
Paride	*Parus xanthogenys*	yellow-cheeked tit	R	C	S G
Phasianidae	*Gallus gallus*	Red jungle fowl	R	C	FSGRiV
	Lophuro leucomelana	Kalij pheasant	R	O	F
Picidae	*Chrysololates lucides*	Large Golden. backed woodpecker	R	C	F Ri S
	Micropternus brachyurus	Brown woodpecker	R	O	F S
	picus canus	Black napped woodpecker	R	C	F S
	Picus chlorolophys	Small Yellow napped woodpecker	R	C	F R S
	Picus flavinucha	Lg. yl. napped woodpecker	R	C	F S
Ploceidae	*Passer domesticus*	house sparrow	R	C	S V Ri
	Passer montanus	Tree sparrow	R	C	S G V

Podicipedidae	*Podiceps ruflicollis*	Little grabe	R	C	L
Psittacidae	*Psittacula alexandrii*	Rose-breasted parakeet	R	C	F S
Pycononotidae	*Pycnonotus cafer*	Red-vented bulbul	R	C	F S G
	Pycononotus leucogencys	White-cheeked bulbul	R	C	F S
	Pycnotus melanicterus	black-headed yellow bulbul	R	O	F S
Ralidae	*Amaurornis akool*	Brown crake	R	O	M
	Amaurornis fuscus	Ruddy crake	Mi	O	Ri M
	Gallicrex cinerea	Water cock	R	O	M
Rostratulidae	*Rostratula benghalensis*	Painted snipe	Mi	O	G Ri M
Sittidae	*Sitta castaenea*	Chestnut-bellied nuthatch	R	C	F
	Sitta frontalis	Velvet-fronted nuthatch	R	C	F
Sturnidae	*Acridotheres fuscus*	Jungle myna	R	C	F G S Ri V
	Acridotheres tristis	Common myna	R	C	FGSRiV
	Saroglossa spilptera	Spot-winged stare	R	O	G Ri
	Sturnus malabaricus	Gray-headed myna	R	C	FGSRiV
Sylviidae	*Orthotomus sutorius*	Tailor bird	R	C	S G
	Phylloscopus collybita	Brown leaf warbler	R	C	F S
Turdidae	*Copsychus saularis*	Robin dayal	R	C	F S V
	Enicurus immaculatus	Back backed forktail	R	C	F S
		Pied bush chat	R	C	G S Ri
	Copsychus saularis	Robin dayal	R	C	F S V
	Enicurus immaculatus	Black backed forktail	R	C	F S
	Sexicola caprata	Pied bush chat	R	C	G S Ri
Upupidae	*Upupa eops*	Hoopoe	Mi	C	S G V
Zosteropidae	*Osterops Palpebrosa*	White eye	R	C	F

R = Resident, Mi = Migratory, Occ = Occasional; C = Common, F = Forest, S = Shrubland, G = Grassland, Ri = Rice field (cultivated land); V = village; M = marshland, L = Lake (keep water)

Appendix V

Mammals Recorded in the Study Area.

Family	Scientific Name	Common Name	Local Name
Conidae	*Canis aureus*	Jackal	Shyal
	Vlpes bengalensis	Indian fox	Phyauro
Cercopithecidae	*Macaca mulatta*	Rhesus monkey	Bandar
Cervidea	*Muntiacus muntjak*	Barking deer	Ratuwa
Filidae	*Felis bengalensis*	Leopard cat*	Chari bagh
	Felis chaus	Jungie cat	Jungli biralo
	Neofelis nebulosa	Clouded leopard*	Dhwanse chituawa
	Panthera Pardus	Leopard	Chituwa
Herpestidae	*Herpestes auropunctatus*	Small Indian mongoose	Dhaunse chituwa
	Herpestes edwardsi	Common mongoose	Niaurimusa
	Herpestes urva	Crab-eating mongoose	Kanthe niaurimusa
	Hystrix indica	Indian porcupine	Dumsi
Leoparidae	*Lepus nigricollis*	Blacknaped hare	Kharayo
Manidae	*Gounda ellioti*	Bush rat	Salak
	Manis crassicaudata	Pangolin	Salak
	Mus booduga	Indian field mouse	Musa
	Mus musculus	House mouse	Musa
	Rattus rattus	house rat	Musa
	Tater indica	India gerbil	Musa
Mustelidae	*Lutra lutra*	Common otter	Ott
	Lutra perspicillata	Small Indian otter	Ott
	Martes flavigula	Him.yellow throated martin	Malsapra
Pteropodidae	*Cynopterus sphinx*	Short-nosed fruit bat	Chamero
	Pteropus giganteus	Indian flying fox hat	Chamero
	Rousettus leschenauti	Fulvous fruit bat	Chamero
Rhinolophidae	*Rhinolophus luctus*	Great eastern Horseshoe	San chamero

		bat	
Sciuridae	*Callosciurs pygerythrus*	Hoary-bellied Him. squirrel	Lokharke
	Funambulus palmarum	Three-striped palm squirrel	Lokharke
Talpidae	*Suncus murinus*	House shrew	Chuchundro
Ursidae	*Selenarctos thibetanus*	Himalayan black bear	Bhalu
Vespertilionidae	*Pipistrellus coramandra*	Indian pipistrelle	Bhalu
Viveridae	*Papuma larvata*	Himalayan pain civet	Lampuchare
	Viverra zibetha	large Indian civet	Neer biralo

Appendix VI

Survey Data Sheet for study in Rupa Lake.

Date Time start: Time off Protocol Number

Weather Vantage point Transect

S.N.	Bird Species	No. of Birds	Location	Behaviors	Remark
1.					
2.					
3.					
4.					
5.					
6.					
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9.					
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11.					
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28.					
29.					
30.					

Annex VII

Total Orders and Families of the Birds Recorded in Study Area

S.N.	Family	Order	Number of Species Observed
1.	Ciconiformes	1. Scolopacidae	1
		2. Phalucrocoracidae	1
		3. Ciconidae	1
		4. Charadriidae	2
		5. Jaconiadae	2
		6. Ardeidae	4
		7. Accipitridae	1
		Total species	**12**
2.	Passeriformes	8. Sturnidae	1
		9. Corvidave	1
		10. Hirundinidae	2
		11. Passeridare	3
		Total species	**7**
3.	Coraciformes	12. Decilonidae	1
		13. Cerylidae	1
		14. Alcedinidae	1
		Total species	**3**
4.	Anseriformes	15. Anatidae	4
		Total species	**4**
5.	Gruiformes	16. Rallidae	4
		Total species	**4**

Appendix VIII

A. List of birds observed in the different season in Rupa Lake 2005-06.

S.N.	Observed Summer Birds	Fi	Fi log Fi
1	Indian pond heron	14	16
2	Little grebe	8	7.22
3	White throated kingfisher	2	0.60
4	Red walted lapwing	11	11.45
5	common king fisher	1	0
6	Pied king fisher	1	0
7	Pheasant tailed Jacana	15	17.64
8	Cattle egret	13	14.64
9	White browed wagtail	2	0.60
10	Nepal house martin	10	10
11	Common moorhen	4	2.40
12	Little egret	7	5.91
13	Intermediate egret	3	1.43
14	Bronze winged Jacana	32	48.16
		123	135.89

Calculation

$$H = \frac{n \log n - \sum fi \log fi}{n} \qquad H = 0.98 \qquad J = \frac{H}{H max} = 0.855$$

B.List of birds observed in the different season in Rupa Lake 2005-06.

S.N.	Observed Autumn Birds	Fi	Fi log Fi
1	Indian pond heron	11	11.45
2	Little grebe	11	11.45
3	common coot	7	5.91
4	White throated kingfisher	7	1.43
5	Red walted lapwing	9	8.58
6	Common king fisher	1	0
7	Pied king fisher	1	0
8	Pheasant tailed jacana	5	349
9	Cattle egret	10	10
10	White browed wagtail	1	0
11	Temminck's stint	2	0.60
12	Nepal house martin	13	14.42
13	Common moorhen	4	2.40
14	Little egret	4	2.40
15	Intermediate egret	3	1.40
16	Bronze winged jacana	30	44.31
		115	117.93

Calculation

$$H = \frac{n \log n - \sum fi \log fi}{n} \qquad H = 103 \qquad J = \frac{H}{H\,max} = 0.858$$

C. List of birds observed in the different season in Rupa Lake 2005-06.

S.N.	Observed Winter Birds	Fi	Fi log Fi
1	Indian pond heron	23	31.31
2	Little grebe	25	44.94
3	Great cormorant	8	7.22
4	Woolly necked stork	11	11.45
5	Common coot	45	74.39
6	White throated King Fisher	3	1.43
7	Red walted lapwing	13	14.48
8	Common king fisher	2	0.60
9	Pied Kingfisher	2	0.60
10	Cattle egret	35	54
11	White browed wagtail	3	1.43
12	Citrine wagtail	3	1.43
13	Purple Swamp hen	6	4.66
14	Gadwall	14	16
15	Temmincks sting	3	1.43
16	Sand martin	30	44.31
17	Nepal house martin	25	34.94
18	Common pochard	6	4.66
19	Common Mororhen	3	1.43
20	Mallard	4	2.40
21	Little egret	6	4.66
22	Ferruginous pochard	12	12.95
23	Intermediate egret	5	3.49
24	Bronze winged jacana	35	54
25	White breasted water hen	3	1.43
		325	461.26

Calculation

$$H = \frac{n \log n - \sum fi \log fi}{n} \qquad H = 1.09 \qquad J = \frac{H}{H\,max} = 0.78$$

D. List of birds observed in the different season in Rupa Lake 2005-06.

S.N.	Observed Spring Birds	Fi	Fi log Fi
1	Indian pond heron	4	2.40
2	Little grebe	10	10
3	common coot	2	0.60
4	White throated kingfisher	2	0.60
5	Red walted lapwing	8	7.22
6	Pied king fisher	1	0
7	Cattle egret	12	12.96
8	White browed wagtail	1	0
9	Temminck's stint	2	0.60
10	Nepal house martin	16	19.26
11	Common moorhen	2	0.60
12	Little egret	5	3.49
13	Intermediate egret	2	0.60
14	Bronze winged jacana	28	40.5
		96	98.24

Calculation

$$H = \frac{n \log n - \sum fi \log fi}{n} \qquad H = 0.95 \qquad J = \frac{H}{H\,max} = 0.82$$

Appendix IX

a. Rainfall (mm) for Pokhara Airport

Year	Months											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1999	7.5	22.6	0.0	20.6	899.7	979.6	950.5	899.7	730.7	176.4	0.0	0.6
2000	10.6	13.3	51.5	199.5	682.9	875.7	1032.0	1192.4	572.7	136.0	18.4	0.0
2001	3.0	25.0	15.3	111.7	359.2	711.5	856.4	1521.9	716.1	115.3	77.1	0.0
2002	44.4	54.0	61.9	202.1	437.1	703.4	1815.1	693.3	335.4	114.0	23.5	0.0
2003	36.6	84.6	100.1	202.6	245.9	785.4	129.8	586.0	953.0	17.2	16.9	42.1
2004	31.2	10.9	28.4	265.7	432.5	773.0	716.9	788.7	864.0	184.2	33.0	0.0

b. Monthly mean Air Maximum Temperature (^{0}C)

Months	1999	2000	2001	2002	2003	2004
Jan.	20.6	20.6	19.6	20.1	19.7	19.8
Feb.	25.3	25.3	23.3	23.4	21.9	23.4
Mar.	29.4	29.4	27.9	27.1	25.7	29.3
Apr.	33.6	33.6	30.8	29.2	30.1	28.9
May.	30.0	30.0	29.6	29.8	30.2	30.6
Jun.	30.1	30.1	30.7	31.4	30.8	31.0
Jul.	29.3	29.3	30.7	30.2	30.5	29.9
Aug.	29.1	29.1	30.4	30.3	31.4	31.4
Sep.	29.9	29.9	29.8	29.7	30.1	29.4
Oct.	27.6	27.6	28.7	28.0	29.0	27.3
Nov.	24.3	24.3	25.5	24.6	24.7	23.5
Dec.	21.6	21.6	21.1	20.9	21.2	21.1

c. Monthly Mean Air Minimum Temperature (^{0}C)

Months	1999	2000	2001	2002	2003	2004
Jan.	6.5	6.5	7.5	7.1	6.9	7.5
Feb.	10.7	10.7	10.0	9.9	9.6	10.3
Mar.	13.2	13.2	12.3	13.7	12.8	15.9
Apr.	18.6	18.6	15.4	16.5	16.9	16.6
May.	19.1	19.1	19.2	19.3	17.6	19.3
Jun.	20.8	20.8	21.6	21.6	21.1	21.0
Jul.	21.7	21.7	22.5	22.4	22.1	22.1
Aug.	21.4	21.4	22.2	22.1	22.5	22.6
Sep.	21.4	21.4	20.8	20.7	21.0	21.1
Oct.	17.4	17.4	17.8	16.9	17.6	16.2
Nov.	12.7	12.7	13.2	12.4	13.3	11.1
Dec.	9.1	9.1	8.8	8.9	8.3	8.7

d. Monthly Mean Relative Humidity (%)

Months	1999	2000	2001	2002	2003	2004
Jan.	88.0	88.0	91.5	90.7	94.0	92.3
Feb.	80.5	80.5	85.8	87.3	89.6	87.4
Mar.	64.3	64.3	71.0	78.9	82.2	78.6
Apr.	59.6	59.6	62.3	79.4	74.0	78.9
May.	83.0	83.0	79.4	82.6	74.1	78.5
Jun.	81.4	81.4	87.5	85.0	85.4	84.1
Jul.	90.3	90.3	87.4	92.2	90.4	91.2
Aug.	89.9	89.9	91.2	89.9	88.4	86.3
Sep.	88.4	88.4	86.7	87.2	89.5	91.2
Oct.	84.5	84.5	85.0	84.0	83.0	86.6
Nov.	87.8	87.8	88.2	87.2	90.8	87.2
Dec.	88.0	88.0	92.1	91.2	91.5	91.1

Appendix X

QUESTIONNAIRE

Date:

Name : Sex : Age :

Education: Occupation: Site :

1. Are you native ?

2. If not, migrated, when ?

   _____

3. What changes have you seen in this area during last ten years ?
   i. Human Increment /and encroachment to lake
   ii. Road construction
   iii. Occurrence of landslide
   iv. Others

4. In which season you see more birds ?
   i. Spring ii. Summer iii. Autumn iv. Winter

5. In case of water, which habitat do they prefer ?
   a. Clear water b. Vegetated wetlands

6. How many types of birds you have seen ?
   a. 10 species b. 20 species
   c. 30 species d. Above

7. Which are the common birds of this lake ?

   _____

8. Do you use currents and posons while foshing in lake and up stream

_____

9. Which birds are comparatively harmful to you ?

_____

10. Do you hunt birds ? a. Yes b. No

11. If yes, why do you hunt.

a. Food b. Medicine c. Trade d. Others

12. Which types of birds do you hunt ?

a. Terrestrial b. Water birds

13. Which stage of birds do you hunt ?

a. Egg c. Chick c. Adult

14. Which instrument do you use most for hunting birds ?

a. Catapult d. Gun c. Net d. Other

15. Do you see migration in birds ? a. Yes b. No

16. It decreasing because of

a. Hunting b. Loss of habitat c. pollution d. other

17. It increasing because of

a. Conservation b. Migration d. afforestation d. Other

19. Could you name any birds that have seen since last 10-15 years ?

_____

20. Do you have any suggestion for preservation of birds ?

Photographs ? (Last page)

In front pages
Contains
Recommendation
Approval
Exam Approval
Acknowledgements
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