Monitoring Protocol for Indicator Species

(Koshi Tappu Wildlife Reserve and Ghodaghodi Lake Area)

Government of Nepal
Ministry of Forests and Soil Conservation
Conservation and Sustainable Use of Wetlands in Nepal (CSUWN)
2011

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Conservation and Sustainable Use of Wetlands in Nepal (CSUWN)
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Cover Photographs: from right top: (1) Wild Rice
(2) Marsh Mugger Crocodile
(3) Cotton Pigmy Goose
from left top: (1) Wild Water Buffalo
(2) Swamp Francolin

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Government of Nepal
Ministry of Forests and Soil Conservation

Ph. 4211567
4211892
4211928
4211936
4211742
Fax. 4211862
4211868

P.O.Box No. 3987
Singha Durbar, Kathmandu

Ref. No.

Date :-

Few words

Nepal has put substantial efforts in managing its natural resources. As a result, 23.1% of the total land has been set aside as Protected Areas and 9 wetland sites designated as Ramsar sites of International Importance. This is a remarkable achievement for Nepal and a demonstration of importance accorded to biodiversity conservation. Conservation and Sustainable Use of Wetlands in Nepal (GoN/UNDP/GEF) is being implemented in two Ramsar sites; Koshi Tappu Wildlife Reserve and Ghodaghodi Lake Area since 2009. Biological Monitoring is a prerequisite to gauge and assess the health of the ecosystem in a given habitat. For this purpose, the Project has identified and established some indicator species for both of its sites. The scientific monitoring of these species is possible only with the use of a standard Protocol. Realizing the above need, the Project has developed monitoring Protocols for the identified species. These Protocols can be used by both the scientists as well as practitioners. I hope this Monitoring Protocol will be able to meet the above purpose and generate scientific information through regular monitoring of these species in both the Project sites on the long run.

At this juncture, I would like to express my special gratitude to the Ministry of Forests and Soil Conservation, Department of Forests, and Department of National Parks and Wildlife Conservation for their continued support and cooperation. I would like to take this opportunity to thank UNDP and GEF for providing the technical and financial support. I would also like to thank various conservation partners and individual experts who have contributed directly or indirectly towards realizing the above objective. I would like to acknowledge and thank the expertise of Dr. Hem Sagar Baral of Himalayan Nature for the preparation of this Protocol. Finally, I would like to thank the PMU team of CSUWN including Mr. Top B. Khatri, NPM for technical backstopping; Mr. Hari K. Uprety, WBS and Ms. Shalu Adhikari, GMCO for the technical inputs and consultation in bringing out the monitoring Protocol to this stage.

Dr. Annapurna Nand Das
Chief, Planning and Human Resources Division, MFSC
and
National Project Director, CSUWN

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Acronyms

CSUWN	Conservation and Sustainable Use of Wetland Nepal
DNPWC	Department of National Parks and Wildlife Conservation
DoF	Department of Forests
GLA	Ghodaghodi Lake Area
ha	Hectare
HN	Himalayan Nature
IUCN	International Union for the Conservation of Nature
KTWR	Koshi Tappu Wildlife Reserve
MFSC	Ministry of Forests and Soil Conservation
RIS	Ramsar Information Sheet
sp/spp	Species
UNDP	United Nations Development Programme
Verbally	Personal Communication

1. Introduction to the Protocol

An indicator species is any biological species whose presence, absence, or relative well being in a given environment is indicative of the health of its ecosystem as a whole. Numerous plant and animal species are used as indicator, along with organisms like lichens and fungi, in environmental ranging from mountain tops to the continental shelf. For instance, these species indicate an environmental conditions such as pollution, climate change and habitat degradation. These indicator species are among the most sensitive species in a region. Therefore, environmentalists and conservationists monitor these species to track the habitat condition.

Conservation and Sustainable Use of Wetlands in Nepal (CSUWN) had identified and established indicator species for its project sites as proposed in the Project Document. Although the Project Document had proposed two species, one for each of the site, additional species were recommended in 2009 based on the consultation of wildlife experts, conservationists, academia, ornithologists, DNPWC and DoF for both of its sites. The indicator species were added in order to avoid risk from stochastic events. Cotton Pigmy Goose *(Nettapus coromandelianus)*, Marsh Mugger Crocodile (*Crocodilus palustris)* and Wild Rice *(Oryza rufipogon)* were identified as Indicator Species for GLA while Wild Water Buffalo *(Bubalus babalis arnee)* and Swamp Francolin *(Francolinus gularis)* for KTWR. The presence of Cotton Pigmy Goose makes Ghodaghodi Lake a reason for being listed in Ramsar site while KTWR being the first Ramsar site of Nepal supports the last remaining population of wild water buffalo in Nepal. These species were also chosen on the basis of their threatened status at global level (1, 2 and 4), importance and uniqueness of the wetlands they are associated with, representativeness of the ecosystem, broader spectrum of taxa, and are relatively easy to monitor (CSUWN 2009).

The ecological methods for periodic monitoring of different indicator species in general are widely in use globally (Southwood 1978, Sutherland 1996). Monitoring guidelines of species for Protected Areas have been developed for mountain region (Tucker et al. 2005). Protocols for monitoring the flagship species such as tigers and rhinos have been developed recently but no protocols for the biological monitoring of species in wetland ecosystem have been developed. Since, wetlands being complex in nature and differ in many ways compared to the terrestrial ecosystems (Brönmark and Hansson 1998), the need for developing the protocol for biological monitoring of species has to be looked into a wider perspective.

With this monitoring protocol in place, these indicator species will be monitored during winter and summer every year by the project and its implementing partners. These species will be monitored in terms of their number, abundance and distribution in different habitats.

2. Brief on the Study Area

CSUWN is a joint undertaking of the Government of Nepal, Global Environment Facility and the United Nation Development Programme. Ministry of Forests and Soil Conservation is the executing agency while Department of National Parks & Wildlife Conservation and Department of Forests are the major partners. The duration of the project is from 2008 to 2012. The project is being implemented in two Ramsar sites namely KTWR and GLA since 2009.

2.1 Ghodaghodi Lake Area

GLA, 28°41'N 80°56'E includes all smaller wetlands close to Ghodaghodi lake including Nakhrod. This area is situated in the far southwestern terai and the main lake's southern tip is bordered by the East-West Highway. GLA forms an important wildlife corridor between the Terai and Siwalik hills. It is the habitat of 34 species of mammals, around 29 species of fish, over 200 species of birds (migratory & resident) representing nearly one quarter of the national avifauna, and 9 species of herpetofauna including 3 species of turtle. It is also a nesting area for large turtles and Marsh Mugger crocodile. It harbors an estimated 1% of South Asian biogeographic population of Cotton Pygmy-goose *Nettapus coromandelianus*. The area supports several globally threatened species including three species of endangered to critically endangered vultures as well as globally vulnerable species e.g. Indian Spotted Eagle *Aquila hastate* and Lesser Adjutant *Leptoptilos javanicus* (Baral 1992, Baral and Inskipp 2005).

It also supports a number of plant species including 388 vascular plants (Anon 2003). Native aquatic plant like; Water primrose and Bladderwort with unique physiological adaptation are found in this lake. Ghodaghodi Lake is surrounded by subtropical broadleaved trees such as Sal *Shorea robusta* and Saj or Asna *Terminalia alata*. Other tree species include Amala *Phyllanthus emblica*, Mitho Neem *Murraya koenigii*, Kyamun *Cleistocalyx operculata*, Bael *Aegle marmelos*, Karma *Adina cordifolia*, Kusum *Schleichera trijuga* etc. Small patches of Narkat *Phragmites karka* grow in the shallow area of the lake. In other lakes, for example Nakhrodi, Bainsha trees *Salix* spp. are abundant.

2.2 Koshi Tappu Wildlife Reserve

Koshi Tappu Wildlife Reserve (KTWR) was established in 1976 and spread over three districts of eastern Nepal along the flood plain of Koshi River. The flood plain is a complex mosaic of lotic and lentic ecosystem and characterized by grassy marshes, oxbow lakes, swamp lakes and many depressions which retain water throughout the year. It lies between 75 to 81 m above sea level. Including the buffer zone it covers an area of 348 km^2, however the core area is only 175km^2 and is in rectangular shape. The reserve is the first Ramsar site of the country which was enlisted on 17 December 1987. This area is managed under protected area system of the country.

Koshi Tappu provides habitat for 493 species of resident and migratory birds (Baral 2005, press releases). The area holds large populations of globally threatened Swamp Francolin and is home to nearly all the water birds recorded in this country. It also has the largest heronry in Nepal. Recently, an endemic subspecies of Rufous-vented Prinia *Prinia burnesii nepalicola*, was described from here (Baral *et al.* 2007, 2008). South Asian River Dolphin, Gharial, Marsh Mugger, Hog Deer, Smooth-coated Otter, Soft-shell Turtle and many other aquatic species are also found (Shah 1997). The reserve is the only remaining habitat of Asian Wild water Buffalo in Nepal, whose population is 219 according to 2009 census. The existing vegetation of the reserve consists of diverse physiographic types, which harbors 658 species of plants including submerged, aquatic, floating and tall reed grassland. The forest types include *Dalbergia-Acacia, Bombax* and the grassland includes *Typha, Vetivera, Phragmites, Saccharum* etc.

2.3 Presentation of Monitoring Protocols

Monitoring Protocols are study guidelines that explain how data are to be collected, manage, analyzed and reported, and are a key component of quality assurance for periodic monitoring of natural resources. Protocols are necessary to ensure that changes detected by monitoring actually occurring in nature and not simply a result of measurement taken by different people.

Data analysis has been briefly discussed to come up with the total number of individuals. Most of the data sheets provide space for recording different age groups e.g. Marsh Mugger, Cotton Pygmy Goose and Wild Buffalo. The total number of individuals is the total population. However, a distinction should be made between population and mature individuals. The latter is defined as the number of individuals known, estimated or inferred to be capable of reproduction. IUCN often uses the latter definition to assess species against threat categories. Swamp Francolin population count gives direct count figures on total population of mature individuals and also through formula extrapolates a maximum possible of the same.

Interpretation of the data should be carefully done. Comparison between years can give a quick view of population increase or decrease of the species. First of all, nature of the data and methods applied to collect should be compared. Methods may not be wrong but a direct comparison of data between results obtained using two different methods would be harmful. Comparison of data for several years (where available) should give information whether the species is undergoing cyclic population fluctuation or not. If the species' population at the particular place is known to fluctuate, data should be interpreted accordingly. Natural fluctuations vs induced fluctuations should also be identified. Usually the latter is of greater magnitude.

Monitoring protocols adopted here advice for a rigorous direct counting of individuals by direct observation except for Swamp Francolin. Swamp Francolin is difficult to sight but high vocal especially during, before and after the breeding period help to identify the species. From the data obtained population index can be also calculated by applying appropriate formula.

3. Monitoring Protocols for Indicator Species

3.1 Wild Rice *Oryza* spp.

Nepal has four species of wild rice that belong to Genus Oryza, *Oryza rufipogon* Griff., *O. nivara* Sharma & Shastry, *O. meyeriana var. granulata* (Nees & Arn. ex Watt) Duister. and *O. officinalis* Wall & Watt. Of which, 3 species, *Oryza rufipogon*. O. *nivara* and *O. officinalis* are wetland dependent.

Oryza rufipogon Griff. is a perennial tufted and scrambling grass with nodal tillering and wide spreading panicle, sometimes floating, lower part spongy. This is a common wild rice species that occurs in deep water lakes, marshes, swamps, fish ponds, along roadsides ditches and canals and at the edge or inside paddy field in tropical and subtropical zones at 100-1500 m. This species has been recorded from Kailali, Banke, Bardiya, Surkhet, Dang districts in west Nepal. Kapilvastu, Rupandehi, Kaski, Palpa, Dhanusa, Saptari districts in central Nepal and Morang district in east Nepal (Siwakoti & Tiwari, 2007). The patches of wild rice occurs both in Ghodaghodi lake area and Koshi Tappu (south west near Kankalimai temple). Wild rice is a source of genetic diversity, resistance to diseases and pests as well as tolerance for some adverse soil conditions. *O. rufipogon* is reported to be resistance to 6 Philippine race of bacterial blight (Ikeda *et al.*, 1990). It has also traits for principal source of cytoplasmic content of male sterility used in the hybrid rice program (Lin and Yuan, 1980), also tolerant to salinity. In addition, it also has cultural value, and used for Hindu ceremonies called Rishi Panchami and Tinchhatthi in August – September. During the festival, there is a tradition that women eat rice from non ploughed land. The Wild Rice is known by different names in Nepal such as: Tinni, Auri dhan, Nabo dhan, Chhita, Chinni dhan, Jangali dhan, Jharanga, Jharuwa dhan, etc. The grains do not mature at one time, some grains mature earlier and fall down, and so harvesting of grains is a tedious job. In Nepal, mostly the rice is used as grass for fodder before flowering. Those involve in wild rice harvesting tie the panicles in a bundle immediately after grains starts to develop.

Areas under wild rice were mapped in 2009 within GLA. Ghodaghodi, Tendi and Tinchatiya were found to harbor wild rice which occupy a total area of 3.6 ha (CSUWN, 2010).

Materials and methods: There is no such methodology or protocol developed to monitor wild rice systematically. The most important variables to measure would be location, habitat, species, plant population/patch size, phenology, etc.
In Nepal, most of the wetlands are quite small that contains wild patch of rice. In such cases, the total sampling of the wild rice area is recommended. This would entail visiting the site and recording wild rice area and measuring different variables mentioned above and given in the sample form.

Fixed point photography is recommended from a suitable site showing maximum coverage and important features of the species.

Data analysis: The analysis on wild rice data would be quite descriptive and use of MS Excel would suffice the purpose. The main variables and their status in different seasons and between years should be noted down. Pattern of change in phenology in relation to season/different years can be found out by comparing different sheets.

Frequency of surveys: Two times a year, one during dry period (Dec-Feb) where only tufts/clumps of dead rice could be located, other during monsoon period (August to October) where rice can be seen. This will allow to compare the status of wild rice in two different seasons.

Sheet 1: Wild Rice Record Form

Wild Rice Record Form

Name of Wetland: Date:

Overall surrounding habitat: Time:

Observer: Weather:

Photograph taken:

Species	Phenology (seed / seedling / juvenile / immature / virginile / reproductive / subsenile / senile)	No. of Spots	Average clumps per spot / size of clumps	Nearest next wild rice habitat	Remarks

Threats / conservation / remarks

3.2 Marsh Mugger Crocodile (Broad-snouted Crocodile) *Crocodylus palustris*

The mugger is a highly social species that communicates through visual and audible signals, has a dominance hierarchy and exhibits territoriality. Males thrash their tails and lift their snouts to establish territories and gain dominance before courtship and mating. One month after mating, between February and April, the female lays 10 – 48 eggs in a nest site that she returns to every year for much of her life. After 55 – 75 days of incubation, the eggs hatch and the hatchlings are carried to water by the female and sometimes even the male. The sex of the hatchlings is determined by the temperature at which they incubate. Males result from eggs incubated at higher temperature and females result from eggs incubated at low temperature or below 32.5 ºC (Crocodile Specialist Group 1996). The juvenile muggers remain in the territory for up to a year. They reach sexual maturity at six years. Muggers consume crustaceans, insects and small fish when young, and move on to a diet of fish, frogs, crustaceans, birds, monkeys and squirrels in adulthood. The species is found in countries like Iran, Pakistan, India, Nepal, Sri Lanka and Bhutan. It is perhaps extirpated from Bangladesh and may occur in few Indo-Chinese countries. In Nepal, it is found throughout the lowlands where suitable habitat remains and hunting is minimal (Shah and Tiwari 2005).

Twelve individuals of the species were recorded in GLA during 2010.

Materials and methods: A pair of binoculars is necessary to make close observation of the individuals. All major wetlands in GLA should be visited to record presence/absence of Marsh Mugger. Survey should then concentrate on areas that show evidences of the presence of species. A fixed route should be followed to check suitable basking sites both on the land and in water and to find out sites that have been used by crocodiles. The whole counting of the individuals should be done at the same time to avoid double counting.

Most past surveys have established favourite hunt of the crocodiles in the lake area, therefore these sites should be given the first priority. Besides, any new sites suspected to occur should also be surveyed. Sunny days in winter months are best for counting this species and therefore ,this should be given high priority. Summer survey usually result less sightings of crocodiles because of their shyness and increased outside temperature. If necessary this should be done between the mid May and end of June before the onset of monsoon when crocodiles may start venturing away from the permanent wetland areas. However, recommended time to maximize the count of the Marsh Mugger would be during winter months. Approximate length of the crocodile should be noted which will give indication of age class. The age classes can be categorized from the length of the animal as young (<2 years), sub-adult and adult (Karan Bahadur Shah *verbally* 2010).

Data analysis: The most important analysis here would be on the number of basking spots, breeding sites if confirmed, size/age class/maturity of the crocodile together with their population. Most of these analyses can be carried out simply by the use of MS Excel. The maximum count of a day should be added to come up with the number of crocodiles.

The density of marsh mugger can be calculated by dividing the total number of crocodiles seen (excluding hatchling numbers) by the total area surveyed.

Frequency of surveys: One time survey with at least 7 sample size during dry months (December-March).

Sheet 2: Marsh Mugger Record Form

Marsh Mugger Record Form

Name of the Wetland:

Equipment:

Area surveyed:

Observer:

GPS of the site:

Location Date/Time/Weather	Distance from observer	Approx. Length	Age Group*	In water	On Bank	Half in water & Half in land	Remarks (including observation on habits, nests etc.)

*Age group: hatchling <.5m, young <1m, subadult >1m to <1.5m, adult (five feet or >1.5m), EO: Eyes only seen

3.3 Swamp Francolin *Francolinus gularis*

Swamp Francolin is endemic to the Ganges and Brahmaputra river basins, from the terai of western Nepal through Uttar Pradesh, Bihar, West Bengal, Sikkim, Assam, and Arunachal Pradesh, northern India, to Chittagong, the Chittagong Hill Tracts and the Sundarbans, Bangladesh (Ali and Ripley 1987).

In Nepal, where its range covers 2,400 km² with an area of occupancy of 330 km², the population is estimated at <500 birds and perhaps gradually declining. Swamp Francolin is globally threatened species and listed in IUCN Threatened Species List as Vulnerable (BirdLife International 2009a).

It is resident in tall, wet, natural grasslands, particularly those dominated by *Phragmites*, *Arundo*, *Saccharum* and *Narenga*, and also occurs (at lower densities) in wet agricultural areas dominated by sugarcane and paddy interspersed with natural vegetation. It is predominantly known from the lowlands (generally <250 m), but moves to slightly higher altitudes during periods of high flood. Its range size is small compared with other Galliformes, offering hope for the species' conservation. A matrix of habitat including some agricultural areas is capable of supporting the species, however in human modified areas retention of some natural grassland habitat associated with wet areas appears to be critical.

Most remaining habitat within its range is subject to intense pressures from drainage for agriculture, human encroachment, fire, grass harvesting, grazing by domestic stock (especially during chick rearing), commercial forestry plantations and dam and irrigation schemes. Hunting and trapping the species for sport (cock fighting) and food purpose pose serious concerns. Agricultural pesticides may affect its numbers, either through direct mortality or reduction in potential food sources (invertebrates), and poisoning of wetlands for fishing is a threat reported

from Nepal. Drying out of swampy areas during the breeding season represents a threat that may become more severe owing to climate change.

Although formerly distributed throughout lowland Nepal, now the species is restricted bird can be found only in Koshi Tappu and Suklaphanta Wildlife Reserves (Baral 1998, Inskipp and Inskipp 1991). The last remaining populations of Swamp Francolin in Chitwan and Bardia have been extirpated only 2 to 3 decades ago (Baral 1998). Koshi Tappu holds one of the largest population of the bird in the world giving Nepal an international responsibility for its conservation and management. A figure given by BirdLife International on its world population as 10000 to 19999 (BirdLife International 2009a) may be an overestimate.
A total of 36 pairs of the species were recorded a long the eastern embankment of Koshi River during May 2010.

Materials and methods: Systematic surveys have been carried out on the species since the mid 1990s and a number of studies have been done since then (Baral 1998, Dahal 2000, 2001, Shakya *et al.* 2001, Singh 2007, Dahal *et al.* 2009). Dahal *et al.* (2009) have recommended the use of a standard methodology for Swamp Francolin survey for enabling comparison between years and surveys done by different researchers.

Based on the information presented by Dahal *et al.* (2009) who studied best survey techniques for surveying Swamp Francolin at Koshi Tappu and based on calling (territorial) male birds, is the point count method to be undertaken during the breeding season (February-March) and in the early morning (05h45– 07h15). This method recorded the highest number of birds without double-counting and since then it has been recommended for surveying Swamp Francolin at Koshi Tappu. Similarly same study has recommended study of habitats which has been in practice for a number of years in Koshi Tappu and is presented here with slight modifications.

CSUWN has now permanently established 22 point count survey stations to cover the entire length of the Koshi River mainly on the eastern dyke. These are situated along the dyke at 750 m from the next nearest point, on top of the bunds so that there were two points in each of the 1.5-km line transects. The coverage of the points will depend on the number of community members available to man the stations for 90 minutes. Ideally in total, each point should be surveyed six times per season. When a bird is heard calling, the distance and direction from the observer should be estimated, its activity and details of habitat use should be recorded (see appendices). The direction and distance of each calling bird with noting down the time of call on each arrow. The observer should be able to ensure that calling birds are not double-counted.

Habitat and disturbance variables: Detailed habitat information should be collected by randomly placing ten quadrants of size 10m x 10m within the area of the reserve to the west of, and adjacent to, each of the 20 count stations, giving a total of 60 habitat sampling points. These should be established by dividing each 1.5km transect into two 0.75km sections, initially by walking for two minutes into the grassland perpendicular to the embankment, where the first was established, then for two minutes due south for the second, two minutes east for the third, etc. The different topography and ease of access through the vegetation means that the quadrants could not be placed in a regular square. This process should be repeated for each 0.75km section. When a bird is heard calling its approximate location should be estimated and a broad description of vegetation (e.g. woodland, grassland, mixed, etc) recorded, together with approximate plant cover and dominant plant species. The plants should be either identified in situ with assistance from local people or with help from an experienced field botanist. Additionally, during each point count survey, the number of people and livestock (principally cattle) present within 150 m of each transect or point count location and to the west of the embankment, should be counted. Any additional people or livestock that enter the survey area during the course of the survey should be also noted.

Frequency of surveys: It is recommended that the survey should be done two times in a year, one during dry months (Dec-Feb), and an additional one in Summer (mid-May-June). This will give ample knowledge about bird's biology and its population.

Data analysis: Habitat data should be analysed as described in Dahal *et al.* 2009, first categorizing the habitat information broadly into four based on the dominant plant species and amount of water present. The four categories are Woodland, where greater than 50% of land cover is trees; Woodland-Grassland mixture, where less than 50% of land cover is trees and these areas are interspersed with grasses; Wet Grassland, where grasses dominate, no trees are present and the area contains water; and Dry Grassland, where grasses dominate, no trees are present and the area contains no water. A measure of habitat use can be derived by calculating the proportions of all Swamp Francolin records that are present within each of the four habitat categories, at each point count survey and in each season.

The population (mature individuals) of Swamp Francolin can be calculated by adding the maximum count obtained simultaneously. For example, if all the sites were covered say two times only: the first count gave a figure of 33 and the second count gave a figure of 36 calls, then the latter should be taken. Total mature individuals can be calculated simply multiplying the total calls viz N = calls x 2. This gives the minimum number of breeding adults in the study area.

The estimate on maximum number can be derived using following equation (Bibby *et al.* 2000) and adding the upper limit after correction.

$$N = nA/a$$

Where N= the estimation of the species population status (calls heard), A= the area of the study region
a= the area of the sampled sections where bird populations were actually heard
n= the number of birds counted in the sampled sections

The confidence limits on this population estimation are calculated as follows (suggested to use only the upper limit for giving population range).

upper limit = n+(mean+1.96 x SE) x (A-a)
lower limit= n-(mean + 1.96 x SE) x (A-a)

Density (D) of the birds within the study area can be calculated using the following formula:

$$D = \frac{\text{Number of birds}}{2 \times L \times W}$$

where, L = Total length of transect (in metres) and W = width of transect on one side. While calculating the density figure intended to calculate the entire reserve population, the number of birds should be kept as average rather than maximum.

Sheet 3A. Swamp Francolin: Vegetation Survey Data Sheet

Swamp Francolin Monitoring

Vegetation Survey Data Sheet

Station No.: Date:

Transect No.: Weather:

Quadrat No.:

Surveyers:

S.N.	Local Name	No.	Old	Young	Sapling	Coverage	
Tree Data Sheet (10m)							
Shrub Data Sheet (10m)							
Herb Data Sheet (1m)							

Sheet 3B. Swamp Francolin Survey Data Sheet

Swamp Francolin Monitoring

Swamp Francolin Survey Data Sheet

Observer: Date:

Name: Start Time:

Weather:     End Time:

Transect No.:

Station No.:

N	
W	E
S	

Habitat Features

3.4 Cotton Pygmy Goose *Nettapus coromandelianus*

It is one of the smallest waterfowls on earth, at as little as 160 g (5.5 oz) and 26 cm (10.5 in). Male in breeding plumage is glossy blackish green crown, with white head, neck, and underparts; a prominent black collar and white wing-bar. These birds have rounded head and short legs.

It is found on all still freshwater lakes (jheels), rain-filled ditches, inundated paddy fields, irrigation canals/ tanks [reservoirs], etc (Ali and Ripley 1987, Inskipp and Inskipp 1991). It feeds mostly on seeds and vegetable matter, especially water lilies; also insects, crustaceans, etc.

It is largely resident, apart from dispersion in the wet season. Breeding season is mainly from July to September depending very much on SouthWest Monsoon pattern. The nest is a natural hollow in a tree-trunk standing in or near water, sometimes lined with grass, rubbish and feathers. Eggs- 6 to 12, ivory white. This species is found in south and southeast Asia including parts of Papua New Guinea and south to northern Australia (BirdLife International 2009b). Currently the species is considered to be Least Concern at global scale.
GLA harbors 1% South Asian population of this species. New breeding site was recorded for the first time in GLA. As it was said that the breeding is restricted to only Pokhara Valley of Nepal. A total of 188 individuals were recorded in 2010 at GLA.

Materials and methods: A pair of binoculars and where resources are present a telescope is also needed. All major wetlands in GLA should be visited to record presence/absence of Cotton Pygmy Goose. Survey should then concentrate on areas that show the evidences of the species. A fixed route should be followed to count numbers of Cotton Pygmy Goose.

Most past surveys have established concentration of Cotton Pygmy Goose in the main lake i.e, the Ghodaghodi. Therefore, three permanent count stations should be marked on the bank of the lake that are easily accessible by the counters. On the first day, these stations should be attended simultaneously by three counters for the entire day. On the second day, only the hour when maximum counts have been made should be chosen. The time spent on one station should be at least one hour but should be kept within the flexibility of 3 hours. At least two counts should be collected per station and the maximum count should be taken as the number of the birds nearing to the true population of the geese.

Frequency of surveys: Two times a year, one during dry months (Dec-Feb), other in Summer (mid-May-June).

Data analysis: The maximum count of any time should be projected as the total population of the bird. Average population can be calculated by adding individual counts of each day without repeating the same count and dividing the total by number of days. During winter count, sex discrimination is difficult therefore should not be included in the analysis.

Sheet 4. Cotton Pygmy Goose Record Form

Cotton Pygmy Goose Record Form

Name of Wetland: Habitat information:

GPS:

Equipment: Observer:

Date/Location/Time	Total	Adult male	Adult female	Sub adult	Activity	Weather/Remarks

3.5 Wild Water Buffalo *Bubalus arnee*

Remnant populations of Wild Water Buffalo are thought to occur at single sites in each of southern Nepal, southern Bhutan, western Thailand, eastern Cambodia, and northern Myanmar, and at several sites in India.

The total world population of Wild Water Buffalo is almost certainly less than 4,000 individuals. However, these figures are little more than informed guesses, since any assessment of buffalo numbers is hampered by the difficulty of distinguishing between free-ranging domestic buffaloes, feral buffaloes, truly wild buffaloes, and hybrids between wild and other buffaloes. Individuals of Wild Water Buffalo and Domestic Water Buffalo are difficult to distinguish in some areas, and some domestic populations may be very closely related to (perhaps identical to) Wild Water Buffalo. There are few detailed analyses of the purity of the presumed remaining Wild Water Buffalo populations, nor in many cases is it obvious how such an assessment would be made. Some feral and domestic populations may have conservation significance, retaining some of the genetic stock of the wild populations for that particular region. This may be especially true in Indochina due to traditional methods of Water Buffalo husbandry (Hedges *et al.* 2010).

Wild Buffaloes are tied to the availability of water. Historically, their preferred habitats were low-lying alluvial grasslands and their surroundings with riparian forests and woodlands also used (Prater1971).

Little has been published on the diet of wild (or feral) Water Buffaloes. They are probably grazers by preference, feeding mainly on grasses when available, but they also eat herbs, fruits, and bark as well as browsing trees and shrubs. Shrestha (1981) provided a little information about the diet in Nepal. Wild Buffalo also feeds on crops, including rice, sugarcane, and jute, sometimes causing considerable damage (Lekagul and McNeely 1977).

Wild Water Buffalo can be both diurnal and nocturnal. Typically, it forms maternal groups of loosely structured herds, typically containing 10–20, sometimes up to 100, individuals, year round. Adult males form bachelor herds of up to 10 individuals, with older males often solitary. The species exhibits a polygynous mating system, with females typically giving birth to single offspring, although twins are possible. It is a seasonal breeder in most of its range, typically in October and November, however, some populations breed all year round. Its gestation lasts 10-11 months, with an interbirth interval of one year. Age at sexual maturity is 18 months for males, and three years for females. The maximum known lifespan is 25 years in the wild (Hedges *et al.* 2010).

Major Threats:

The most important threats to Wild Water Buffalo are interbreeding with feral and domestic buffalo, hunting, and habitat loss/degradation (Hedges *et al.* 2010). Diseases and parasites (transmitted by domestic livestock) and interspecies competition for food and water between wild buffalo and domestic stock are also serious threats. Most of the species' in the lowland habitat has been lost to agriculture, and what remains is highly fragmented. The invasive *Mikania micrantha* also potentially threatens wetlands in the South Asian range of Wild Water Buffaloes. Hydropower development and resulting changes in water flow and level conditions downstream also threaten the ecological maintenance of floodplain areas which is the prime habitat of the species.

Disease epidemics spreading from domestic livestock presumably pose a threat, especially given the close overlap of Wild Water Buffalo populations and domestic livestock in South Asia, the high densities especially of the latter, and the small and localised nature of Wild Water Buffalo populations.

Wild Water Buffalo is included in CITES under Appendix III (Nepal) and is legally protected. Koshi Tappu Wildlife Reserve holds the only population in Nepal, where as 219 individuals (DNPWC/KTWR/CSUWN 2009) has been counted.

There is an urgent need to evaluate the integrity of wild-living buffalo populations, including those generally taken as being truly wild and those living as wild animals within the native range, using habitat typical of wild animals, and which have lived outside even occasional husbandry for a long time, in order to determine populations of conservation priority. This should involve the assessment of the relationship of such populations in the context of obvious domestic lineages, especially those in close proximity to wild populations. Such an

approach should use multiple genetic markers in addition to an assessment of morphological characteristics (Hedges *et al.* 2010).

Materials and methods: For the count of Wild Buffalo, one needs to cover larger areas. In KTWR, domestic elephants can be used in the interior parts of the reserve. Some blocks can be counted on foot depending upon the changes brought about by the Koshi river. A pair of binoculars is necessary to do the head count and if possible a good telescope is needed for the observer to be able to correctly sex and age the buffaloes. Sex and age identification are very important to find out the current status of the animal (Nilamber Mishra and Ashok Ram *verbally* 2010).

The area of Koshi Tappu should be divided into blocks and at least two experienced groups should be covering different blocks simultaneously. Under the current methodology the reserve is divided into four to six blocks for counting. We recommend that this practice should be carried on for being able to compare data between years. Vegetation notes should be kept as broadly as possible on remarks or vegetation columns. Head counts, sexing and aging should be done as accurately as possible.

Frequency of surveys: One time of year (March-May).

Data analysis: The total counts of all the blocks should be added and projected as total population of the species seen as a result of direct count method. Relationship with habitats can be shown in percentage figure stating the number of animals and habitat utilisation. Examples include Riverine forest was used by 20 individuals (which is 10% of the total population recorded), grasslands were used by 120 individuals (60 % of the total population) etc. Breeding adults (mature individuals) vs calves/non-producing animals should also be given in figures or in a table with actual numbers.

The density of the species can be calculated as number of animals seen divided by area of the block surveyed or transect area (where area = transect length x transect width).

For example: Data may come from six different blocks, as follows:

Block	1	2	3	4	.....	6	Mean	Variance
Density	11.2	6.9	4.8	16.8	.....	6.4	10.4	±16.3

The variance should be transformed to the standard deviation (SD), standard error (SE) and confidence limit (CL, 95%) as follows:

Variance =16.3, SD= (16.3)½=4.03, SE= 4.03/23½=0.84

Confidence Limits= SE x t value =SE x 2.07 = ± 1.74

The mean density and confidence limits for the protected area is thus 10.4± 1.74 km². For a protected area of 175 km² this will give an estimated total number of animals of 1820 ± 305 or between 1515 and 2125 animals.

Sheet 5. Wild Buffalo Record Form

Arna Monitoring Form

Data Sheet:

Date:

Data recorded by:

Time of record:

Ambient temperature:

No of group members:

Name of group:

Weather condition:

Name of site	GPS Location		Group Pattern	Adult M	Adult F	Sub Adult	2nd Year Calves	1st Year Calves	Backcrossed	Habitat type (TG, SB, SG, RF)	Habitat Condition	Remarks
	Latitude	Longitude	(Herd / Single)						(Ad F, SA M/F, calves)			(Time of Sightings)

TG: Tall Grassland, SG: Short, Open Grassland, SB: Sand Bank, RF: Riverine Forest

4. Conclusion

The purpose of monitoring is to find out the status of the particular species which in turn will reflect the overall health of the ecosystem. Monitoring results also provide important information for ecological restoration to increase or maintain the population of the species. Any restoration work within the project sites may first need to know the carrying capacity of the site for the species. This requires a study on the optimum population level for these indicator species in different sites.

The proposed monitoring protocols to the best of our knowledge will get the vital information needed for maintaining the status and population of the species when threatened or numbers start plummeting due to various reasons. The forms have been kept simple in the view that a complicated form may be very tedious to work on in the field. Also from participatory monitoring purpose some basic training to local people can enable them carry out the exercises. Very often complicated forms with data on too many variables are duplicating the information. Therefore, only the vital data collection is considered here.

Monitoring protocols are dynamic and they will continue to evolve and refine in the future. In circumstances other than normal population monitoring, new forms and new methods need to be designed to fulfill the particular need of the researchers. In future, it needs to be revised to incorporate some other important issues not included/understood at this stage. While doing so, the essence of the early format should be continued that will enable comparison of data between years and the new information from the new variables. Also, new technologies are being invented every day, therefore technology that make our work easy should also be incorporated in these forms.

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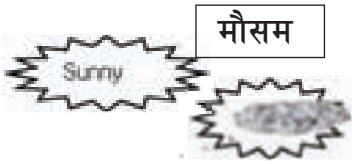
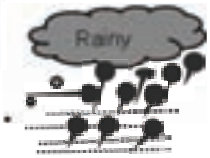
वनस्पति सर्वेक्षण फाराम





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क्वाड्रान्ट नं.

सर्वेक्षक :

शुरू समय :

समाप्त समयः

मितिः

क्र.सं.	स्थानीय नाम	संख्या	रूख	खम्बा	लाथ्रा	ढाकिएको क्षेत्र	काटिएको क्षेत्र
रूख तथ्याङ्क फाराम							
झाडी तथ्याङ्क फाराम							
जडिबुटी तथ्याङ्क फाराम							

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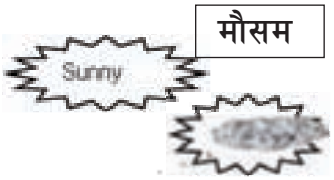

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उत्तर

पश्चिम	पूर्व
वासस्थानको विशेषता	दक्षिण

For further information, please write to:
Ministry of Forests and Soil Conservation
Conservation and Sustainable Use of Wetlands in Nepal (CSUWN)
Training Section Building, Second Floor, Forestry Complex
Babarmahal, Kathmandu
Phone: 977-1-4226230/4229669
Fax: 977-1-4229670
Email: info@wetlands.org.np
URL: www.wetlands.org.np