FINAL REPORT
(MAY 2012 – APRIL 2013)

STUDY OF BIRDS IN
HETAUDA-DHALKEBAR-DUHABI
400 kV TRANSMISSION LINE PROJECT

Submitted to:

Hetauda- Dhalkebar- Duhabi 400 kV Transmission Line Project

Darbar Marga, Kathmandu

Submitted by:

ENVIRONMENT AND SOCIAL STUDIES DEPARTMENT,

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Abbreviations and Acronyms

AP	Angel Point
BCN	Bird Conservation Nepal
DNPWC	Department of National Parks and Wildlife Conservation
ESSD	Environment and Social Studies Department
GoN	Government of Nepal
GPS	Global Positioning System
ha	Hectare
HCE	Hydro Consult Engineering Limited
IBA	Important Bird Area
IEE	Initial Environmental Examination
IUCN	International Union for Nature Conservation
KBO	Kosi Bird Observatory
km	Kilometer
kV	Kilo Volt
m	Meter
MTSC	Modified Times Species Counts
NEA	Nepal Electricity Authority
RoW	Right of Way
sq.km.	Square kilometer
TL	Transmission Line
ToR	Terms of Reference
TSC	Timed Species Count
VDC	Village Development Committee
WN	Ward Number

1 BACKGROUND

This report has been prepared as per the requirements stipulated by the MOU between the Project and Environment and Social Studies Department (ESSD) of Nepal Electricity Authority (NEA) for conducting Study of Birds in Hetauda – Dhalkebar – Duhabi 400 kV Transmission Line (TL) Project to fulfill the requirement of World Bank for Project funding. Hydro-Consult Engineering Limited (HCEL), formerly Hydro Consult Private Limited (HCPL) is the Consultant involved in the study.

Nepal Electricity Authority, Transmission Line and Substation Construction Department intend to construct Hetauda- Dhalkebar- Duhabi 400 kV TL Project. The Initial Environmental Examination (IEE) study of the proposed project was conducted by ESSD as per the Environment Protection Rule (EPR), 1997 and World Bank Guidelines. The IEE study document the presence of Bird and their migration route at some of the localities in TL. Since TL passes about 40% forest area in its total length the impacts on Bird has been envisaged in IEE report. This report presents more specific and detail study on the bird species found in the Hetauda – Dhalkebar – Duhabi 400 kV TL Project area.

2 SCOPE OF SERVICES

The scope of the work is to conduct specific study on bird, species found along the Hetauda – Dhalkebar – Duhabi 400 kV TL route. One hundred and thirteen species of birds were reported in IEE conducted for the project (*ESSD 2011*). Out of that 10 species are summer migrant, 8 are winter migrant and 6 are passage migrant. The data shows that 66 species are resident and 23 are winter visitors. Several bird species visit Nepalese wetlands, seasonally coming from different parts of the World like India, Arab, China, Tibet, Russia and Northern Himalayas. These migratory birds are mainly water birds. Birds follow a certain migratory routes usually following a river system like Koshi River in the eastern Nepal, Bagmati River and Kamala River in the central Nepal across the proposed transmission corridor.

The proposed TL crosses Koshi River between Angel Point (AP) 50-53 of Dhalkebar- Duhabi Stretch, Bagmati (AP27-AP28 of Hetauda-Dhalkebar section) and Kamala (AP10A - AP11 of Dhalkebar-Duhabi Substation). Out of the total 285.2 km length of TL 96.6 km is aligned close to existing 132 kV line. This includes 29 km from Nijgadh to Bagmati, 20km from Bagmati to Dhalkebar and 47.6 km from Dhalkbear to Kanchanpur section. The bird study included field work and information derived from existing literatures covering:

- Identification of the bird species found in the project area;
- Identification of the migratory bird species found in Bagmati, Kamala and Koshi River and adjoining wetland crossings;
- Collection of information about migration season, size of the bird, wing span, flying behavior, active period feeding and nesting behavior and preferred nesting and feeding ground;
- Collection of the information about the number of bird in each migratory group for both terrestrial and water birds;
- The information about the rest places in and around the proposed transmission line for both terrestrial and water birds;

- Collection of the information about bird hit for existing 132 kV TL with subsequent details such as number bird take rest in transmission line, type of bird, size of bird and season;
- Identification of the impacts of the proposed project on birds during construction and operation phases;
- Review available literature and studies on the impact of transmission lines on birds, their migration and general movements;
- Compile relevant information on mitigation measures used to minimize the adverse impacts identified above; and
- Review the mitigation measures proposed in IEE and recommend additional measures or modify the proposed program based on the detail study to minimize the impacts.

3 PROJECT DESCRIPTION

The TL passes through 4 zones (Narayani, Janakpur, Sagarmatha and Koshi), 10 districts, 77 Village Development Committees (VDCs) and two municipalities. It covers the area of Makwanpur, Bara, Rautahat, Sarlahi, Mahottari, Dhanusha, Saptari, Siraha, Sunsari and Morang districts. The proposed 400 kV transmission line is 285.2 km in length, commencing at the under construction Hetauda substation (for Hetauda-Bardghat 220 kV Project) located at Hetauda Municipality Ward Number (WN) 1 of Makwanpur district and terminating at the new Duhabi substation located at WN 7 Bhokraha Tole (Hanif Tole) of Bhokraha VDC in Sunsari district. The TL passes through 112.66 km of forest area which consists of 95.7 km of forest area, 8.2 km of shrub land and 8.76 km of grass land. The total forest land along the alignment Right of Way (RoW) is 518.24 ha. The TL passes close to buffer zone of Koshi Tappu Wildlife Reserve. The minimum distance of the alignment from the KoshiTappu Wildlife Reserve is 1.8 km. The salient features of the project are given in Table 3-1.

Table 3-1: Salient features of the project

Features	**Description**	
General		
Project	Hetauda – Dhalkebar- Duhabi 400 kV Transmission Line Project	
Development region	Central and Eastern Development Region	
Districts	10 districts (6 from Central Development Region 4 from Eastern Development Region)	
Development Region	Districts	VDCs/municipalities
Central Development Region	Makwanpur (6)	Hetauda Municipality and Churiyamai, Hatiya, Hurnamadi ,Shreepur Chatiwan and Dhiyal VDCs
‘’	Bara (2)	Nijgadh and Bharatgang VDCs
‘’	Rautahat (5)	Chandranigahapur, Kakanpur, Rangapur, Judibela and Paurai VDCs

,,	Sarlahi (10)	Karmaiya, Dhungrekhola, Hariaon, Atrouli, Pattharkot, Lalbandi, Kalinjor, Ranigunj, Bhaktipur and Gourishankar VDCs
,,	Mahottari (3)	Khayarmara, Gauribas and Maistan VDCs
,,	Dhanusha (10)	Tulsichauda, Begadawar, Dhalkebar, Naktajhijh, Hariharpur, Puspalpur, Umaprempur, Yagyabhumi, Bharatpur and Godar VDCs
Eastern Development Region	Siraha (17)	Ramnagar Mircharya, Fulbariya, Badharamal, Karjanha, Rampurbirta, Chandrodayapur, Chandralalpur, Jamdaha Lalpur, Ayodhyanagar, Asanpur, Dhangadhi, Bstipur, Padariya Tharotole, Govindpur Taregana & Bhadayia VDCs and Lahan Municipality
,,	Saptari (20)	Madhupatti, Daulatpur, Kushaha, Khojpur, Pansera, Kalyanpur, Bhangaha, Khoksar Parbaha, Rayapur, Terahota, Sitapur, Prasabani, Jandaul, Bakdhauwa, Theliya, Dharampur, Rupnagar, Dhodhanpur, Kamalpur and Fatepur VDCs
,,	Udayapur (2)	Thoksila and Tapeswari VDCs
,,	Sunsari (4)	Mahendranagar, Singiya, Dumraha, and Bhokraha VDCs
Initial point	New Hetauda Substation , HetaudaMunicipality Makwanpur	
Terminal point	New Duhabi Substation, Bhokraha VDC, Sunsari district	
Number of major road crossing	3	
Number of major river crossings	4	
Number of 33 kV line crossings	1	
Number of 66 kV line crossings	1	
Number of 132 kV line crossings	1	

Clearances	
Highways	9.5 m
Normal ground for pedestrians only	8.6
Power lines	6.5 m for 11 & 33 kV and 6.1 for 66 & 132 kV
Telecommunication lines	36m
Roads and streets	9.5m
Residential areas	9.2m
Water surface at maximum flood	7.5 m
To metal clad or roofed sheds or structures upon which a man may stand	6m
Vertical clearance for forest	7.5m
Horizontal clearance for forest and settlement	46m
Substation	
New Substation	400/220/132 kV at Hanif tole of Bhokraha VDC
Upgrading	Construction of 400,220,132 and 33 kV voltage level buses at Dhalkebar substation and 220 kV bus and transformers at new Hetauda substation.
Finance	
Project Cost	USD 144 million for both transmission line and substation
Funding Agency	Government of Nepal (GoN)/ World Bank

Note: For other objects not listed above the requirements for minimum clearances shall comply also with NESC (NATIONAL ELECTRIC SAFETY CODE).
Source: IEE Report, 2011

4 STUDY APPROACH AND METHODOLOGY

4.1 Study Approach

A team of experts with several years' professional experience in their respective areas carried out the study of avian fauna in Hetauda – Dhalkebar – Duhabi 400 kV TL Project areas guided by the Terms of Reference (TOR) and Inception report cleared by the World Bank/Project. The names of the personnel that carried out the field survey and report preparation are given in Table 4-1. Research Assistants were hired locally to assist the bird expert in field survey for the birds.

Table 4-1: Study Team

SN	Name	Expertise/position

1	Rabindra Chaudhary	Coordinator
2	Pranav Acharya	Team Coordinator
3	Dr Hem Sagar Baral	Bird Expert/Team Leader
4	Balram Bhattarai	Associate Coordinator
5	Amrit Poudel	Environmental Specialist
6	Pradip Gautam	Environmentalist
7	Sanjib Acharya	Research Assistant (Bird Specialist)
8	Tika Sherpa	Research Assistant (Bird Specialist)
9	Buddhi Ram Mahato	Research Assistant (Bird Specialist)
10	Badri Chaudhary	Research Assistant (Bird Specialist)
11	Anish Timsina	Research Assistant (Bird Specialist)
12	Dheeraj Chaudhary	Research Assistant (Bird Specialist)

The following general approaches were followed during the study period:

- Mobilization of technical experts as envisaged in the TOR.
- Selection of tested and proven methods and technologies.
- Effective communication with the client and all the concerned agencies.
- Optimum utilization of the available study reports, maps, drawings, standards etc.

Considering the project site location, ease of access, and seasonality, field studies were planned carefully and were conducted systematically. Emphasis was given on:

- Frequent and effective co-ordination and communication with the client
- Effective coordination and interaction with the team members
- Good and reliable management of the field logistics, equipment and other support facilities
- Careful management of study team movement to and from the field site
- Use of standard formats and checklists for collecting uniform and quality field data.
- Establishment of a database of the baseline data for analyses and future reference for monitoring.

4.2 Methods and Materials

4.2.1 Survey Methods

Birds are the best studied vertebrates in the entire world. They are relatively easy to count once considerable experience is gained on their identification and behavior. Many birds are brightly colored and all birds are mobile and often give signs of their presence by way of their calls and songs. Because they are highly vocal, the detection of birds is considerably higher than the detection of other taxa. A number of bird census techniques have been discussed by various researchers (see a list of references below). There are pitfalls for all kinds of survey methods. Therefore while surveying birds for this particular project, care was taken that the assumptions followed for the survey method were not violated to the best of our knowledge.

A survey has been carried out to ensure that objectives of the proposed work are met. In this regard, methods were chosen that were best suited to give optimal results for the intended work.

For collecting information on avian fauna and related habitat, a number of complementary methods were employed. These included i) literature studies, ii) unstructured interviews with community members as well as expert and selected stakeholder consultations and iii) field visits.

Literature Studies

A vast number of literatures are now available on Nepal's birds. These include published and grey literature (*Inskipp and Inskipp 2012*). IEE and other reports available for the area were collected. Available relevant literatures were studied and information was extracted to fulfill the objectives of the current task in the final report. Most of the literature studies were done in Kathmandu; they were obtained using means of communication such as emails, internet, telephones and visiting libraries. Information on birds' measurements etc was taken from *Ali and Ripley 1987*. Habitat and Nepal specific bird species behavior were extracted from *Inskipp and Inskipp 1991* and *Fleming et al. 1984* (Refer Bibliography for a full list of references collected).

Consultations and Interviews

Consultation with experts and selected stakeholders were held on a one to one basis. Consultations also included informal discussion with Conservation Officers of Koshi Tappu and Parsa Wildlife Reserves. Specific consultation was done with Koshi Tappu Wildlife Reserve long-serving staffs, Koshi Camp staffs and knowledgeable locals to obtain information on the bird casualties from the existing 132 kV TL. A full list of people consulted is presented in *ANNEX A*, *ANNEX B* and *ANNEX C*.

Field Surveys

The exact locations that high voltage lines will pass through various districts/VDCs/forests were located through maps supplied by NEA and an initial field visit was carried out between 3rd July and 14th July 2012. During this visit, study sites were established near the Bagmati, Kamala and Koshi Rivers, some of the main migration routes of migratory birds through Nepal. A total of 6 locations was set up and covered twice in the season. These included two locations each near the Bagmati, Kamala and Koshi Rivers for Modified Timed Species Count

(MTSC) data collection. The MTSC counts have also covered forested stretch in Bagmati and Kamala areas aiming to record forest/edge species that are resident or migrants. Additional observations of river stretches and adjoining wetland crossings for recording migrating water birds were done separately and birds seen were logged in a diary.

As Koshi is a more important migration corridor compared to the Bagmati and Kamala, additional observations were recorded from the Koshi area. The initial batch of information on migratory birds was obtained from Kosi Bird Observatory (KBO) run by Himalayan Nature. One of the fixed locations was situated near the proposed spot for the high voltage lines (near Shukrabare, Mahendranagar VDC) and another location was further north close to the KBO. Both these points were exceptionally good for recording migrating birds. In addition to these two locations, birds recorded at KBO, birds recorded along the stretch of the Koshi River from Chatara to Prakashpur, and on birds from Dharan Forests Important Bird Area (IBA) were also recorded.

Field visits were carried out in Koshi at different time intervals: 3-13 July 2012, 9 to 13 October 2012, 18 to 23 November 2012, 10 to 19 January 2013, Feb 2013, 25-30 March 2013 and 28 April- 1 May 2013.

Lists from all these separate visits at different time of the year were compiled to produce a comprehensive list of birds recorded in the area. As the main resting area for many migratory birds was Koshi Tappu Wildlife Reserve, its northern reaches were also surveyed on both these visits. Similarly, the western end of the Dharan Forests IBA was also surveyed. From these surveys information were generated on the type of birds that may pass through the affected area, especially the migrating birds.

The basic methodology followed was similar to the Timed Species Count (TSC) (e.g. *Bibby et al. 2000*) with a slight modification to note species' abundance. The method is therefore referred to as the Modified Times Species Counts (MTSC) (Table 4-2). TSC works on the basic principle that the more abundant a species is, the sooner it is likely to be encountered during survey, and conversely scarcer species will be encountered later (on average). The 'on average' statement is important, as it is perfectly possible to encounter a rare species, such as a Red-headed Trogon (*Harpactes erythrocephalus)*, immediately upon entering a forest and starting a TSC. Therefore a slight modification to the original TSC is proposed –the modified form is shown in this report with addition of a column to record numbers. Bird species were recorded on sight and sound. Habitat data was broadly recorded as vegetation type, state of the vegetation (degraded/undisturbed/primary/secondary), and measurement of girth size of dominant trees on the same form as the birds. MTSC data were collected from the three migration corridors twice: July 2012 and May 2013, along with the data on migratory birds in key localities for a meaningful final analysis.

Table 4-2: Modified Timed Species Count Bird Survey-Sample form used

Location:
WTLD
Date:
Secondary 
Time:
Weather:

Vegetation: SF, MF, RFA, RFB, GRLD,

Primary/Secondary/Approx age if

Observer:
GPS:

0-10 minutes	No	10-20 minutes	No	20-30 minutes	No	30-40 minutes	No	40-50 minutes	No	50-60 minutes	No

Note:

SF: Sal Forest, MF: Mixed Sal and riverine forests, RFA: Silk Cotton/Vellor, RFB: Sissoo/Acacia, (Degraded/Moderately managed/Well Preserved)

GRLD: Grassland, WTLD: Wetland (Dense/Medium/Thin or Open) DBH of Dominant Tree(s) (five measurements' average):

Habitat data broadly recorded as vegetation type, state of the vegetation (degraded/undisturbed/primary/secondary), and measurement of girth size of dominant trees on the same form as the birds.

4.2.2 Data Analysis

A daily list of all birds seen and heard was logged in a notebook. This list was used to make a cumulative list of birds from the affected area and its close vicinity. Information received from consultations and the surveys were added together with other literature consulted to produce a final list of birds for the project affected sites. Birds that were recorded at Koshi Tappu Wildlife Reserve and its vicinity were also taken into account while considering impact of the proposed project.

Simple analyses were performed to obtain abundance and frequency of the bird species from TSC data. Birds recorded were evaluated against their global and national importance e.g. threatened, cultural value etc. as well as migratory status, flying height, nature of migration (night/day flying), size of birds etc. Habitat information was correlated with birds recorded and was used especially with threatened/migratory species of birds.

Disturbance factors and their possible impacts on bird fauna during the construction phase of the proposed 400 kV TL were discussed in line with bird fauna recorded in the area. Threats due to the power line project were evaluated in the field and listed. Recommendation/mitigation measures have been also outlined and these also consider the measures discussed in the IEE report.

4.2.3 Materials

Global Positioning System (GPS), digital camera, pairs of binoculars together with measuring tapes and stationary materials were taken during the field survey. Maps and topo-sheets of the area were made available and the affected area/study areawere marked on the maps. In the Koshi River which is usually the most important migratory course for birds telescopes were used to observe birds and for their identification. The most commonly used bird field guide for Nepal by *Grimmett et al. 2000* was used in case consultation was needed for bird identification. More references were obtained on bird identification and their description – a full list of literature obtained for consultation is given under the Bibliography.

5 RESULTS AND DISCUSSION

A total of 309 species representing 54 bird Families and 15 Orders was recorded during the survey. An estimated total of nearly 30,000 birds were counted altogether. A checklist of birds recorded during the survey is presented in *ANNEX D*. Bird fauna was heavily dominated by breeding residents (50%) followed by winter visitors (30%) and rest 20 % falling into other four categories (Figure 5-1).

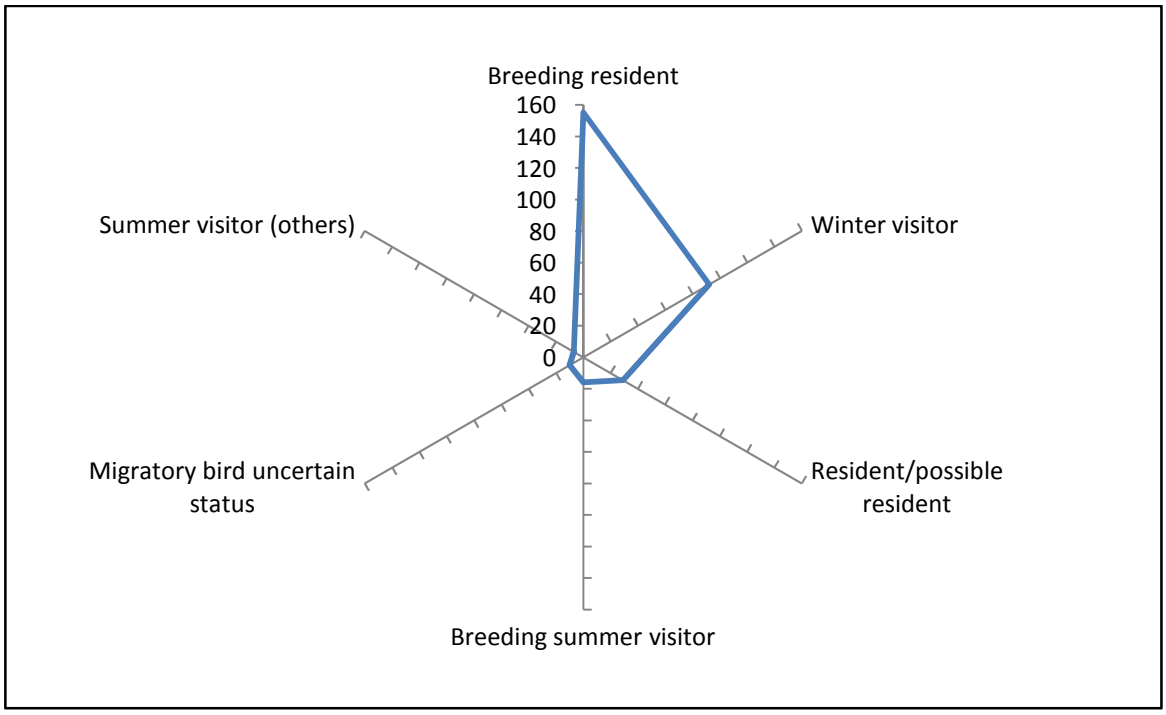

Figure 5-1: Status of birds in the study area in terms of movement and breeding, scale same on all axes of the radar chart

The Bird record list includes eight globally threatened and 29 nationally threatened species (Table 5-1, BCN and DNPWC 2011). Additionally one more species, Greater Necklaced Laughingthrush (*Garrulax pectoralis;* marked with # in the table) has been proposed as a nationally threatened species under the Vulnerable category in an ongoing work on Red Data Book on Birds of Nepal (*www.himalayannature.org*).

Table 5-1: List of birds considered to be at risk, threatened, endangered and critically endangered

English Name	***Scientific Name***	**IUCN Status**
Bengal Florican*	*Houbaropsis bengalensis*	Critically Endangered
White-rumped Vulture*	*Gyps bengalensis*	Critically Endangered
Black-bellied Tern*	*Sterna acuticauda*	Critically Endangered
River Tern	*Sterna aurantia*	Critically Endangered
Eastern Imperial Eagle*	*Aquila heliaca*	Critically Endangered
Blue-breasted Quail	*Coturnix chinensis*	Critically Endangered
Eurasian Curlew	*Numenius arquata*	Critically Endangered
Red-necked Falcon	*Falco chicquera*	Critically

		Endangered
Rufous-vented Prinia	*Prinia burnesii nepalicola*	Critically Endangered
Swamp Francolin*	*Francolinus gularis*	Endangered
Indian Spotted Eagle*	*Aquila hastata*	Endangered
Lesser Adjutant*	*Leptoptilos javanicus*	Endangered
Yellow-breasted Bunting*	*Emberiza aureola*	Endangered
Yellow-wattled Lapwing	*Vanellus malarbaricus*	Endangered
Indian Courser	*Cursorius coromandelicus*	Endangered
Hooded Pitta	*Pitta sordida*	Endangered
Yellow-vented Warbler	*Phylloscopus cantator*	Endangered
Oriental Darter	*Anhinga melanogaster*	Vulnerable
Black-headed Ibis	*Threskiornis melanocephalus*	Vulnerable
Grey Francolin	*Francolinus pondicerianus*	Vulnerable
Red Jungle fowl	*Gallus gallus*	Vulnerable
Brown Wood Owl	*Strix leptogrammica*	Vulnerable
Himalayan Griffon	*Gyps himalayensis*	Vulnerable
Western Marsh Harrier	*Circus aeruginosus*	Vulnerable
Northern Harrier	*Circus cyaneus*	Vulnerable
Pied Harrier	*Circus melanoleucos*	Vulnerable
Asian Open bill	*Anastomus oscitans*	Vulnerable
Black Stork	*Ciconia nigra*	Vulnerable
Common Babbler	*Turdoides caudatus*	Vulnerable
Greater Necklaced Laughingthrush#	*Garrulax pectoralis*	Vulnerable

Note: *Birds considered to be at risk in Nepal and globally are marked with asterisk (*) {BCN and DNPWC 2011} and Birds listed as threatened in the Red Data Book on Birds of Nepal are marked with (#) in the above Table.*

Photo 5-1: Asian Openbill, a nationally threatened species
(Photo Source: Himalayan Nature)

Of the species recorded, birds larger than crows were divided into three broad categories depending on their size and wing-span. Medium Small or Medium Large (MS, ML), Large (L) and Extra Large (EL). All others (nearly all the passerine birds) were classed as small. In this regard, the most important bird species that needed special consideration were from Ciconidae family (Storks, Ibises and Spoonbills), Accipitridae (Vultures and large eagles), Gruidae (Cranes) and Otidae (Bengal Florican) (Table 5-2). Records of sensitive species from the study area included Bengal Florican (*Houbaropsis bengalensis)* from grassland areas near the Koshi River, White-rumped Vulture (*Gyps bengalensis)*, Himalayan Vulture (*G. himalayensis)*, Steppe Eagle (*Aquila nipalensis)*, Imperial Eagle (*A. heliaca)*, Indian Spotted Eagle (*A. hastata)*, Lesser Adjutant (*Leptoptilos javanicus)*, Black Stork (*Ciconia nigra)*, etc. Except Steppe Eagle, all other species are threatened at national level and most also on a global scale. All other birds classed as small have been considered less likely to have injuries compared to the bigger birds. The mitigation measures proposed at the end are specially considered to minimize threats to larger birds and it is envisioned that such measures will be automatically more beneficial to birds classed as small.

A recent study has revealed that Koshi area is home to nearly 10% of world's Bengal Florican populations (*Baral et al. 2013*). Of all the birds recorded in the area, this species may be the most vulnerable due to power lines effects, therefore special consideration must be done to ensure the continued survival of this species in good numbers. White-rumped Vulture, Lesser Adjutant and Indian Spotted Eagle are breeding resident in the area: and are all globally threatened. Most other larger species visit Koshi area during winter and their well being must be taken into account.

Table 5-2: List of larger birds recorded during the survey and considered to be at greater risk

English Name	*Scientific Name*	Size Category	Nepali Name
Himalayan Vulture	*Gyps himalayensis*	EL	हिमाली गिद्ध
Lesser Adjutant	*Leptoptilos javanicus*	EL	भुँडीफोर
White-rumped Vulture	*Gyps bengalensis*	L	डंगर गिद्ध
Steppe Eagle	*Aquila nipalensis*	L	गोमायु महाचील
Eastern Imperial Eagle	*Aquila heliaca*	L	रणमत्त महाचील
Bengal Florican	*Houbaropsis bengalensis*	M	खरमुजुर
Black Stork	*Ciconia nigra*	M	कालो गरूड

Data collected from modified Timed Species Counts have given baseline information on the richness, frequency and abundance of the birds in and around the affected areas, especially the three migration routes identified earlier. These data will be archived electronically and can be used for comparing changes in faunal assemblages at later stages.

Information on the bird casualties from the existing 132 kV TL that passes through the middle of the Reserve could not be obtained even after consultations with local bird experts and Reserve staff. Lack of systematic monitoring scheme and high predation rates for the dead birds possibly resulting from the casualties are two possible explanations behind this.

6 CONCLUSION AND RECOMMENDATIONS

The entire lowlands of Nepal are quite rich in terms of birdlife. The current survey has recorded 309 bird species especially along the three major bird rich areas; Kamala, Bagmati and Koshi river stretches. These areas were identified as the bird rich areas by an earlier work carried out for producing IEE (*ESSD 2011*). Bird species that are of great concern are medium to large sized birds of prey, storks and cranes, Bengal Florican (a bustard species), and large to medium-sized water birds. These birds have limited capacity for maneuvering. In addition the proposed high voltage lines may affect birds flying in poor weather which results in low visibility for birds and may also affect birds flying at night.

Current high voltage power line project is a national priority project. In this regard, the project has carefully proposed the alignment of high-voltage lines to avoid the protected areas and its buffer zones as well as avoiding Important Bird Areas (IBAs). However as identified in the IEE report, Koshi River crossings and its surrounding areas are crucial in terms of large flying birds (*ESSD 2011*). Kamala and Bagmati River crossings are also important migration paths for migratory birds although these paths are not used in the same scale as the Koshi River. The power lines pass through the north of Koshi Tappu Wildlife Reserve and its buffer zone and south of the Dharan Forests IBAs. IBAs are of international concern for conserving Nepal's dwindling bird populations (Baral and Inskipp 2005). The latter IBA alone has recorded a total of 485 bird species (*Baral 2005*) –many more than any other protected area of that size within Nepal and the south Asian region. A centre for grassland and wetland studies, Kosi Bird Observatory has been set up by Himalayan Nature recognizing the value of the site for bird and wildlife studies (*Himalayan Nature undated*).

Studies elsewhere have already documented that high voltage power lines pose serious threats to birdlife due to electrocution and other life threatening injuries (*Haas et al. 2005*). Modification in power lines structure, routes and other careful mitigation measures can reduce threats to birdlife.

During the construction phase, the clearance of ground vegetation and the associated disturbance including possible hunting are added threats to many species of conservation concern. It is therefore recommended to that adequate resources are invested to minimizing the threats that the current project will have on wildlife and especially on birds. The project should also invest in the compensation of the adverse impacts to birdlife by creating, restoring and managing habitats for birds and addressing issues that impact bird populations. Following, but not limited to, are some of the conservation measures proposed:

A. Modification to physical structure and added safety installments

Underground cabling is the safest way to avoid bird casualties. Unfortunately the cost implications of such schemes for high voltage wires are very high (*Raab et al. 2012*). Therefore in practice, high-voltage power lines are almost exclusively above ground (*Haas et al. 2005*). Areas that are critical habitat for IUCN red listed species should be avoided and pylons and other structures should be placed in areas that disturb the wildlife to minimum level. Placement of pylons and structural modification should be carried out to minimize impacts to bird life. Following text is an extract from the recommendations by *Haas et al. 2005*.

Because of their long suspended insulators, the risk of electrocution in high voltage power lines is low (Figure 6-1). Poles with suspended insulators are fairly safe provided the distance between a likely perch (cross-arm) to the energized parts (conductors) is at least 60 cm. Conductors should be spaced at least 140 cm apart. Hardware that is used to prevent arcing ("St. Elmo's fire" on both sides of the insulators) should not be used. In spite of doing this, fatalities by electrocution are reported: in humid weather, flocks of small birds can cause arcing; arcing can also be caused by the urination jet of large birds roosting on the cross-arm above the insulators.

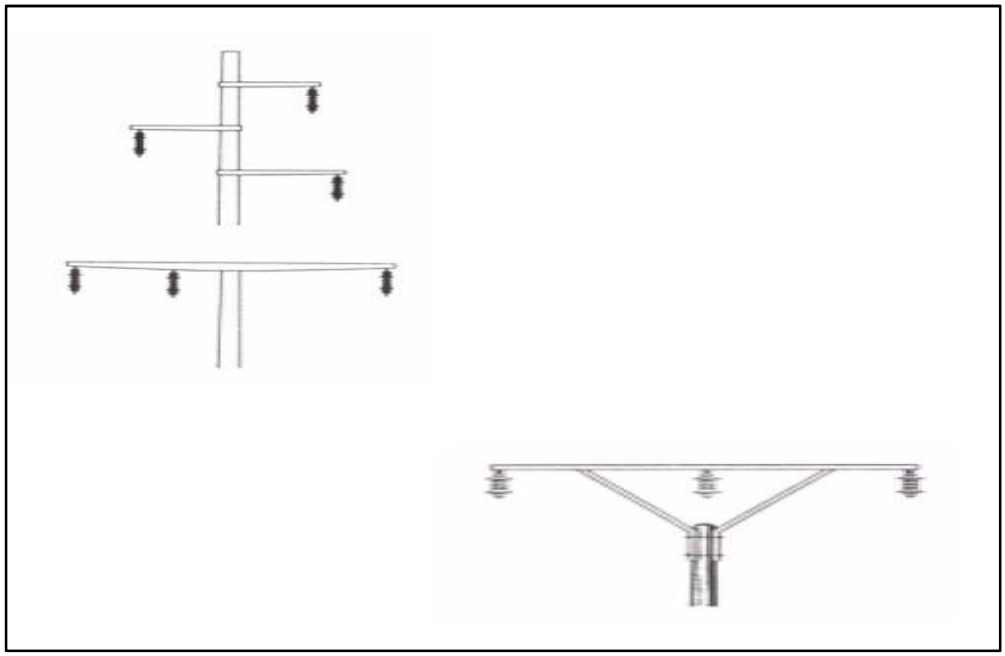

Figure 6-1: Power poles with suspended insulators

The latter can be avoided by suitably arranged bird rejecters above the insulators. In wet weather wooden poles with upright insulators can be a hazard as well as poles that are grounded. For mitigation, the top of armless poles has to be well above the uppermost wire (Figures 6-2, two images on the top). Mitigating electrocution effectively is possible either by treating poles (a) with insulating caps made of plastic for outdoor use 130cm in length or (b) insulating power lines with tubing 130cm in length. The conductors have to be spaced at a distance of at least 140cm. If this is not possible they should be insulated with tubing (Figures 6-2, bottom two images).

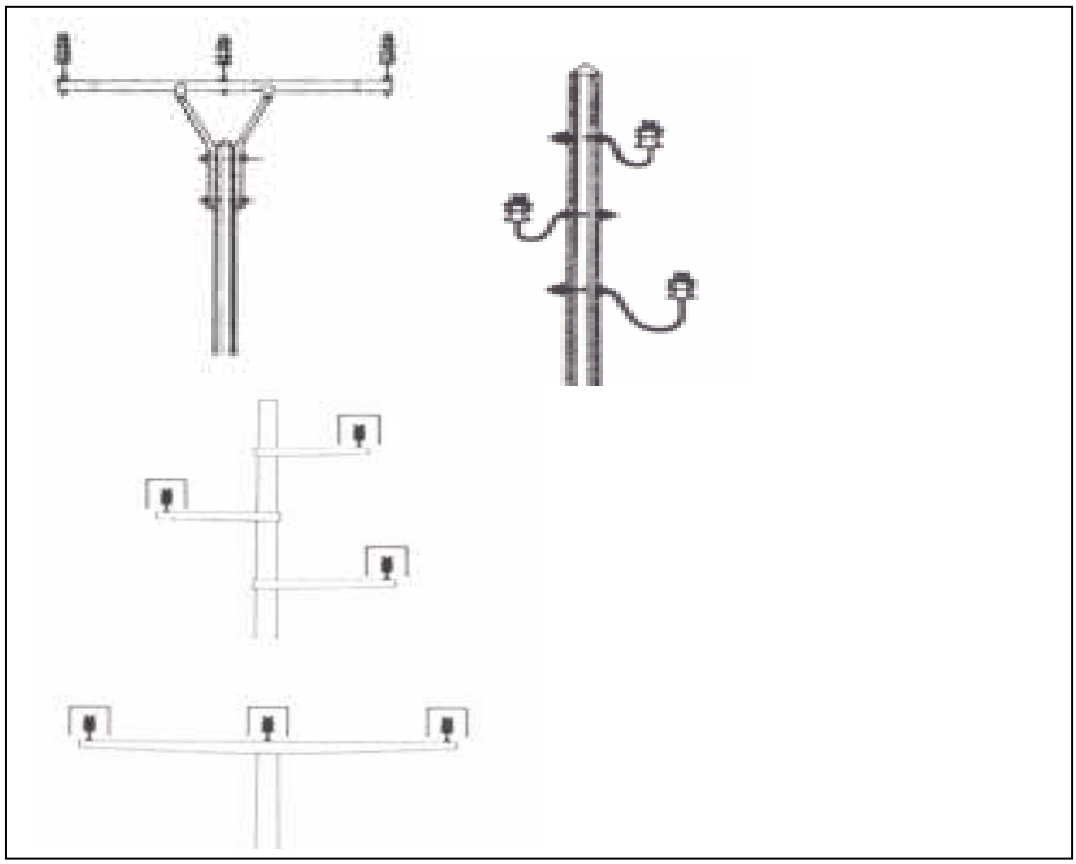

Figure 6-2: Power poles with upright insulators

Frequently over voltage reactors extend above the tops of terminal poles and tower stations. This hazard for birds can be avoided if the over voltage reactor is attached below the cross-arm and all down leading wires are insulated with tubing. On tower stations all contacts directly above the switch as well as between the switch and transformer should be treated likewise. Hardware used to prevent electrical arcs should not be used (Figure 6-3, image on left hand side).

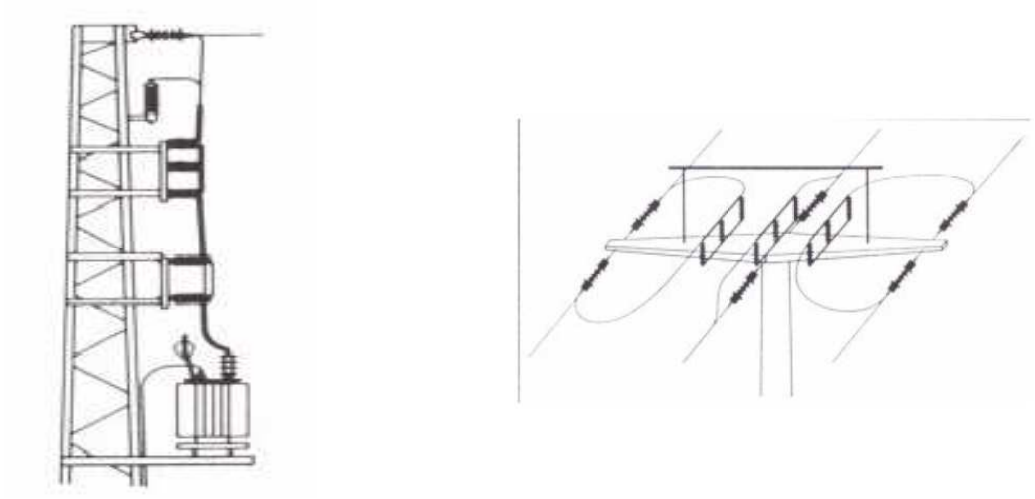

Figure 6-3: Suggested position of transformer (left image) and an extra insulated perch above the wires (right image)

The safest switch towers have their switches attached below the cross-arm (Figure 6-3, image on right hand side). Otherwise, mitigation measures are more complicated and do not provide the same high degree of safety for birds.

Death by collision with the cables is by far the largest peril posed by high-voltage power lines. Different tower constructions are in use and have different levels of risk. Tower constructions are not only driven by technical necessities, but also by national standards and regulations and in particular by design heritage and traditions of the different electric companies. Highest risks are posed by those power lines where the conductor cables are arranged at different heights (multi-level arrangements) and/or with neutral cables high above the conductor cables (Figures 6-4). Please note that the gap between the cables and the cross-arm is quite small.

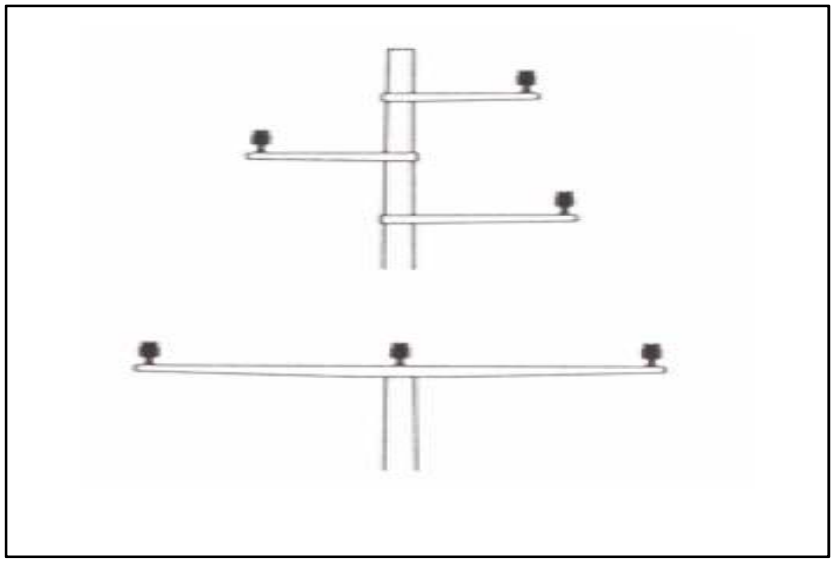

Figure 6-4: Power poles constructed on pre-stressed concrete or metal with upright insulators rank as the most dangerous of all types

Less dangerous constructions are in use, which have the conductor cables arranged at one height (single-level arrangement) and with the neutral cable only slightly higher. These constructions fulfill the same purpose as the high multi-level towers, but pose a significantly reduced risk. Even more favorable are those single-level power lines which use no neutral cable at all.

In more sensitive areas special constructions are installed on power lines:

- Single-level arrangement: multi-level towers are replaced by double poles;
- Markings for daylight using clearly-visible balls on the neutral cables;
- Warning lamps at night.

For bird safety on existing power lines and new ones which are still being erected with the neutral cable high above the conductors' cables, the thin neutral cable should be made

clearly visible by suitable markers. Such provisions can reduce collision accidents by 50 to 85 percent, as most collisions occur with the thin neutral cable.

As markers for better visibility of the neutral cable, vertically hanging black and white plastic oval flaps, which flash and rotate in the wind, have recently been shown to provide the most effective, but are not yet used. Often plastic spirals are used which can be dangerous in other ways. In any case, warning provisions are inevitably less effective than the removal of the neutral cable high above the conductor cables.

The durability of many bird-protection armatures must be significantly improved. Materials used must withstand all weather conditions and UV light for decades. Markers on high-voltage cables must be compatible with high electric fields and high heat input. In practical application, worn out protective caps or markers are nuisance. Until materials of acceptable long-term stability and durability for use on insulators and cables are available, construction measures must remain the preferred solution for new power lines.

B. Mitigation in sensitive areas

Bird migration in Nepal is not funneled through a channel like in many other countries where it takes place through a special migration corridor. Migrations of birds seem to take place along the entire length of the country. However, river corridors like Koshi, Bagmati and Kamala area are preferred routes of migration within the affected areas.

Of all the sites, the Koshi river corridor carries special conservation importance for birds. Besides Koshi, mitigation measures should be also carried out in Kamala and Bagmati River areas as well as at the crossings of the wires over the Rapti River, Makawanpur District.

Ramdhuni forest is known as a breeding ground of White-rumped Vulture. All pylons and wires that pass over/through the northern and eastern fringes of Ramdhuni forests therefore require special markers and modifications as these areas are frequently visited by vultures.

It is recommended that measures for line visibility (attachment of colored balls between, silhoutters to conductors, light reflecting bright objects and installation of cables electrically insulated with epoxy compound in key migratory areas AP 50-53 (Koshi River), 27-28 (Bagmati River) and 10-11 (Kamala River), AP start to AP0 (Rapti River, the first two APs starting from Hetauda station). In addition to these, vulture sensitive areas near Ramdhuni forests (AP 54-60) should also feature safety installations as above and modify the physical structure to minimize bird casualties.

C. Special environmental conservation briefing to workers during construction

The project workers should be given special briefing regarding environment and its various components including the bird life. Such briefing can be given by experts in the related field.

D. Environmental monitors during construction for controlling anthropogenic activities

Activity of the construction work should be monitored by bird expert. Feedback on monitoring should be seriously considered by the management. If necessary any defaulters should be fined, fired and legally challenged.

E. Monitoring avian fauna

Birds are known as very good indicators of environmental health, representing not only of their kind, but also the entire ecosystem. Therefore, monitoring of bird fauna along the already established transects in Bagmati, Kamala and Koshi rivers using same methodology should be carried out periodically. During construction and after one year of construction are recommended time frames. Results and recommendations from such studies should be fed back to the management and if necessary additional conservation measures should be adopted.

F. Investing in nature conservation

Hydro power stations exist because of a healthy nature that protects watersheds and snow fields. Policy makers with long-term vision will invest in nature for the sustenance of the nature but equally water sources and for energy derived from these natural sources. In this regard, compensation in the form of good conservation investments should be made for habitat loss and damage. Following nature conservation programs are suggested:

i) Habitat Restoration for Bengal Florican

Literature elsewhere suggest that bustard species is the most vulnerable among the birds (*Jenkins and Smallie 2009, Silva et al 2010, Raab et al. 2012*), it is imperative that this project invests resources for their conservation in Koshi and elsewhere in Nepal. Management and restoration of grasslands can be done within Koshi Tappu Wildlife Reserve and islands north and south of the Reserve. Within the Reserve, the work has to be implemented with support from the Koshi Tappu Wildlife Reserve. This project offers a good opportunity to the funders to demonstrate that development agencies also equally care for environmental conservation.

Photo 6-1: Bengal Florican, Critically threatened bird species

(Photo Source: Bed Bahadur Khadka)

ii) Conservation of vultures and large birds of prey

Koshi is renowned for large birds of prey –a high total of 52 species has been recorded in and around the Reserve only (*Baral 2005*). Vultures have breeding at Koshi Tappu and currently may have the second largest White-rumped Vulture colony in the country (*Himalayan Nature unpublished data*). A vulture restaurant is opened up in Ramdhuni forest, on the northwestern part close to the project area. Conservation of vultures in Koshi and elsewhere in Nepal should be also taken up as a priority by this project.

Photo 6-2: White-rumped Vulture, Critically threatened bird species
(Photo Source: Himalayan Nature)

iii) Conservation of large waders and waterfowls

Large waders and waterfowls are plentiful in Koshi area. By properly managing the mudflats, creating awareness, and conducting studies on them, their numbers can be stabilized or increased in Koshi. Species like Lesser Adjutant, Black Stork, cranes and other larger birds will benefit from this activity. These activities are best carried out in partnership with a non-profit or by hiring an expert with proven skills in the related fields.

Photo 6-3: Flock of Bar-headed Geese
(Photo Source: Bed Bahadur Khadka)

In addition to these recommendations, literature on bird casualties due to high voltage power lines and possible mitigation measures are available in various literatures (some listed below) and should be thoroughly consulted. A recent research paper has pointed out that the diverters and flappers kept for supporting birds in flight as ineffective in mitigating bustard collision risk and other birds (*Jenkins and Smallie 2009, Martin 2011*). Therefore maximum caution with implementation of proposed mitigation measures should be taken to execute this project so as to avoid or minimize bird casualties especially to Bengal Floricans.

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Cover Photo

Long-tailed Shrike (*Lanius schach)*, Photo Source: Himalayan Nature

ANNEX A

LIST OF BIRD EXPERTS CONSULTED

LIST OF BIRD EXPERTS CONSULTED

SN	Name	Position/Expertise	Organization
1	Dhan Bahadur Chaudhary	Coordinator	Jatayu Vulture Restaurant Management Committee, Pithauli
2	Dinesh Giri	Field Ornithologist	Himalayan Nature
3	Hathan Chaudhary	Field Ornithologist	Nepalese Ornithological Union
4	Hem Subedi	Field Ornithologist	Nepalese Ornithological Union
5	Laxman Prasad Poudyal	Ornithologist	Nepalese Ornithological Union
6	Suchit Basnet	Field Ornithologist	Nepalese Ornithological Union
7	Tika Ram Giri	Field Ornithologist	Bird Education Society
8	Tulsi Subedi	Raptor Biologist	Himalayan Nature

ANNEX B

LIST OF KNOWLEDGEABLE PEOPLE CONSULTED IN THE FIELD

LIST OF KNOWLEDGEABLE PEOPLE CONSULTED IN THE FIELD

SN	Name	Position/Expertise	Organization
1	Anil Gurung	Field Ornithologist	Bird Education Society
2	Arjun Karki	Community Forest Guard	Koshi Tappu Wildlife Reserve Buffer Zone
3	Basu Bidari	Field Ornithologist	Bird Education Society
4	Binod Acharya	Official	Koshi Bird Society
5	Ashok Kumar Ram	Conservation Officer	Koshi Tappu Wildlife Reserve
6	Dr. Vivekananda Jha	Field Manager-Koshi	Conservation and Sustainable Use of Wetlands in Nepal (CSUWN), GoN/UNDP
7	Dinesh Ghimire	Official	Koshi Bird Society
8	Jagannath Singh	Chief Conservation Officer	Parsa Wildlife Reserve, Aadhabar, Parsa
9	Bhagawan Raj Dahal	PhD Candidate on Forest and Farmland Birds	The Queensland University, Australia
10	PremThulungRai	Official	Koshi Bird Society
11	SanjibAcharya	Field Ornithologist	Kosi Bird Observatory
12	SrijanaKarki (Ms)	Trainee Birder	Kosi Bird Observatory
13	ParasBikram Singh	Ornithologist	National Trust for Nature Conservation
14	JagatGiri	Long serving staff	KoshiTappu Wildlife Reserve

ANNEX C

LIST OF PEOPLE CONSULTED AT NATIONAL AND INTERNATIONAL LEVELS

LIST OF PEOPLE CONSULTED AT NATIONAL LEVEL, KATHMANDU

SN	Name	Position/Expertise	Organization
1	Top BahadurKhatri	National Programme Manager	CSUWN

LIST OF PEOPLE CONSULTED AT INTERNATIONAL LEVEL

SN	Name	Expertise
1	Carol Inskipp	Ornithologist –all birds in general
2	Dr Charlotte Packham	UK: Bengal Florican
3	Markus Handschuh	Bengal Florican
4	Ian Barber	Bengal Florican
5	Dr Robert DeCandido	Birds of Prey including Vultures

ANNEX D

LIST OF BIRDS RECORDED IN THE STUDY AREA